RC HELICOPTERS

The Pilot's Essentials

P. LAWRENCE

RC Helicopters

The Pilot's Essentials

Written By
P. Lawrence

Index

Disclaimer

The information in this book is designed to offer helpful basic information, tips, and ideas on the radio controlled (RC) helicopter hobby to our readers. It is provided with realization that the author and publisher are not engaged in rendering any kind of legal, advice or professional flight instruction service.

While the best human efforts have been utilized in writing and preparing all the contents of this book, the author and publisher make no warranties or representation of any sort and are not liable in any way with regards to the completeness or accuracy of the contents. The author and publisher specifically refuse to claim any implied warranties of fitness of use or accuracy or merchantability for a specific purpose.

Neither the publisher nor the author shall be made liable to any individual or corporate entity with regards to any loss of property, loss of life, personal injury or accidental or consequential damages that may have been caused or that is alleged to be caused, indirectly or directly by the ideas, tips, information, procedures or processes contained herein.

Therefore, no kind of warranty is allowed to be made or extended by any seller or sales representative or in any written sales materials. Each brand, model, type and size of helicopter and pilot are unique and the ideas, advice, tips and information contained in this book may not be appropriate for your own situation. Hence, you should also seek for the services and advice of a competent and experienced professional RC helicopter flight instructor before you start to fly your RC model helicopter or to repair, service, or make any adjustments to it. The reader should cross check with manufacturer manuals when in doubt.

All references provided are strictly for informational purposes; they are not intended as an endorsement of any sources or websites.

Terms of Use

Thank you for buying this book. By buying this book, you have accepted to abide by its terms of use. So please take time to read them thoroughly.

You may only use this book as permitted by law including all copyright and intellectual property rights laws. Using this book does not concede the ownership of the intellectual property rights in the book or the content thereof. You may not make use of any of the content of this book without obtaining written permission from the author and publisher. These terms do not permit you to copy and use any form of branding used in this book. Do not obscure or remove or alter any of the legal notices included in this book.

This book is intended to introduce you to the RC helicopter hobby and serve as a concise reference material. You should use this book in conjunction with a detailed flight instruction manual, or some form of professional flight instruction. You are responsible for the outcome and consequences of using the information and instructions given in this book.

The author and publisher give you a personal, global, non-exclusive and non-assignable right to use this book for personal use only in the manner permitted by this terms. You are not allowed to copy, put in any retrieval system, adjust, modify, sell, distribute or lease any part of this book or its entire contents without the written permission of the author and publisher.

Neither the author nor publisher makes any specific promises about the outcome of using the content in this book. For instance, we do not make any type of commitment about the content of the book, its value, availability, reliability or ability to satisfy your needs. This book is provided “as is”. All warranties are excluded. So you use it at your own risk.

Safety Disclaimer

While all necessary precautions have been taken by the author to provide the reader with precise, accurate, useful and up to date information, it is recommended that you should use your discretion before taking any decisions based on the information supplied in this book. RC helicopters and their associated accessories are not casual toys. Therefore, you should cross-check every instruction or advice with a professional helicopter flight instructor before making any decision on them.

The author and publisher hereby present the information in this book solely for educational and reference purposes. We are not providing it as a legal or professional advice. Therefore, the author and publisher do not provide any safety warranties of any type. The author and publisher do not accept any liabilities of any sort with regards to the safety or security implications of the contents. The author and publisher specifically absolve themselves of any claim or implied warranties of safety or the fitness of the contents for a specific purpose. Neither the author nor publisher shall be held responsible or liable to anybody or corporate entity with regard any loss of life, injury or damage to property that is caused or alleged to be caused, indirectly or directly by the information, procedures or advice contained herein.

Therefore, no form of warranty is made or should be made or extended by any designated sales representative or as part of related sales documents. Since each RC helicopter is unique, all users or pilots or persons who read the contents of this book and intend to fly an RC helicopter should also read all the operational and service manuals for their helicopter and consult a qualified and experienced professional RC helicopter flight instructor before carrying out any flight, setup or maintenance procedures. The reader should double-check any information when in doubt.

Module 1: Introduction

Chapter 1

What to Expect From this Hobby.

This is an introductory book that provides the basic facts you need to know and understand about the RC helicopter hobby. It will be of immense benefit to those who are planning to start flying RC helicopters but don't have the time to read and research all the websites on this subject. Such people will appreciate this short and concise introduction to the world of RC helicopters. This book also covers many of the questions and vital topics people search for when they are starting out with this exciting hobby.

This book is divided into four main modules. Each module then consists of several chapters. For instance, Module 1 (Introduction) contains Chapters 1 – 6. Module 2 (Electric RC Helicopter Types) contains Chapters 7 – 10; Module 3 (Learning to Fly an RC Helicopter) contains Chapters 11 – 15; and Module 4 (Modifications) is made up of Chapters 16 – 21. The guidelines provided in this book will help you to overcome the initial difficulties that most hobbyists encounter.

If you are new to RC helicopters, you should take the time to read through this book from the beginning to the end. Thereafter, it can serve as a quick reference material when you need to solve a problem or refresh your memory. After reading through this first chapter, you will have a better understanding of what an RC helicopter is, what to expect from this hobby and what you need to get started.

What is an RC Helicopter?

An RC (radio controlled) helicopter is a model helicopter that is controlled remotely by radio waves. It could have single or multiple rotors and it is elevated and propelled by one or more rotor blades. A typical RC helicopter has at least four flight controls including: roll, elevator, rudder and pitch/throttle. These controls can be used in harmony to perform virtually all the maneuvers that can be performed by a full sized helicopter.

RC helicopters are typically made of aluminum, carbon fiber, glass-reinforced plastic or ordinary plastic. Apart from recreational flying, RC helicopters are used for aerial photography, video recording, remote observation and inspection by the police and other security agencies. These machines can either be powered by fuel or with electricity.

Brief Overview of RC Helicopter Types

RC helicopter types will be treated in greater detail in subsequent chapters. But it is necessary to give a brief summary of the major types of RC helicopters. This will help you appreciate the value of each major type and help you to choose the most appropriate one to start off your hobby.

1) Toy RC Helicopter. Toy helicopters come as a ready-to-fly (RTF) packages. They are very cheap and they have limited controls. But they are easy to fly and they provide a lot of fun. Toy RC helicopters can withstand a lot of abuse and crashes. But they are usually limited to indoor flying. These helicopters are good for people who simply want to have fun by controlling a small device with a radio control.

2) Coaxial Fixed Pitch Helicopter. Micro coaxial fixed pitch RC helicopters have two rotors. They provide a good starting point for most people who want to develop their flying skills. They are fairly easy to assemble and control so you can use them to practice real helicopter movements. Several manufacturers even make RTF packages that don't need to be assembled. Coaxial RC helicopters are much better than toy helicopters because if you crash the helicopter, you can easily get replacement parts from a reliable hobby shop.

3) Single Rotor Fixed Pitch Helicopter. This model of RC helicopter is a bit harder to fly than the coaxial one. But if you are sure that you will like to advance with this hobby, you may prefer to start with a fixed pitch helicopter. Recent models now have more stability and allow you to do simple aerobatics. They usually sustain less damage during crashes than the collective pitch machines. You can also get one as a ready-to-fly package.

4) Single Rotor Collective Pitch Helicopter. This is the RC helicopter that has all the performance capabilities and aerobatics such as inverted flying as well as several exciting helicopter controls. It is the "professional" hobbyist's helicopter. However, it is not recommended for beginners. This is the machine that you aspire to learn how to fly by using the previously described trainer machines.

The RC Helicopter Hobby: What Should You Expect As A Beginner?

New entrants into the world of RC helicopter flying usually have several questions on their minds. First, they want to know how much it will cost to purchase an RC helicopter, the height and speed at which they can fly, and the ease with which they can learn to fly RC helicopters. Virtually all these questions will be answered as you read the subsequent chapters of this book. But here are a few things you can expect from the RC helicopter hobby.

The Learning Curve

Learning to fly RC helicopters takes some time to master. But it is very exciting and fulfilling. Just like all other hobbies, you need to have strong interest and some persistence to pass through the initial learning stages. That is why you should start with a relatively cheap helicopter and then after you have learned the basic skills, you can proceed to purchase a more expensive machine. To really enjoy this hobby, you should be prepared to learn all you can about the following:

- Basic parts of an RC helicopter and their functions
- Basic operation of an RC helicopter
- The major types of RC helicopters
- How to select and purchase an RC helicopter
- How to assemble and replace components
- Helicopter flight theory
- How to control and fly the helicopter skillfully

This book serves as a primer to RC helicopters. It will enable you gain a sound knowledge of the basics. Then through practice and further study, you can eventually become an expert at flying RC helicopters.

A Rewarding Experience

Building and flying RC helicopters is an enjoyable, challenging, multi-faceted and rewarding hobby. It provides a lifetime of fun and excitement. And you can practice this hobby through all the seasons of the year. In addition, you can join flying clubs and interact with veterans who will offer you a lot of practical flying tips and advice.

As you read the rest of this book, make sure you put what you read into practice. This will help you to quickly learn and master most of the new terms and words associated with RC helicopters.

Chapter 2

What are RC Helicopters and How Can They Fly?

An RC helicopter is a type of model aircraft that is similar in design but much smaller than a conventional helicopter. The pilot of the helicopter controls the flight and movement of the aircraft using a radio transmitter. These helicopters are designed to maneuver and fly in all three axes of rotation, in six directions, and also fly while it is inverted.

Designs of RC Helicopters vary by source of power (nitro, turbine, gas, or electric), by size (micro, mini and large), by the number of rotors (single or multiple), and by the amount of building and assembly required before they can fly (helicopter kit or ready-to- fly).

Electric vs. Gas

An electric RC helicopter is powered by an electric motor instead of a gas or nitro engine. A battery pack takes the place of the gas tank and the throttle servo on the gas RC helicopter is replaced the electronic speed controller. Some of the reasons why electric RC helicopters have become very popular include: the new brushless dc motors, brushless speed controllers and the long lasting lithium polymer batteries.

Gas is usually used to power large RC helicopters. Therefore, they are not usually used for serious 3D stunts and aerobatics which the new electric powered helicopters are now known for. However, a gas RC helicopter almost always has a longer flight time than an electric powered machine. In fact, some of them can run for close to 30 minutes before refueling them.

Small vs. Large

Various sizes of RC helicopters exist today. Small-sized RC helicopters are suitable for indoor and restricted outdoor flying. They are usually classified as micro or mini helicopters depending on the size of the rotor blades. Those who are interested in trying out RC outdoors should opt for a mini RC helicopter first. They usually have a blade-width of about 300 mm.

Larger helicopters are ideal for flying within a large open field. Their sizes are coded with two digit numbers. For example, there are 30-size, 50-size, 60-size and 90-size helicopters. All the large size helicopters are collective pitch helicopters.

Ready to Fly vs. Assembly

Most RC helicopter manufacturers now sell ready-to-fly (RTF) or almost ready to fly (ARF) machines. These pre-built machines save you the mental effort and time required to assemble your helicopter. Most small helicopters have pre-built versions. The question many beginners ask is: Is it better to buy a pre-built helicopter or a helicopter kit that needs to be assembled? The answer is strictly a matter of personal preference.

Building a radio-controlled helicopter is not an easy task. However, if you plan to make significant progress with this hobby, you need to learn to assemble, maintain and fix your helicopter early. For example, after your first crash (which is a normal part of the learning process), you will need to fix some parts of your helicopter. So a good understanding of the function of each part and how to couple them together will be a vital asset.

Therefore, it is better to choose a helicopter kit when you are buying your first helicopter. This will enable you to learn how to assemble it early and to fix it with ease when it crashes. Subsequently, you may decide to purchase a ready-to-fly helicopter to save yourself time, especially if you don't really enjoy building a helicopter.

How Can RC Helicopters Fly?

RC helicopters are capable of traveling in six directions: up, down, right, left, forward and backward. In addition, they can rotate 360 degrees in each of the six directions even in an inverted position. Here are five basic divisions of an RC helicopter flight:

Main Rotor: The main rotor is located above the body of the helicopter. It has two or more blades that extend out of the central rotor head. The main rotor produces a lifting force that enables the helicopter to fly. The rotor blades on most RC helicopters have the airfoil shape of an airplane's wing. But they are narrower and thinner. As these blades rotate in the air, the change in air pressure above and below the wing generates a lifting force. The lift that is generated is based on the speed and pitch angle of the rotor blades. The pitch angle is controlled by the collective and cyclic controls that are transferred to the main rotor through a swash plate.

The lifting force produced by the rotor blades helps the helicopter to overcome the force of gravity and rise vertically into the air. As long as the lifting force is greater than the gravitational force, the helicopter will keep rising. But when it is balanced (i.e. equal to the force of gravity) the helicopter will hover.

The Tail Rotor: To prevent the body of the helicopter from rotating in the reverse direction (due to Newton's third law of motion), another force is required. In an RC helicopter, with a single rotor, this force is supplied by a smaller rotor attached to the tail of the boom known as the tail rotor. The tail rotor controls the rotation (or yaw) of the helicopter.

The Swash Plate Assembly: This is used to turn the pilot's commands into the required motion of the rotor blades or fly-bar. This component fits on the rotor shaft underneath the hand of the rotor and has a non-rotating and rotating disc.

Collective Control: Collective control lifts up the whole swash plate assembly. As the helicopter's swash plate moves up or down, it alters the current pitch angle of all the rotor blades at the same time – that is why it is called collective control. An increase in the pitch angle or angle of attack raises the helicopter while a reduction in the pitch angle decreases the altitude of the helicopter.

Cyclic Control: The cyclic control tilts the swash plate upwards or downwards and increases the current pitch angle of a single rotor blade as it revolves. Hence the pitch angle on a single side of the RC helicopter will be greater than the angle on the other side. This enables the helicopter to travel in all directions – left, right, forward or backward.

Conclusion

In this chapter, we have discussed basic facts about RC helicopters and how they fly. The concepts introduced in this chapter will be explained and expanded further in subsequent chapters that deal with types of RC helicopters and learning how to fly.

Chapter 3

Electric vs. Gas

Understanding Two Major Power Sources

One of the first choices you need to make when selecting an RC helicopter model is the engine or power source. After selecting your power source, other specifications such as size, type of pitch, and radio transmitter will be much easier to choose. This chapter focuses on two of the most popular RC helicopter power choices: electric and gas. You should be aware that this is not an attempt to examine all the parts, functions and design concepts of electric and gas powered helicopters. Rather, the aim of this discussion is to compare the two power systems side by side under seven topics so you can select the option that will meet your needs.

Design

Electric power systems are available for micro to large sized RC helicopters. A few very large electric powered helicopters are available but they are quite expensive. The electric power system makes use of a brushless high speed electric motor, electronic speed controllers and lithium ion battery packs. Currently there are several varieties of electric motors and speed controllers for you to choose from.

Gas power systems are available for mini to large sized helicopters. There are no gas powered micro helicopters because the internal combustion engine and other parts like fuel tank will not fit into the micro sized helicopter design. The design of the gas internal combustion engine offers very little variety. For a given size of helicopter, you will have relatively few options to choose from.

Cost

Electric power systems are usually more expensive than gas power for the same size of helicopter. This is because the large capacity lithium polymer batteries are expensive. However, using an electric RC helicopter will offer you lower long-term operating costs since you will not need to purchase fuel for each flight. It will also save you maintenance costs.

Gas powered helicopters are typically cheaper than electric versions of the same size. The gasoline and engine oil required to run the engine can easily be purchased anywhere. But the long-term cost of maintaining a gas powered helicopter is considerably higher than an electric helicopter. In addition, due to the large size and weight, the larger models usually suffer more damage during a crash.

Assembly

Assembling an electric powered helicopter is relatively easier. You do not need to learn how to tune up a carburetor, fuel, or exhaust systems. But you need to know how to carefully select your electric motor and match the capacity with the gear ratio and lithium battery parameters. However, assembling the electric power system will require some soldering.

When you are assembling a gas RC helicopter, you need to know how to tune up the carburetor and regulate the air/fuel mixture. The gear ratios are however fixed and they seldom need to be customized. No soldering is required when assembling a gas powered helicopter.

Operating Performance

Electric RC helicopters are less likely to stop in mid air due to air/fuel mixture or ignition problems that usually affect gas powered models. The brushless electric motors used to power most electric models are very quiet and they are almost vibration free. The quiet operation of the electric models makes them ideal for flying in neighborhoods that operate under very strict noise regulations. The weight of the machine and its centre of gravity will not change during the flight as they do with gas powered models. Electric models are also quite easy to start, fly and stop. There's no need to use starting equipment like glow plug panels. In addition, they can be flown indoors without any poisonous gas emissions from exhaust fumes.

However, electric models require more time to recharge in between consecutive flights. You need to cool and recharge your battery or you will need to buy several additional batteries if you want to fly back-to-back with minimal waiting time. The electronic parts can also cause glitches due to electrical disturbances in your radio-control system. If you use an electric powered helicopter, you will find it more difficult to detect the amount of power available in the battery while the aircraft is flying. Batteries may also get damaged if they are over-charged or over-discharged.

Gas powered engines have longer flight times; sometimes they can fly without re-fuelling for up to 30 minutes. Their size also allows them to provide helicopter flight characteristics that are closer to real full scale helicopters. The fuel level in the gas powered machine can easily be seen so you can monitor the amount of fuel remaining. However, the reciprocating engine and exhaust pulse produces excessive vibration and noise. The air/fuel mixture could also fail in mid-air while spark plugs and high voltage ignition can produce radio interference. Unfortunately, due to emission of exhaust gases which are poisonous to humans, gas powered helicopters cannot be flown indoors.

Speed Control

Electric models can start and stop on demand; they do not require a clutch mechanism. They respond better to instant maneuvers because they offer much quicker acceleration. But the power supplied by electric powered helicopters tends to reduce as the battery gets discharged. Electric powered helicopters can run without installing speed governor as long as the electronic speed controller has its own governor.

Gas models need a clutch mechanism to stop the rotor from turning while the engine is in idle mode. These models tend to have a slower response to instant maneuvers. However, power supply is usually consistent even when the fuel tank is draining out.

Maintenance

Electric RC helicopters are very easy to maintain. There is no oil or fuel to clean up after each flight. There are no plugs or engine bearings to maintain. Apart from ensuring that batteries are recharged after each flight and carrying out repairs after a crash, generally electric models do not require regular maintenance.

Gas powered RC helicopters need to be cleaned up after every flight. The fuel lines and glow plugs also require maintenance. You also need to be able to tune up the air/fuel mixture.

Lifespan

The battery performance of an electric model reduces gradually as the battery gets older. So users of electric models need to change their batteries every 3 to 5 years depending on the frequency of use. But engine performance of a gas powered helicopter will not degrade if it is well tuned and maintained.

Conclusion

The strengths and weaknesses of electric and gas powered RC helicopters have been presented so you can make an informed choice anytime you need to buy a new RC helicopter. When you are making your purchase decision, you should also factor in the cost of maintaining your aircraft and ensure that the model you buy will serve both present and future needs. Beginners will definitely find it easier to start flying and maintaining an electric model until they have mastered the fundamental aspects of this hobby.

Chapter 4

Small vs. Large

Understanding RC Helicopter Sizes

RC Helicopter size is an important aspect of the RC Helicopter hobby. As a beginner, you will soon discover that there are several size specifications used by manufacturer's and RC helicopter hobbyists. Terms such as "50-size", "600 class", micro, mini, small and large are frequently used to describe the sizes of RC helicopters. In order not to get confused by these terms, it is vital to understand what they mean. It is also important to have a standardized method to classify different sizes of RC helicopters.

In this chapter, we will be discussing various sizes of RC helicopters from the smallest to the largest. We will also look at common terms used to classify sizes of RC helicopters as well as the pros and cons of each one.

Explanation of Terms Used to Describe Helicopter Sizes

Engine Capacity: Initially, when all RC helicopters were powered by internal combustion (IC) engines, the size of the helicopters was determined by the capacity of the engine. For example, a 30-size helicopter means that the engine has a 0.30 cubic inch engine. This classification is still used for internal combustion engines that run on nitro fuel, methanol or gasoline. RC helicopters powered with fuel are classified into sizes from small 10-size helicopters to very large 90-size models.

Electric Motor Numbers: With the advent and rapid increase of helicopters powered by electricity, several manufacturers started using the physical size of the electric motor to describe helicopters. For instance, the smallest electric powered helicopters are called 100 series electric helicopters while the very large electric models run on 700 series or higher.

Subjective Sizes: In addition to the power specifications, other size classifications such as micro, mini, small, medium and large are also used to classify RC helicopters. Although we classify helicopters using these terms in this chapter, the use of these terms is somewhat arbitrary. So it is better to have a more objective method of specifying helicopter sizes.

Rotor Blade Diameter: The diameter of the rotor blade is still one of the best and most consistent ways to determine the size of an RC helicopter. Whether the aircraft is powered by gas or electricity, the manufacturer will specify the diameter of the main rotor. This is the distance from the tip of one rotor blade to the other tip. It is similar to the wing span of an airplane. This distance is specified in millimeters by most manufacturers although some will also specify it in inches.

Classification of Small and Large Helicopters

In order to help you gain better understanding of the sizes of RC helicopters, you should carefully go through the four classes described below. Each category includes the rotor diameter as well as electric motor sizes and IC engine size. Examples, benefits and some drawbacks are also provided.

Micro RC Helicopters

The main rotor diameter of these models is usually between 150 mm and 375 mm (between 7" and 15"). The electric motor size is usually 200 or lower. Most of the coaxial and fixed pitch helicopters are in this category. You can also find several new collective pitch brands in this class. Due to the small size of these models, there are no internal combustion engines in this category. Examples in this class include; Blade mCPx and Blade Nano CPx.

Benefits

Small Size: These helicopters can be flown easily indoors. They can be used to learn about 50% of what you need to learn to fly an RC helicopter conveniently.

Crash Resistance: Due to their small size and weight, they are more resistant to crashes. And they are easier and cheaper to repair after a crash.

Low Cost: Micro RC helicopters cost the least amount of money. They are made of cheaper materials with a lot of plastic and they use smaller batteries.

Drawbacks

Short Flight Distance: The small size of these helicopters does not allow you to fly them far away from you. This is very significant when you are flying indoors. High wind sensitivity also makes it difficult to fly them outdoors except on a very calm day. This tends to reduce the excitement you can derive from flying your micro RC helicopter.

Mini RC helicopters

The main rotor diameter is usually between 375 mm and 600 mm (i.e. between 15 inches and 24 inches). The electric motors used for mini helicopters are the 200 to 350 series. Helicopters in this category are mainly collective pitch models although a few coaxial and fixed pitch models may still be available. Examples in this category include: Blade 300X, Trex 250 and Blade 130X.

Benefits

Small Size: The relatively small size of these helicopters makes them easy to carry and move around. They can be flown successfully in a garage or a gym.

However, they perform better outdoors. They have a distinct advantage over micro helicopters because of the large size and better visibility while flying.

Low Cost: These helicopters are easier to afford for most hobbyists who want an entry-level collective pitch helicopter. Repair costs are also lower and their batteries cost far less than larger models.

Drawbacks

Low Wind Resistance: Their small size makes them fly poorly in windy conditions. In fact, once the wind speed rises above 5 mph, you will find it very difficult to fly effectively in any direction.

Medium Size RC Helicopters

The main rotor diameter typically measures between (600 mm and 1100 mm) and (i.e. between 24" and 44"). These helicopters are powered with electric motors in the 350 to 500 series. Internal combustion engines in this category have 10-size to 30-size engines, although some are larger. Virtually all the helicopters in this category are collective pitch models. The fixed and coaxial models are very rare and will most likely be ineffective.

Benefits

Not too Large: These models are fairly easy to transport and they provide very good visibility from a far distance. You can easily see the actual orientation of the helicopter even when it is very far from you.

Good for Windy Conditions: You can easily fly this size of helicopter in slightly windy conditions when the wind speed is over 8 mph. Hence, medium-sized helicopters are excellent for learning aerobatics. It is also easier to get them to do rolls and loops because of their extra weight.

Relatively Low Cost: Although they are more expensive than the smaller models, they cost about half the price of the large RC helicopters. For the electric powered versions, batteries are also relatively cheap.

Excellent for Learning: This is the size that is recommended for serious learning. Experience has shown us that this class of helicopters is superb for learning virtually everything you need to know about flying an RC helicopter - from basic flight control to advanced 3D flight. Also, you cannot outgrow this type of helicopter. So, even when you become an advanced learner or experienced pilot, you will still enjoy flying it.

Drawbacks

No Indoor Flight: The size of these models makes them unsuitable for flying indoors. However, you may be able to fly one in a very large gym with plenty of overhead space.

Large RC Helicopters

Large RC helicopters have main rotor diameters that are larger than 1100 mm (above 44 inches). Electric motor sizes include 550, 600, 700 series and above. Helicopters with internal combustion engines of 40-size and above are considered to be large RC helicopters. Examples include Align Trex 600 and Bergen Intrepid.

Benefits

Visibility and Wind Resistance: They can fly in most windy conditions. This makes them excellent all-season flight machines. Besides, you can fly them at very far distances without any loss of orientation.

Exciting Flight: Large helicopters provide the benefit of exciting aerobatics. But you should also note that this is best done on an electric powered aircraft. Large gas powered models offer a little less excitement because of their extra weight.

Drawbacks

High Cost: They cost twice or more of the price of the medium sized RC helicopters. So they are not the first choice of anyone who has a relatively tight budget.

More Maintenance: Basic repairs take more time due to the size of these helicopters. Repairing a large helicopter after a crash can also be quite expensive.

Flight Restrictions: You can only fly these huge RC helicopters in a large open field. This means that they require special flying areas. Most neighborhoods will not allow you to fly them because a crash can cause serious human injuries and damage to cars and houses.

Conclusion

The knowledge of RC helicopter sizes makes it easy for you to select a suitable model that will meet your needs as you progress with your hobby. When you need to choose an RC helicopter on a budget, it is better to deduct the cost of the radio transmitter first and then buy the largest one you can afford with the balance.

Chapter 5

Ready to Fly vs. Self Assembly

Many manufacturers of hobby-grade RC helicopters provide both traditional self-assembled helicopter kits as well as the modern ready-to-fly helicopters. Previously, all RC helicopters were sold as kits and it took several days or weeks to assemble them.

Gas powered helicopters were the first to be sold in RTF form. But in 1999, the first mass-produced ready-to-fly RC helicopter – the Ikarus ECO Piccolo was released into the market. The success of this product attracted many new RC helicopter hobbyists because they could start flying micro RC helicopters indoors with ease.

Currently, there is faster growth in the RTF market due to the convenience, user-friendliness and the massive electronic revolution. The advancement in technology has brought about improvement in radio control technology, electric motors, transmitters, receivers, electronic speed controllers, battery packs, servos and gyros. These components have also reduced in weight so that micro and mini helicopters are now lighter, cheaper and easier to fly.

However, when you are buying an RC helicopter for the first time, you need to decide whether you should buy a helicopter kit and assemble it or simply buy an RTF model and start flying your helicopter within a few minutes or hours. That is why, in this chapter, we will be looking at the features of ready-to-fly helicopters, and some of their advantages and disadvantages. Thereafter, we will examine what you need to know to assemble a new helicopter as well as some of the benefits and drawbacks of assembling your own RC helicopter.

Ready to Fly

A ready to fly (RTF) RC helicopter is a pre-built model aircraft. There are two major types of ready to fly packages: almost ready to fly (ARF) and fly straight out-of-the-box packages. Typically, all ready to fly helicopters come as a complete package. They include virtually everything you need to fly your helicopter such as:

- The radio-controlled helicopter
- The helicopter battery and charger
- The radio transmitter (usually without the transmitter batteries)
- Pre-installed receiver, servos and gyro

Almost Ready to Fly

Almost ready to fly helicopters still require final assembly. The gas powered models need fuel tank and engine installation while the electric motor, battery

and electronic speed controller will need to be installed on an electric powered helicopter. Other components that may need to be installed on an electric powered helicopter are the servos, gyro and fly-bar. Most ARF RC helicopters can be built within 24 to 50 hours of work depending on the amount of installation required and the amount of experience the builder has previously acquired.

A beginner pilot who just needs an RC helicopter to learn basic flight operations without bothering about all details involved in building and balancing a helicopter should be very cautious when buying an ARF package. Although these kits save you plenty of time, they still require a good working knowledge about how each part helps the helicopter to fly and function properly.

Fly Straight Out-of-the-Box

The out-of-the-box package is a true ready-to-fly RC helicopter. These kits are made for those who simply want to open the package, put in the batteries for the radio transmitter and start flying the helicopter within a few minutes. Several micro RC helicopters now come as ready-to-fly packages. For instance, most coaxial fixed pitch RC helicopters now come as RTF packages. They are quite stable in the air and are therefore excellent tools for basic orientation practice (such as nose-in and side-in). These helicopters can fly in small indoor spaces but they are not suitable for outdoor flight due to poor wind resistance.

Advantages of Ready to Fly Packages

- RTF helicopters are easy to operate and fly
- They are good for basic flight training
- RTF models are excellent for micro helicopters
- They cut down the amount of time required to learn how to fly
- No technical knowledge is required to operate an RTF helicopter
- They are good for those who are only interested in the fun of flying
- RTF models are good for kid's helicopters
- No special tools and equipment are required

Drawbacks

- RTF models do not allow the pilot to learn how to build and maintain a helicopter
- Many of the larger RTFs require tune up before they can fly satisfactorily
- RTF packages do not allow the pilot to taste the fulfillment that comes from successful assembly and flying
- Most of these models are not easy to customize or upgrade
- RTFs are frequently used as a marketing gimmick against unsuspecting buyers and beginners

Self Assembled RC Helicopters

Most mid-range and large RC helicopters are presently sold as self-assembled helicopter kits. A few manufacturers are however offering pre-assembled and tested versions at an extra cost. It is important to note that anyone, who plans to be a very active RC helicopter hobbyist, must know what assembling a helicopter is about. Why? Sooner or later you are going to experience your first crash.

No matter how smart or careful you are, a minor accident will definitely occur while you are learning how to fly. When this happens, you will have the option of repairing the aircraft yourself or calling for help. From experience, it is far better to be able to fix your helicopter and replace damaged parts by yourself than to keep calling for external assistance. That is why all serious RC helicopter enthusiasts are encouraged to take the pains to learn how to build and tune up their first RC helicopter. Once you are familiar with the basic facts on how helicopters are assembled, you can decide to get an RTF package if you are not technically oriented, or you do not have the time to properly assemble one.

Self Assembly Preparation Tips

When you decide to take the plunge and buy a helicopter kit, you will need to be properly informed and prepared. This will boost your confidence and help you overcome any difficulties you may encounter during the building process. Here are a few points you should keep in mind.

Get All Your Basic Tools: Some of the basic tools you will need to build your first RC helicopter will also be used to repair and maintain it. These tools include: a complete set of screwdrivers (both standard and Phillips), rulers (imperial and metric scale), cordless hand drill, hobby knife, hex drivers, sandpaper, soldering iron, solder, wire cutter, scissors, grease, light oil and loctite to keep vibrating bolts from getting loose.

Prepare to Follow All Instructions Meticulously: This is the best help you can offer yourself when you are assembling your helicopter. It will save you time, effort, resources and even your life. In fact, after you receive your kit, you should read the instructions first. Don’t bother if some of the instructions sound strange. If there’s any term or diagram you do not understand, ask questions before you proceed. Remember not to start unpacking the kit until you have read through the instructions at least once.

Get a Suitable Work Surface: Your work surface should be flat and big enough to place all the components of your helicopter kit. You should also be able to work on your RC aircraft without any disturbance from pets and children.

Mark off Every Instruction: It will take you several days or even weeks to finish building your first RC helicopter. Therefore, you should mark off each instruction immediately after you complete it. That way, you will easily know where to proceed when you take a break and return.

Advantages of Self Assembly

- It helps you to understand the function of every part of the helicopter
- Building an RC helicopter successfully brings a lot of confidence and fulfillment
- It makes maintenance and repair very easy and fast
- It provides the experience required to tune up any ready-to-fly model you decide to buy later on
- Self assembly helps you gain new friends on discussion forums online as you interact, ask for help and share your successes and failures
- It is cheaper than the corresponding RTF model

Disadvantages of Self Assembly

- It is time consuming and it can delay the exciting feeling you get from flying your first helicopter
- The number of component parts and details can be overwhelming for a non-technical hobbyist
- It may require you to learn how to use special equipment
- Errors in assembly could lead to costly accidents
- If you do not have a good source of support, assistance or training, you could make costly mistakes and damage some parts in the process.
- Successful assembly requires a good knowledge of how each part functions.

Conclusion

The recommended choice for most first time RC helicopter buyers who want to become long-term hobbyists is to purchase a helicopter kit for self assembly. Then subsequently, they can choose to buy a ready to fly package or almost ready to fly package and carry out minor installation and tune up to save time.

Chapter 6

Indoor vs. Outdoor

Which Helicopter is a Good Helicopter for Beginners?

One of the frequently asked questions among most beginners in the RC helicopter hobby is: which type of helicopter should I start with – a small indoor model or a larger sized helicopter that can only fly outdoors? This question is not very easy to answer without considering several other factors that make a specific type of helicopter appropriate for a particular learner. In this chapter, we will be considering the major factors you need to bear in mind when you are deciding on the most suitable helicopter you should use to learn how to fly.

What Are Indoor RC Helicopters?

Indoor helicopters are typically micro or small helicopters (with a rotor diameter of 15 inches or less). These helicopters are usually coaxial RC helicopters but there are also a few fixed pitch single rotor models of this size. Indoor RC helicopters are powered by electricity. And they are usually packaged as ready to fly kits.

Most indoor RC helicopters can be flown within a large sized living room, a garage, a gym or dedicated indoor flying site. There are now several well established indoor flying sites where hobbyists can take their small and micro RC helicopters to and practice their flying skills.

These flying clubs give learners the opportunity to interact with both experienced and upcoming pilots. They also give beginners a chance to develop more confidence and become more adventurous. In addition, it is relatively safer to use these indoor flying sites since there will be less distraction and the negative effects of crashes will be minimized.

Benefits of Indoor Helicopters

Low Cost: Small and micro RC helicopters are very budget-friendly. For as low as $30; you can purchase a little toy helicopter to fly in your living room. But serious hobbyists may need to spend a little more to acquire an indoor helicopter that will be both affordable and useful for developing the required flying skills.

Easy to Fly: Most beginners find it easier to control and fly micro RC helicopters indoors. For instance, micro coaxial helicopters are easier to hover and fly indoors than the bigger single rotor models. There are 2, 3, or 4

channel transmitters that beginners can easily use to learn how to control their helicopters.

Good Visibility: Since the indoor space is restricted, it is easy to see the orientation of your helicopter while you are flying it. This makes it easier to control. You will be able to see the effect of the commands you send to it through your radio transmitter and this will help you to quickly develop your flying skills.

Easy to Repair: Indoor helicopters are easier to repair. So those who are practicing their hobby on a relatively low budget will find these helicopters easier to maintain and repair after a crash. Coaxial helicopters, in particular, are much cheaper to maintain the collective pitch helicopters.

Constant Availability: The state of the wind is always a major factor when you want to fly an RC helicopter outdoors. This limits the time you can fly to when you the air is relatively still. But indoor flying can be done at any time of day or night. As long as you have good lighting where you are flying, you will able to control your helicopter with ease. In addition, you don't have to bother about neighborhood restrictions or distraction from onlookers who are constantly asking you questions about how to start flying helicopters.

Outdoor RC Helicopters

Outdoor RC helicopters are the large size helicopters that cannot be flown effectively within an enclosed space. All fuel powered helicopters must also be flown outdoors because of the exhaust gases they emit. Virtually all collective pitch single rotor RC helicopters are to be flown outdoors. These helicopters can be flown over a sports field or at a park where such activities are permitted.

However, most beginners find it a bit difficult to fly successfully in windy conditions. So it is better to start outdoor flying at times when the air is relatively still - after sunset or in the early hours of the morning.
Advantages of Learning How to Fly Outdoors

More Space: When you are flying outdoors, you have more space to practice and develop your flying skills. You can practice flying at a far greater height than anyone can do while flying under a roof. In addition, you can fly the helicopter and accelerate faster outdoors. All indoor flying is restricted and any attempt to accelerate very fast could easily result in a crash.

Greater Adventure and Excitement: Hobbyists who love adventure will definitely prefer to fly outdoors. You can learn new skills faster outdoors than indoors because there's more room for adventure and experiments. Also, you derive more satisfaction and fulfillment when you see several people standing around to watch your aircraft flying in the open air.

Development of Wind Adaptation Skills: All beginners must learn how to adapt the movement of their helicopter to the current wind conditions. For

instance, it is more difficult to hover a collective pitch helicopter in windy conditions than when you are flying indoors or when the air is still. Constant outdoor practice will enable you to keep your helicopter flying in the desired direction with little effort.

Aerobatics and 3D Flying: All the aerobatics and stunts that make the RC helicopter hobby really exciting can only be achieved outdoors. You can use a collective pitch helicopter outdoors to fly in an inverted position and perform several eye-popping stunts and loops in the open field.

Aerial Photography and Video: In addition to the joy and excitement that all hobbyists derive from flying their aircraft, these helicopters also provide a very good opportunity to create valuable aerial pictures and video recordings. Although these are not usually skills that beginners can easily master, they are important aspects of the hobby that can only be learned outdoors.

Recommendations

Beginners can start with a smaller coaxial RC helicopter and fly it indoors. But they should also realize that this is meant to serve as an introduction to flying. Subsequently, they should proceed to the next stage where they can fly a collective pitch single rotor helicopter in the open field.

Module 2: RC Helicopter Types

Chapter 7

Fix Pitch Single Rotor.

Pitch is one of the defining features of radio-controlled helicopters. New entrants into the RC helicopters hobby usually encounter terms like “fixed pitch single rotor”, “coaxial fixed pitch” and “collective pitch”. RC helicopters are frequently classified by the type of control mechanism or “pitch” that is used to lift the helicopter of the ground and cause it to fly. In this chapter, we will be taking a closer look at the concept of pitch with respect to RC helicopters and then we will focus on the distinct features, mode of operation, benefits and limitations of fixed pitch single rotor helicopters.

What is Pitch?

Pitch is the term used to describe the angle of the helicopter’s main rotor blade – measured relative to the horizontal plane or ground. The blade pitch is also referred to as “angle of attack”. Changing the pitch of the rotor blade can make the helicopter rise or fall.

Fixed Pitch Model Design

A fixed pitch helicopter has a main rotor with a fixed or permanent pitch angle. It cannot be adjusted or used to control the lift of the helicopter. In this type of helicopter, the sole determinant of its altitude or height is the throttle. To make the aircraft rise, you need to increase the throttle while to make it fall, you reduce it. The throttle control is usually on the left hand side of your radio transmitter.

On a fixed pitch model, there are just two servos connected to the swashplate. One servo provides forward and backward movement while the other one provides left and right or side-to-side movement. However, the swashplate moves neither up nor down, it only tilts. Most fixed pitch helicopters are now packaged as ready to fly (RTF) kits and they are shipped with a radio transmitter.

Single Rotor Helicopter

This type of helicopter has one main rotor and a single small tail rotor to provide anti-torque stability and control. A fixed pitch helicopter has fewer moving parts than the collective pitch helicopter. They are light weight machines and they weigh between 50g and 300g. Although they do not offer high wind resistance, they are excellent for indoor flying.

Channels

Most fixed pitch single rotor models are designed with 4 channels of control. But some also come with 3 or 5 channels. The higher the number of channels, the greater the flexibility and freedom of movement that you can enjoy while flying your helicopter.

Mode of Operation

All RC helicopters need a mechanism to control their altitude and direction. The two major components used to control altitude are the speed of the rotor and the pitch of the rotor blades. In fixed pitch RC helicopters, the pitch of the rotor blades cannot be changed. Hence, their altitude and direction can only be changed by altering the speed of the rotor blades. This results in a simpler design and fewer controls.

Therefore, most beginner pilots find fixed pitch models easier to fly. They can easily lift or lower the aircraft with a few controls on a simpler radio transmitter. However, it is important to note that fixed pitch rotors respond slower to the pilot's control commands because the entire rotor needs to slow down or speed up to produce the desired change in altitude.

Major Advantages of Fixed Pitch Models

Easy to Fly: Due to the absence of adjustable pitch and associated controls, fixed pitch models are best suited to hobbyists who want to learn how to fly an RC helicopter without enduring the long and steep learning curve associated with collective pitch models. During normal flight, there is no major difference between the mode of operation/flight of a single rotor fixed pitch helicopter and a collective pitch helicopter. Therefore, it is an excellent preparatory helicopter for a beginner. It helps you to develop transferable helicopter flying skills.

Cheaper Maintenance: Fixed pitch helicopters have few moving parts and so there are fewer parts to maintain or repair after a crash. This automatically reduces the total cost of maintenance. In fact, experience has shown that the cost of maintaining a fixed pitch helicopter after a crash is about half the price of repairing a collective pitch helicopter.

Lower Purchase Cost: These helicopters are typically cheaper than collective pitch models. Most of them are lighter in weight and they are more compact. Hence, they are easier to afford for most beginners who want to try out this hobby. A standard 4-channel fixed pitch single rotor helicopter will cost you about half the price of the standard cyclic collective pitch management (CCPM) RC helicopter.

Greater Stability: Fixed pitch helicopters offer better stability (in non-windy situations). They are easier to hover because of the shape of the lift motors and the speed at which they spin. That is why most people who are new to this hobby usually find them easier to fly.

Good for Indoor Flying: It is easier to fly fixed pitch helicopters indoors. Most fixed pitch models are lighter, smaller and easy to control within a small indoor space. In fact, virtually all the micro helicopter models now have fixed pitch designs.

Limitations of Fixed Pitch RC Helicopters

Larger Models Lack Fine Lift Control: Fixed pitch works fairly well in helicopters that have a diameter of about 300 mm or less. Thereafter, the helicopter and rotor mass makes fine/instantaneous lift control more difficult due to delay in the rate at which the motor speed changes. The electric motor (or engine in an internal combustion version) has to subdue the inertia to get the rotor to spin faster or the momentum in the rotor assembly in order to make it slow down.

Poor Wind Resistance: Virtually all fixed pitch helicopters have a tough time when it is windy because the rotor responds much slower than the pitch control in collective pitch helicopters. This can make your aircraft move up much higher than you want when it is hit by a little gust of wind. Slow changes in rotor speed can also result in degraded cyclic performance.

Inability to Perform Stunts: One major limitation of fixed pitch models is that you cannot use them for any serious aerobatics. For instance, 3D or inverted flying is completely excluded. This is because you can only control the movement of the aircraft by changing the pitch angle when it is flying in an inverted position.

Suitable for Small Size Helicopters Only: Due to the slow response of the throttle at larger sizes, you will not enjoy flying a fixed pitch model with a rotor diameter larger than 450 mm. Therefore, larger RC helicopters and full size aircraft must use collective pitch design for effective flight control.

Conclusion

Fixed pitch single rotor RC helicopters provide a low entry barrier for many new hobbyists. They are cheaper to purchase, maintain and repair. A good 4 channel version will also help you to learn flying skills that you can use when you decide to move up to a much larger collective pitch model.

Chapter 8

Fix Pitch Dual Rotor.

Fixed pitch dual rotor RC helicopters are designed with two main rotors – one on top of another. They are different from the conventional helicopter that has a single rotor and a tail rotor. These helicopters are commonly called coaxial RC helicopters. The main focus of this chapter is to describe the design of coaxial RC helicopters, explain how they work and provide a short outline of the advantages and limitations of coaxial RC helicopters.

Coaxial Helicopter Design

Most coaxial RC helicopters have two distinct electric motors. Each electric motor drives one main gear which powers a single rotor shaft. The external shaft that powers the lower rotor has a hollow shape. But the inner shaft powers the upper rotor and spins inside the external hollow shaft in a different direction. Since the two rotors spin in opposite directions, the upper and lower blades are curved in opposite directions. The lower rotor blade spins in the clockwise direction while the upper rotor spins in the counter-clockwise direction.

Coaxial helicopters use a contra-rotating system which cancels the torque generated by each rotor blade. It also eliminates the need to use a tail rotor to prevent the helicopter from spinning. The possibility of flying without the tail rotor permits manufacturers to eliminate the aircraft's tail boom and reduce the helicopter's weight.

How Coaxial RC Helicopters Work

Cyclic Control

Hobby grade dual rotor RC helicopter usually have a swashplate. This means that they are capable of cyclic directional control. Cyclic control gives these models some of the agility that the bigger and more complex collective pitch helicopters have. The swashplate connected to the lower rotor provides various cyclic controls including: fly, hover, left and right, forward and backward.

Yaw Control

The two motors that work together to raise or lower the helicopter are also responsible for the yaw or turning movement of the aircraft – in the same way the tail rotor controls the yaw on a single rotor model. When one rotor slows down a bit, but the second rotor is sped up, the rotor that is moving faster

produces a greater reactive torque than the slower rotor. Therefore, the helicopter will turn.

The yaw movement is effectively controlled by an electronic mixing board. This device mixes the speed of the two motors to provide the desired turn rate. It also ensures that the lift of the helicopter remains constant. In the coaxial helicopters that have tail rotors, the pitch can be controlled using the tail rotor.

Advantages of Coaxial Helicopters

1. Beginner-friendly: These helicopters are excellent learning tools for people who are new to this hobby. As a beginner, coaxial helicopters allow you to start off without grappling with the complexity and higher price of the single rotor collective pitch helicopter. They also enable you to develop transferable flying skills. For instance, hobby grade dual rotor helicopters use the swashplate cyclic control found in several full size helicopters. Therefore, some of the skills you acquire while learning to fly coaxial helicopters can be transferred to single rotor collective pitch helicopters. One good example is the control reversals that are used when practicing nose-in hovers.

2. Stability: Coaxial helicopters are more stable than most single rotor models. This is because the two rotors add more mass to the aircraft and this creates a stabilizing gyroscopic effect on the aircraft. Apart from helicopters with 3-axis electronic stabilization devices, the dual rotor design has the most stable mechanical design. This is one of the reasons why they are easier to fly.

3. Conservation of Engine Power: The coaxial design provides greater payload for lifting the helicopter than the single rotor design with a tail rotor. The tail rotor usually wastes a valuable portion of the engine power that can be fully utilized to lift or thrust the helicopter. But since most coaxial designs do not use a tail rotor, this engine power is conserved.

4. Reduced Noise: Dual rotor RC helicopters produce less noise than the single rotor models. Part of the loud noise produced by these single rotor helicopters comes from the two airflows produced by the main rotor and tail rotor. And in some instances, this noise can be extremely loud.

5. Compact Design: Coaxial models are typically more compact than others – they occupy less space on the ground. Hence they are more suitable for indoor flying. They can be flown effectively in areas where you have restricted flying space.

6. Increased Safety: Due to the absence of the tail rotor, the coaxial design reduces the occurrences of injuries to users and people standing by.

Limitations/Drawbacks

Complex Motor Hub: The major disadvantage of the dual rotor design is the added complexity of the hub for the two rotors. The swashplates and

linkages for the two rotors must be coupled on top of the mast. This swashplate/rotor arrangement is more complicated than single rotor systems because of the need to rotate the two rotors in different directions.

Higher Possibility of Mechanical Faults: Due to the increased complexity of the hub, this model is prone to developing mechanical faults. Hence it could increase the cost of repairs after a crash. For instance, some critics say that dual rotor models are more likely to experience whipping of blades or blade self-collision.

Limited Outdoor Use: The dual rotor model has two drawbacks when used outdoors. First, it has limited forward speed so it does not respond very fast when you want to fly fast and cover a long distance within a short period of time. In addition, the fixed pitch micro coaxial models have higher wind-sensitivity. So they can only be flown effectively when the air is still – preferably at dawn or at sunset.

Conclusion

The fixed pitch dual rotor RC helicopter design is good for people who want to start learning how to fly radio-controlled helicopters. They are generally cheaper than single rotor models and they offer good stability for beginners who want to start with indoor flying. The flying skills acquired while flying a coaxial helicopter will be an asset when the pilot decides to move over to the more demanding single rotor collective pitch RC models.

Chapter 9

Fix Pitch Twin Motor – Dual Rotor.

In this chapter, we will be discussing multi-rotor helicopters. This category of RC helicopters is the most recent and the fastest growing segment in the radio-controlled helicopter sector. Multi-rotor helicopters are also known as multicopters. A multicopter has more than two rotors connected directly to fixed pitch propellers. There is no single rotor or tail rotor that is common in conventional helicopters. In a multicopter, the speed and direction of the propellers are coordinated by advanced electronic devices to provide all normal helicopter flight movements such as fly, hover, left, right, forward and backward and yaw. These models are also capable of performing several aerobatic stunts.

The most popular type of multi-rotor helicopter is the quadcopter which has 4 propellers arranged in two sets of twin motors and rotors. These propellers have a fixed pitch; two of them spin in a clockwise direction while the other two spin in a counter-clockwise direction.

The multi-rotor RC helicopter design is quite simple. When compared to the conventional fixed pitch and collective pitch RC helicopters, these helicopters have a remarkably simple mechanical design. In the case of the quadcopter, there are just 4 moving parts – the four spinning shafts that connect the electric motors directly to the propellers.

Component Parts

The multi-rotor RC helicopter has fewer mechanical parts and a few more complex electronic circuits. The most important parts of a multicopter include:

Frame: This is the structure that keeps all the parts of the helicopter together. The frame could be made of wood, aluminum, or carbon fiber. In a quadcopter, the frame is made up of three major parts: a centre plate which serves a mounting platform for electronic boards, four arms connected to the centre plate, and the four motor brackets which connect the motors to the arms.

Brushless Electrical Motors: These motors spin at a higher speed and consume less power than normal DC motors. They are more energy-efficient because they do not lose power because of the absence of the brush-transition found in conventional DC motors.

Propellers: These are mounted directly on the shaft of each motor. Quadcopters have two sets of twin propellers. One set is responsible for front and back movement while the other set is responsible for left and right

movement. The propellers for mid-sized quads usually have 4.5 pitch. The diameter of the propellers determines the thrust that the propellers can generate. However, longer propellers will require more power to drive them.

Electronic Speed Controller (ESC): This device is necessary because the brushless motors have 3 phases and so they cannot receive normal DC input. The ESC serves as a motor controller board. It receives battery input and provides a three phase output for the brushless motors to run.

Electronic Flight Controller: This is the brain of the multi-rotor RC helicopter. It coordinates the speeds of the motors and produces the required movement based on the input from the radio transmitter

Other vital components include: battery pack, radio transmitter, inertia measurement unit (IMU) – a combination of a gyroscope and accelerometer.

How it Works

Multi-rotor RC helicopters use fairly complex computing power to control all the propellers accurately. These propellers must be accurately monitored and controlled to produce precise movement and keep the aircraft stable. Why? Virtually all multi-rotor helicopters are unstable on their own (without electronic stabilization). For instance, it is when all the propellers are rotating at the same rate and they are generating the same amount of thrust and torque that the helicopter can hover steadily.

There is no known method of achieving this manually. But the electronic stabilization system, brushless motors and several microprocessors enable these helicopters to fly and hover with amazing accuracy. In fact, good quality hobby grade multicopters can be used by beginners in easy modes where the aircraft will provide the stability offered by most stable coaxial helicopters. And these same multicopters can be set to provide breath-taking aerobatics and stunts consisting of fast rolls and flips.

Currently, many mid-sized quadcopters now have video cameras, GPS positioning and several other sensors. These features give them the capacity for autonomous flight control, programmed flight paths and they can even return home if the radio link gets disconnected. In reality, you do not fly these machines like conventional RC helicopters. All you do is to tell them what you want and the programming and electronics takes over the job of flying the aircraft.

Advantages

Mechanical Simplicity: The simplicity of these multi-rotor helicopters makes them easy for many hobbyists to design by themselves. It also allows manufacturers to focus more on adding powerful electronic gadgets and circuitry that have now made these machines the most suitable devices for aerial surveillance and photography

Easy to Fly: Many hobbyists who simply want to have fun with aerobatic performance within a few days or weeks of flying have chosen the quadcopter as their first RC helicopter. This choice has made it possible for them to experience the fulfillment of 3D flight and aerobatics that takes other people close to one year to experience with conventional single rotor collective pitch helicopters. Quadcopters are amazingly stable while hovering due to the stability provided by the electronic stabilization system.

Excellent Aerial Video, Photography and First Person View: Due to the superior lift efficiency, stable hover and extremely short learning curve, multi-rotor aircraft now have several applications for aerial video, photo and first person view in sports, real estate, and wildlife. They can easily be set on auto-pilot and they will deliver results with precision. Several quadcopters now have fixtures that you can use to mount your GPS enabled camera.

Limitations

The major limitation of multi-rotor RC helicopters is their size. Due to the use of several electric motors and propellers, the weight of these models will increase and more power will be required to lift them as they increase in size.

Conclusion

Multi-rotor helicopters are currently growing in popularity due their very short learning curve and the features that make them suitable for auto-piloting and aerial photography. They have a very simple mechanical design and sophisticated electronic capability. They are however limited in size because they use several motors and propellers to fly.

Chapter 10

Adjustable Pitch.

Adjustable pitch helicopters have the same design as most full size conventional helicopters. They are also known as collective pitch RC helicopters. They have a single main rotor and a tail rotor. One major feature that distinguishes this type of helicopter from others is their ability to fly in an inverted position. In this chapter, we will be taking a closer look at various features of this type of RC helicopter.

Component Parts

Power Systems

Collective pitch RC helicopters have two major types of power systems – internal combustion (IC) power and electric power. The three popular types of IC powered collective pitch helicopters include the nitro RC helicopter, the gas RC helicopter and the turbine RC helicopter.

Nitro RC models are also called “glow powered” helicopters. Glow powered RC helicopters are still being produced because they offer a fair power to weight ratio, they are tough, and they provide very durable and stable performance for several years. Nitro models are the least expensive option among internal combustion engines. They use a special fuel consisting of nitro methane, oil and methanol. They also use a glow plug instead of the spark plug used in gas powered models.

All fuel powered collective pitch helicopters have the following components: fuel tank, tubing, engine, centrifugal clutch, starting shaft, shroud, cooling fan, timed exhaust or muffler, a servo for controlling the carburetor, and a governor to control the speed of the engine.

Electric powered collective pitch helicopters are, however, the most popular among beginners. In fact, several veterans who started out with nitro or gas powered helicopters have shifted to electric powered models. The components that are different in the electric powered models include: the electric motor, lithium polymer (LiPo) battery pack, electronic speed controller (ESC).

All collective pitch models (regardless of their source of power) have a single main rotor, a tail rotor, swashplate assembly, servo, gyro, and a radio transmitter.

How Collective Pitch RC Helicopters Work

In a collective pitch model, the angle of attack or pitch of the rotor blades can be adjusted to control the lift of the helicopter while the engine/electric motor speed as well as the rotor speed remains constant.

Lift Control

While flying a collective pitch helicopter, the pitch is kept low until a fairly good head speed is attained. Then it is increased gradually to generate lift. The angle of attack can be reversed for aerobatic or 3D flight. This negative pitch is also useful in getting the helicopter down in a gusty wind. The pitch is controlled using the radio transmitter.

As you increase the collective pitch angle of the rotor blades, the helicopter begins to rise instantly without any noticeable time lag. To reduce the rate at which the helicopter rises, you need to decrease the collective pitch of the rotor blades and the aircraft will respond immediately. In fact, you only need to make a very minimal adjustment to the rotor blade pitch to obtain precise lift control on your aircraft.

Collective pitch is the principal method used to control lift in large and full size RC helicopters, especially when the aircraft's rotor diameter exceeds 24 inches (600 mm).

Moving From a Fixed Pitch to a Collective Pitch Helicopter

Many hobbyists express a lot of concerns about the differences between flying fixed pitch helicopters and collective pitch models. This usually happens when they have mastered how to fly a fixed pitch model and they want to move into the more challenging world of collective pitch helicopters. To make the transition smoother and less expensive (i.e. with fewer crashes), here are some vital points to note:

1. Choose the Right Machine and Radio Transmitter

A 400 or 450 size electric powered collective pitch RC helicopter is good for most learners since it can easily be seen (while flying) and it is more affordable for beginners. It also provides adequate stability in low wind conditions. It is important to note that using micro collective pitch models may make learning a little more difficult due to poor visibility. When flying a collective pitch helicopter, you must be able to clearly see the orientation of your helicopter in the air to control it effectively.

2. Basic Differences in Hovering

A collective pitch helicopter requires constant active piloting. Unlike the micro coaxial helicopter that will remain in a stable hover immediately you stop moving it around, the collective pitch model will drift away very fast if you stop making cyclic corrections to help it to hover steadily.

To master how to fly a collective pitch model, you need to learn to provide commands, assess the helicopter's instant reaction and provide counter input to prevent any unwanted movement while hovering. Essentially, collective pitch helicopters are dynamically unstable while hovering so you need to make several control corrections to maintain balance.

Cyclic control is usually the most challenging aspect of flying this type of RC helicopter. But it can easily be mastered by starting with easier ground hover exercises and working up to small hops. Then you can spend a longer period of time in the air as you develop better hand-to-eye coordination required to maintain a stable hover.

Other peculiar aspects of flying collective pitch helicopters will be treated in subsequent chapters that focus on how to fly helicopters.

Major Advantages of Collective Pitch Helicopters

Faster Lift Control: These models provide faster lift. So they can be raised up to a very high altitude within a short period of time. Once the desired revolutions per minute (RPM) is attained, the pitch can be adjusted to raise or lower the aircraft faster than a fixed pitch model.

Higher RPM: The main rotors on the collective pitch helicopter can rotate at a much higher speed than a fixed pitch model of similar size. For this reason, collective pitch helicopters provide faster flight performance.

Aerobatic 3D Flying: Collective pitch helicopters are the only models that can fly in all dimensions. These helicopters are capable of flying in an inverted position and they can be controlled effectively using negative pitch. Hence, they are excellent for learning how to perform exciting aerobatic stunts and various kinds of 3D loops.

Excellent Wind Resistance: This type of helicopter can be flown very well even in turbulent winds. Although it requires a reasonable amount of practice to be able to control the helicopter in turbulent winds, collective pitch helicopters provide the best mechanism for combating the adverse effects of the wind.

Conclusion

Acquiring and learning to fly collective pitch RC helicopters with great skill and proficiency is the dream of most RC helicopter hobbyists. These helicopters are the most versatile flying machines and they provide the greatest amount of fulfillment. However, they have a longer learning curve.

Module 3: Learning To Fly

Chapter 11

Flight Setup.

Virtually every type of RC helicopter needs to be set up properly before it is flown for the first time, whether it is ready to fly (RTF) or built from scratch. Some RTF manufacturers claim that their models have been checked and set in the factory so they do not require any further set up. But experience has shown that several parts of these helicopters still require checking, balancing and adjustment.

Prior to flying your helicopter for the first time, you should take time to ensure that it is flight-ready. This will prevent it from crashing during your first flight. You should check the state of several vital components to ensure that they will function optimally during a flight session. These components include: the swashplate, the main rotor, tail rotor, throttle and electric motor. In this chapter, several important procedures and tips on how to perform flight setup will be discussed.

Swashplate Setup

You should configure the swashplate type on your transmitter before you adjust any other settings because on most transmitters, once you set the swashplate type, you will automatically erase the model memory on your transmitter. To setup your swashplate type properly, study your transmitter manual first to know all the swashplate types that it supports. Then configure your swashplate accordingly. If you don't find your swashplate type, you may need to consult the transmitter manufacturer.

Servo Setup for Collective Pitch Helicopters

Precaution: Make sure you disconnect the motor wires from the electronic speed controller (ESC). Do not rely on the transmitter's throttle-hold function to prevent the electric motor from spinning accidentally. There are three settings to configure in the swashplate servo: centering, reversing and leveling.

Centering: Switch on the transmitter and the helicopter. Take off the transmitter trim from its cyclic controls. Set the throttle stick to rest at the middle of its range. When the throttle stick is at this position, the servo horns should normally be in a perfectly horizontal position. If you notice that a servo horn is not in a perfectly horizontal position, take off the servo horn and rotate it at 180 degrees before you re-install it.

Thereafter, you can fine-tune the servo arms position electronically with the transmitter's subtrim feature. Then adjust all the linkages that hold the swashplate to the servo to ensure that it is in the center of its own travel range once the throttle stick rests in the middle position.

Leveling: After the centering of the swashplate, check that the swashplate is at a precise right angle to the main rotor shaft. It should not tilt to the right/left or forward/backward positions. If you discover that the swashplate is not in a perfectly level position, take it off and re-adjust the linkages from the swashplate to the servos till the swashplate maintains a perfectly level position when its cyclic servos have been centered.

Reversing: Move the throttle stick on your transmitter up or down. When you shift the throttle stick upwards, the swashplate should also move up. And when you move the throttle stick downwards, the swashplate should move accordingly. If this does not happen, you should reverse servo direction settings on the transmitter till all servos move properly.

Pitch Curve Setup for Collective Pitch Helicopters

The pitch curve is setup on the radio transmitter. It sets the main blade's pitch angle for different positions of the left stick. You can establish different pitch curves for normal and idle up modes. You should use a pitch gauge for this procedure. Three pitch curve points need to be set: the first, last and the middle points.

Set the First Point: Follow the directions provided for your pitch gauge and position it on the main rotor blades of your helicopter. Then bring up the pitch curve menu on the radio transmitter. Next, move the throttle stick down to the zero throttle mark. Then set the first point of the pitch curve. The main blade pitch should change. Leave your throttle stick at this position so the transmitter can set the first point on the pitch curve. If you intend to practice flying in very calm conditions, then adjust the initial point for the pitch curve so that the pitch gauge indicator rests on zero degrees. But if you plan to fly in windy conditions, you should set the initial point on the pitch curve to -2 degrees.

Set the Last Point: Move the throttle stick to the maximum throttle position and set the final point on the pitch curve. Leave your throttle stick in this place to enable the transmitter to complete the process. The blade pitch should change immediately after you adjust the last point.

Set the Mid Point: Set the value of the middle point so that the pitch curve can form a straight curve between the first and last points. It is important to note that some collective pitch helicopters may require up to 10 degrees to hover. In such cases, you should raise the last pitch point to 15 degrees and re-adjust the mid points. If the pitch range is insufficient to properly set your first and last points, you should go into the mixing menu for the swashplate and raise the value of the pitch mixing setting.

Cyclic Setup

The swashplate servo setup must be done before attempting cyclic setup; otherwise servo motion will be incorrect.

Transmitter Setup: Move the transmitter stick, on the right, up and then down. The swashplate should move forward and backward. Then move the same transmitter stick left and then right. The swashplate should also move left and then right. Note that this setting applies to transmitters sold for use in U.S and Europe.

Adjust the Swashplate Level: When the transmitter sticks are at the central position, the swashplate should remain perfectly level. To ensure that the swashplate is level, position your helicopter at eye level behind a bookshelf. Then raise or lower it till the swashplate aligns with a bookshelf. If the alignment is perfect then the swashplate is perfectly level.

Check for Binding: Lower the throttle stick to the least value, apply the left/right cyclic, then move the before/after cyclic. Then adjust both together. If the servo is approaching its mechanical limit of motion and giving out a buzzing sound, it is binding. This binding needs to be corrected. Why? A binding servo will consume a huge amount of power during binding. And this will overload the BEC (battery eliminator circuit) and even shut it off. Consequently, the helicopter will go out of control or even crash. To correct the servo binding, you need to bring up the transmitter's swashplate mixing menu then decrease the elevator and aileron mixing to remove servo binding.

After reducing the mixing values, the values assigned to the elevator and aileron should remain equal. If your transmitter does not have swashplate support, you have to lower the left/right and for/aft servo endpoints to remove the servo binding. Make sure the servo travel remains constant after lowering those values.

Balancing Main Rotor Blades

Balancing the helicopter's main rotor blades will reduce vibration. Excessive vibration will hinder smooth flying, cause screws to get loose and increase radio frequency interference. On the other hand, lower vibration will make it easier for your aircraft to hover. It will also lengthen your flight time since it will reduce power consumption and decrease gyro drift. The gyro will also work more efficiently.

The method outlined below does not require any specialized balancing tools. But if you want to use a balancing tool, you can use the KSJ-528 blade balancer. There are two major steps: matching the blades' center of gravity (CG) and balancing the weight of the blades. You should use blade balancing tape for this exercise but electrical tape can also be used as a substitute if you do not have balancing tape.

Match the Blades' Center of Gravity

You can use a sharp point or round shaft as a balancing fulcrum. An old Stanley knife can serve as a sharp point while a spare main helicopter shaft can serve as a round fulcrum.

1. Place the helicopter blade on the fulcrum of your choice
2. Delicately move the blade either right or left across the fulcrum until the blade is balanced.
3. Use a felt pen to mark the balance point
4. Repeat steps 1 to 3 for the second rotor blade
5. Stack the main rotor blades (facing different directions). Insert a bolt into the main hole.
6. Check to see whether the CG marks align within 1.5 mm (1/16").
7. If the marks are very close or perfectly aligned, move to the next major step (Matching blade weight). If they are not, pick the blade whose CG mark is farthest away from the mounting hole.
8. Move the center of gravity of this blade nearer to the bolt hole by sticking about 1 to 2 inches of balancing tape underneath the blade close to the leading edge.
9. Repeat steps 1 to 3 to re-measure the center of gravity.

Matching Blade Weight

1. Weigh the blades so you can know how well matched they are. This will give you an idea of how much balancing is required.
2. Insert a bolt through the two blades to attach them together (facing different directions). Line them up straight either on a counter, a flat wall or a balancing apparatus.
3. Balance one end of the bolt on a book, wooden block or any object that will allow the blades to move freely.
4. If the blades don't appear perfectly horizontal, place a tiny strip of electrical or balancing tape underneath the lighter blade at its center of gravity right next to its leading edge.
5. Keep on adding or removing tape on this blade at its CG point till the blades are perfectly balanced.

Tracking the Blades of the Main Rotor on a Collective Pitch Helicopter

If the blades of the helicopter do not have the same pitch, one blade will produce more lift than the second blade while hovering. This will produce unnecessary vibration and reduce the energy efficiency of the helicopter. Before you track the main blades, make sure that the paddles of the flybar are parallel to one another.

1. Put a tiny piece of colored tape on one rotor blade. It may create some imbalance but it is necessary to determine the blade that is lower or higher while checking the tracking. Remember to take off the tape after you complete the tracking.

2. Slide a 1”x 4” board of about 6 feet length, on top of the landing skids, and through the aircraft’s landing gear. Hold down the board with cinderblocks. This is meant to securely hold down the helicopter if there’s an accident.

3. Check the helicopter and turn on the transmitter

4. Connect the battery pack and arm the helicopter

5. Raise the throttle up about one quarter.

6. Move to a safe distance and place a mirror on your feet, then tilt the mirror in a way that allows you to see the blades while you are standing up. If the blades are spinning in the same plane, they will produce an image that looks like this: -O- . If they need adjustment, they will look like this: >O<.

Tail Rotor Setup

If your helicopter has a tail rotor, you need to ensure that it is setup to move in the right direction. You also need to set the tension of the tail belt to suit your style of flying.

Tail Belt Setup: As a beginner, who is involved in light sport flying, let the belt tension be firm but not too tight. This will reduce friction and increase the belt’s lifespan, while increasing your flight time. If you are an experienced pilot, who is involved in aerobatics and 3D flight, increase the tension of the tail belt. Although it may increase friction and reduce its lifespan, it will stop the tail belt from slipping off in the middle of hard maneuvers.

Transmitter Tail Setup

For collective pitch helicopters, shift the rudder to ensure that the helicopter’s nose moves in the exact direction in which you shift the rudder. But the tail should move in the opposite direction. For instance, when you move the rudder to the right, the tail should move to the left. If the tail motor is installed on the left side of the boom, and you move the rudder to the right, the pitch of

the tail blades should decrease. But if the tail is mounted on the right side, moving the rudder to the right should increase the pitch.

On a fixed pitch helicopter, moving the rudder to the right when the rotor is installed on the left side will slow down the tail blades while if the tail rotor is installed on the right, a similar move will increase the speed of the tail rotor blades. If the tail does not move in the expected direction, simply change the rudder channel on the radio transmitter.

Conclusion

Performing pre-flight procedures is extremely important before your first flight and after you perform any major repairs on your RC helicopter. If possible, you should ask an experienced flight instructor or pilot to help you inspect your aircraft before you fly it.

Chapter 12

Fly Your Helicopter.

This is one of the most important chapters in this book. After your helicopter has been setup and inspected, you need to take the next step – start learning how to fly. All pilots of full size helicopters go through a great deal of training and practice before they can fly safely and comfortably. Similarly, in the RC helicopter hobby, the successful pilots take time to follow detailed flight instructions and practice until they became masters of the art of flying.

Most of the information in this chapter and the subsequent one will be of greater benefit to those who intend to learn how to fly single rotor collective pitch helicopters. However, if you are starting out with a micro coaxial helicopter, you will still gain a lot of valuable knowledge about how to fly. Micro coaxial helicopters do not require much flight instruction. However, the collective pitch models require more training and practice. But they offer greater excitement and fulfillment. Also, collective pitch models cost far more than micro helicopters so a crash will cost you a significant amount of money when you need to carry out repairs. Therefore, you should pay close attention to every detail given in this guide.

To obtain maximum benefit from this guide, you should use it along with a more detailed flight instruction manual. Take all recommended safety precautions, and prepare properly for each flight. Allocate a lot of time for practice until you master basic flight skills.

Basic Safety Precautions

As a pilot, you should always be conscious of the fact that the main rotor blade and tail rotor rotate at very high speeds. Therefore, careless use of the helicopter can result in serious injuries. Respect your aircraft's spinning blades. And make sure you don't fly your helicopter very close to yourself or to spectators. Many on-lookers are not aware of the potential dangers of rotating blades.

Make sure you do not transport an RC helicopter while the battery is connected. Radio interference can occur and activate certain controls on the transmitter. Also, the wind and your clothes could activate the throttle stick and the helicopter's electric motor will begin to spin.

Be sure to disconnect the helicopter battery as soon as the aircraft lands. Resist the temptation to leave your aircraft idle, with the battery connected, while you talk to friends or spectators.

Pre-flight Check up

You should endeavor to use this checklist before every flight session:

- Check all bolts and screws; ensure that they are not backing out or loose.
- Examine all control links on the tail rotor and main rotor. Pull them and make sure they are firm.
- Examine all rubber bands used to keep parts together. For instance, rubber bands may be used on the receiver, wires and batteries. If they are worn out, you need to replace them.
- Make sure that the batteries are fully charged. Do a load test on the battery attached to the receiver.
- Ensure that all electrical wires for power and servo are intact and all connections are firm.
- Look at the foam tape used to hold down the gyro. Make sure the gyro will not come off while flying.

Use Training Gear

The training gear for RC helicopters is an arrangement of sticks, in a cross pattern, with plastic balls at the tip of each stick. This training gear is attached to the base of the helicopter and it can be made of carbon fiber, fiberglass, or wood.

When you want to start flying, install the training gear or an extended landing device on your RC helicopter. As a beginner pilot, you will make a few blunders that can tip your aircraft over and make it crash even before it leaves the ground. Training gear will make it difficult for your helicopter to tip over and it will cushion the effect of hard landing. Training gear is not expensive and you can use it on both micro and large size helicopters. Once you have learnt how to take off and land your aircraft with ease, you can remove your training gear.

Set Up Your Flight Environment

In addition to setting up your helicopter for effective and safe flight, you also need to carefully choose and prepare a suitable environment for flying. This will help you to minimize crash damage. Here are some useful tips:

- Ensure that you have adequate space. Remove any obstructions that can be re-located like plastic crates, cars etc.
- Fly in still conditions. Avoid flying outside, as a beginner, when it is windy. You need to practice without the gust of the wind first before you gradually take on the additional challenge of managing the influence of the wind.
- Use a smooth floor for your initial practice sessions. Gravel, grass or dirt can make your helicopter trip over when it is sliding. However, you should practice low hovering and flying first.

Study Your Transmitter Controls

Before you make your first attempt to fly your RC helicopter, take time to carefully study the basic controls on your radio transmitter. You should also endeavor to use a flight simulator to practice and master the use of basic controls. It is important to note that a little shift of the collective or cyclic controls will have a major impact on the movement of the helicopter. Also, bear in mind that the controls function differently during hovering and forward flights.

Basic RC Helicopter Operation

In this section, we will discuss how to power your aircraft on/off and then introduce the first basic flight operation called hovering. In another chapter, we will go deeper into flying operations and development of flying skills.

How to Switch on Your Helicopter Safely

1. Reserve your transmitter channel (to do this, follow the steps given in your transmitter manual)
2. Carry your helicopter to the place where it will be flown (the helicopter battery must be disconnected while you carry it).
3. Draw out the antenna on your transmitter
4. Switch on your radio transmitter. After a few seconds, it should start transmitting.
5. Turn down the throttle stick to the inactive position.
6. Put on the transmitter's throttle hold
7. Ensure that the radio antenna is placed 2 or more feet from the helicopter's receiver. Then connect the helicopter battery.
8. Give some time for the gyro and ESC to initialize.
9. Check the radio range.
10. Move over to where you intend to stand, then with the throttle stick in the lowest position, switch off the throttle hold.

As a beginner, you should fly in normal mode until you have mastered basic hovering operations.

How to Switch Off Your Helicopter

1. Bring down the throttle stick to zero
2. Apply the throttle hold on your transmitter
3. Put down the transmitter at least 2 feet from the helicopter
4. Don't move near the helicopter until the blades stop spinning
5. Disconnect your helicopters' batteries
6. Turn off the transmitter
7. Retract the transmitter's antenna

Hovering

To hover your RC helicopter is to elevate it from the ground and keep a stable altitude and position in the air. Virtually all flights with your RC helicopter will start with hovering and be completed with hovering. That is why it is the first basic flying skill you must master. Hovering will help you to develop vital cyclic and collective pitch control skills. It will also help you to master how to control the helicopter in any orientation.

Tail-in Hovering

Before we round up in this chapter, we will describe a simple hover drill. The first hovering skill you should learn is tail-in hovering. This involves raising up the helicopter while the tail is pointing to you. It is relatively simple to master because the movement of the aircraft will be the same as the movement of the right control.

All the instructions given here are for the Mode 2 type of transmitter and a single rotor collective pitch RC helicopter. On this transmitter, the rudder and controls are on the left control stick while the cyclic control (aileron and elevator) are on the right control stick.

Drill 1: The aim of this drill is to develop a natural feeling for the aircraft's response to throttle and control inputs.

1. Push up the left stick slowly
2. Raise the main rotor speed slowly till the aircraft lifts up by 1 or 2 inches above the ground.
3. Keep the left stick in this position for about 20 seconds
4. Gradually lower the left stick and allow the aircraft to return to its original position on the ground.
5. Go over this short procedure as many times as it takes to do it without much conscious effort.
6. Repeat steps 1 to 5 and increase the lift to about 6 inches
7. Repeat steps 1 to 5 and raise the helicopter to 1 foot above the ground

As you practice these hovering exercises, keep the helicopter from drifting away from the initial orientation. You can do this by using the right control. You may need to move it slightly to the right to prevent it from drifting. Always make sure you achieve a gentle landing.

Conclusion

Learning to fly your RC helicopter proficiently requires consistent practice. To speed up the learning process, you should join a local flying club, make friends with other pilots, and even take lessons with an experienced flight instructor within your locality.

Chapter 13

Expanding Your Piloting Skills.

Mastering new flying skills is one of the most rewarding aspects of the RC helicopter hobby. In fact pilots, who have been flying for several years still strive to master more advanced flying skills and techniques. The possibilities for learning in this hobby are limitless. But before you start investing time to master new flying techniques, you need to understand that some skills are fundamental and they must be learned first. Thereafter, you can acquire more advanced flying skills.

Some of the basic flight techniques you must master include: tail-in hovering, side-in hovering, and nose-in hovering.

Intermediate flying skills include: forward flight, slow pirouettes, triangle, figure eight. Advanced flight techniques include: the circuit, the square, auto-rotations, loops, rolls and flips, stall turns, backwards flight, inverted hovering and flight, aerobatics and 3D flight.

In this chapter, we will provide some practical steps and tips to enable you develop basic flight skills. Before you start practicing these skills with your helicopter, try them out on a simulator. Using a simulator will drastically reduce the number of crashes and eventually save you plenty of money. Before you start real-life practice, make sure you review all the precautions and flight preparation steps given in the previous chapters.

Tail-in Hovering

Tail-in hovering is raising the aircraft up while the tail points to you and the nose points away from you. Although the main body of the helicopter points away from you, you should always focus on the nose and main body of the helicopter when you are controlling it.

Ground Hovering

This is the first aspect of tail hovering. It involves controlling the helicopter while it simply glides without lifting off the ground. You can also add a few hops as you become more comfortable with this skill. The main objective of this exercise is to learn how to control the helicopter. If you are flying a micro helicopter, you should ensure that you have a hard flat level surface either in your garage or on a pavement. The space should be at least 12 ft by 12 ft. For larger helicopters, use a surface that is at least 21 ft by 21 ft (e.g. an empty parking space).

1. First, ensure that you perform all the aircraft setup and flight preparation procedures.
2. Position your helicopter in the center of the ground space you want to use to practice ground hovering. This will serve as a reference point. Let the nose or pod point into the wind so that you can reduce the effect of the wind on the movement of the aircraft.

3. Follow the procedure in the previous chapter to power on your aircraft safely. Remember to always stand behind the helicopter anytime you are starting your first flight so you can have a good orientation. Stand about 8 to 10 feet behind your helicopter.

4. Raise your throttle stick to get the helicopter light on its skids. Then hold it at this point.

5. Handle any drifting gracefully. If the aircraft tends to drift backwards, give it a little forward cyclic. But if it begins to drift to the right, give it a little left cyclic movement. You only need a very little stick movement to accomplish this.

6. Lower the throttle gently to zero.

7. Repeat steps 4 to 6 about eight to ten times and then take a rest.

Continue this exercise until you are comfortable with the smooth, gentle movement of the two control sticks on your radio transmitter. Then you can move to the next set of tail-in hovering exercises.

Ground Hovering With Cyclic Movement

The aim of this exercise is to be able to get your helicopter to slide on the ground without tipping it over. If you are starting this exercise in a fresh flight session, make sure you follow steps 1 – 3 in the previous exercise.

1. Raise your throttle and get the aircraft light on its skids. Use the cyclic control to keep the helicopter from drifting off but don't allow the aircraft to lift off the ground.

2. Move your helicopter forward with a little forward cyclic command. Then gradually slide the aircraft to about 10 feet in front of the original starting point. You may need a relatively small amount of left or right cyclic movement to keep the helicopter moving in a straight line. A few tail rotor corrections may also be required to help the nose to keep pointing forward.

3. Lower the throttle and bring the helicopter to a halt.

4. Now you should bring your helicopter back to its original position. You can power off the aircraft and carry it back manually, or you can slide it backwards.

5. To slide backwards, simply repeat the steps you took to slide it forward. But this time, you should use the backwards command. The main danger here is that your aircraft's tail could hit the ground and get damaged. If your aircraft's tail rotor tends to hit the ground as you slide it backwards, you may omit the backward sliding and manually carry it back to the reference point.

6. Repeat steps 3 to 5 until you have developed effective hand-to-eye coordination and your hands have become used to the amount of movement required to effectively control the helicopter.

7. Practice moving to the left and right. From your reference point, raise the throttle till it gets light on the skids without lifting your helicopter off the ground. Then slide the helicopter to the left using the right cyclic control. Slide it gradually for about 10 feet to the left. Lower the throttle; then move back to the reference point with the right cyclic command.

Low Tail-in Hovering Exercise

The aim of this exercise is to learn how to hover your helicopter a few inches first, and then a couple of feet above the ground level. If you are carrying out this exercise in a new flight session, remember to do all pre-flight checks and observe all safety precautions. Follow the steps to power on your aircraft safely.

If you have been away from your helicopter for a while, you should refresh your mind and your hands by practicing some of the ground hover exercises.

1. From your reference position, raise the throttle gradually until the helicopter lifts off the ground by about two or four inches above the ground.

2. You will notice that the helicopter wants to drift. Apply a little right cyclic to keep it in a steady hover above the reference point. Then lower the aircraft once again by lowering the throttle stick.

3. Repeat step 2 and then move the helicopter forward/backward/left/right about 10 feet to and from the reference point while it is a few inches above the ground. This should be done in the same way you did the ground hover exercises.

4. Continue this exercise until you can move to and from the reference position in all four directions without the need to stop and land.

5. Gradually increase the altitude of the helicopter till you can hover and move at your eye level without crashing.

Side-in Hovering

After mastering tail-in hovering, you will be ready to attempt side-in hovering. Side-in hovering involves maintaining the helicopter at a stable altitude while the left or right side is facing you. From experience, it is better to take on the challenge of flying, in this orientation, in phases rather than making a sudden jump to 90 degrees side-in hovering. Start with 45 degrees then move gradually to 90 degrees.

Side-in hovering has two orientations: left side-in and right side-in. The left side of the helicopter will face you during a left side-in hover while the right side will face you during a right side-in hover.

1. Begin with a normal tail-in hover that takes the helicopter up to your eye level.

2. Once you have a stable hover, use the rudder stick (on the left) to turn the helicopter into a left side-in hover. Make sure you turn very slowly so you don't lose your orientation. Gradually increase the rate at which you turn as you become more proficient. If you notice that you are losing control, you should quickly return the helicopter to a tail-in position.

3. Repeat step 2 but use the rudder to turn the helicopter into a right side-in.

Nose-in Hovering

This is one of the tough orientations for most beginners. But with patient practice, you can learn to fly nose-in. However, you should try out your nose-in exercises on a simulator before attempting to do them with your helicopter. You should also make sure you are proficient with the tail-in and side-in orientations before you start flying nose-in. If anything goes wrong while flying nose-in, you should use quickly turn your helicopter to a tail-in orientation so you can avoid a crash.

Here are some tips to help you adapt to the nose-in orientation. When you are flying nose in:

- If your helicopter is flying away from you, shift the cyclic away from you.
- If your helicopter is flying towards you, shift the cyclic stick towards you.
- If your helicopter is flying to your left, shift the cyclic stick towards the left
- If your helicopter is flying to your right, shift the cyclic stick towards the right.

Conclusion

Expanding your flying skills requires constant practice for several months. You should always proceed slowly and make sure you master one skill before you move over to the next. This way you will be able to use the previously learned techniques to speed up the development the next set of flying skills.

Chapter 14

Two Basic Controls.

RC helicopters are controlled with radio transmitters. These radio transmitters are electronic gadgets with several parts – buttons, switches and dials - that work together to fly the model aircraft. During flight, the helicopter is steered using two basic controls: the left and the right sticks.

The Left Stick: Collective and Rudder Control

In a Mode 2 radio transmitter, the left stick has two major functions. When you move the left stick on the transmitter up or down, it makes your helicopter rise or descend. This is the throttle or collective pitch control. In addition, you can move the left stick to the right or to the left. This will make the nose of the model aircraft move to the right (clockwise) or left (counter-clockwise) respectively. This function is known as the rudder control. You should bear in mind that this control is also commonly referred to as the tail control. But since you should focus on the nose while flying, this control has been described using the nose of the helicopter.

The Right Stick: Cyclic Control

Similarly, the right stick has two main control functions. When you move the move the right stick on the transmitter up or down, it makes the aircraft move forward or backward. This control is known as the elevator (or fore/aft cyclic control) and it enables the pilot to give forward/backward cyclic commands. Also, you can move the right stick to the left or to the right. This will make the aircraft move to the right or to the left. And it is known as the aileron (or right/left control).

Methods of Holding Control Sticks

There are two basic methods of holding and manipulating the right and left sticks on the radio transmitter. The first is done by using the thumbs only. The pilot grabs the transmitter at the sides with both hands and then pushes the sticks with the thumbs. The second method involves using the index finger and the thumb to hold and move the sticks. This is known as the pinch method. The question most beginners ask is: “which method should I use – thumbs only or pinch”?

The thumbs only method gives you more freedom to use your index fingers to manipulate other parts of the transmitter. For instance, you can use your forefingers to control the Aux 3 and 4 side dials, by the side of some radios, in addition to the toggle switches. However, advocates of the pinch method say

that it enables them to have more accurate stick control. This may be of greater significance when practicing aerobatic maneuvers and 3D flight stunts.

It is important to note that there is really no right or wrong way of handling the left and right control sticks. So initially, you should try and practice with both methods and discover the one that gives you smooth and precise control of the aircraft. If you are really serious about developing your flying skills till you can handle aerobatics with ease, you should seriously consider the use of the pinch method. The pinch method will be an asset in future even though it is a bit more difficult to master.

Components and Functions of RC Helicopter Radio System

In addition to the two basic controls on your radio transmitter, it is vital to understand the basic parts and functions of your helicopter's radio system. This will help get better results from it and master how to use it quickly.

The four main components of a RC radio system are: the transmitter, receiver, servos and receiver battery. The transmitter (Tx) is the device you use to control the helicopter with two sticks, knobs and switches. Modern computerized radios are programmable. They have an LCD/LED menu with special dials and switches for selecting and entering data.

Other components of the radio system such as the receiver (Rx) and servos reside inside the helicopter. The transmitter makes contact with the receiver through a powerful antenna. The receiver captures radio signals sent by your transmitter. Then it transforms these signals into the electrical signals which the servos can understand.

The servos are tiny electro-mechanical devices which transform the electrical signals sent by the receiver into actual physical motion on the swashplate, main rotor, tail rotor and other movable parts of the RC helicopter. The movement of the aircraft's components is proportional to the movement of the control sticks. For instance, (as long as you have not enabled dual rates on your transmitter) if you move the throttle by 20%, the speed of the main rotor blades should only increase by 20%.

The receiver battery provides power to the servos and receiver. The receiver battery also has a special switch that is used to control the power supply to the receiver. And it also has a charging circuit that can be used to connect the battery to the mains for charging. However, in micro helicopters, receiver battery packs may not be present. This is because the electronic speed controller that controls the motor speed also provides power for the gyro, servos and receivers through a battery eliminator circuit.

Recommendations

If you are really serious about going deep into the RC helicopter hobby, you should carefully choose your radio transmitter. In fact, many hobbyists agree that the transmitter you choose will actually determine how well you can

develop your skills and how fast you can grow – moving from one helicopter to a more advanced one.

It is better to buy a well established name brand radio system that uses the latest 2.4 GHz spectrum modulation technology. Although the unrecognized brands may be cheaper (even as low as half the price) than most well known brands, you will eventually get what you paid for.

The name brand will offer you excellent customer support (which will be very important when you need to program and setup the transmitter and the helicopter). It will also give you superior warranties and full system compatibility. This means that when you select your aircraft or swashplate model, you will be able to carry out your flight setup quickly and easily. In addition, these brands of radio transmitters will provide the opportunity for long term growth, offer excellent build quality and a high resale value when you want to sell it to another hobbyist.

Chapter 15

Helicopter Stability.

In order to master the fundamental flying skills and move on to more advanced flying techniques, it is essential to learn and understand the subject of helicopter stability. In this chapter, we will take a closer look at this subject. After a brief definition of stability, we will discuss the components that make a helicopter more stable as well as some of the steps you can take to improve the stability of your helicopter during your early flight sessions.

What is Helicopter Stability?

Stability is the ability to maintain a particular spatial orientation regardless of external influence from the air, wind or other objects. A helicopter is said to be stable when it can quickly recover from little changes to its altitude or position.

Stability in the longitudinal axis, which prevents tilting sideways, is achieved through control commands from the pilot or through an in-built stability augmentation system. When any of these is absent, the aircraft begins to move in a direction that is dictated by its center of gravity and the direction of the wind. However, stability along the vertical axis during forward flight is achieved through the force coming from the tail rotor (where it exists) and the force of the tail's vertical stabilizer.

Why is Stability So Important?

Helicopters are inherently unstable. In fact, while a helicopter is hovering, it can move in any direction on any of its 3 axes. However, without stability, your helicopter will become extremely difficult to control and fly. Constant control input is required through your radio transmitter to keep your helicopter flying in a desired direction. If you stop giving this input, the aircraft can turn and get out of control. That is why it is essential to master the art of hovering thoroughly before you proceed to learn other flying skills.

Stability helps you to prevent costly crashes. Once you have learnt how to bring your helicopter back into a relatively stable hover, you will be able to get it to land without crashing. This is particularly important when you experience sudden changes in the wind velocity, when your helicopter is about to hit an obstacle, or when you notice that your flying session can be hindered by a sudden influx of spectators.

Achieving stability also enables you to use your helicopter for aerial photography and video recording. Stable flight is required to create useful proofs and movies. Once you have learnt how to keep your helicopter stable

while flying, you will be able to enjoy the more exciting aspects of the RC helicopter hobby.

Components That Enhance Stability

Gyro: The gyro or gyroscope is used to keep the tail of the helicopter stable. Why? The body of the helicopter spins in the opposite direction to the main rotor. The tail rotor generates thrust to overcome this tendency. However, while hovering or flying forward, the engine power will change frequently so the tail thrust also needs to vary rapidly. Since the control of the tail rotor can be extremely difficult to achieve with a radio transmitter, gyroscopes have been designed to handle this situation.

Gyroscopes were originally mechanical components equipped with spinning wheels. But modern gyros are now electronic solid state components. And they are more effective at keeping the tail of the helicopter stable. They sense and correct any unwanted tail movements that are not initiated through your radio transmitter.

Flybar: The flybar is a part of the main rotor system of the helicopter. Its major function is to provide automatic stabilization to the main rotor by altering the cyclic pitch. Thus, it reduces the effect of the wind and makes the helicopter easier to control. That is the reason why it is also known as the stabilizer bar.

Electronic Flybar: This is a special arrangement of gyros which control the cyclic servos. These servos will then carry out the function of a normal mechanical flybar. This type of arrangement is also referred to as electronic stabilization in coaxial helicopters.

Techniques to Improve Helicopter Stability

As a beginner pilot, you may discover that your helicopter is rather unstable and this makes it difficult for you to learn how to hover. Here are some steps you can take to lower the cyclic sensitivity of your helicopter and make it easier to learn hovering.

However, before you implement them on a collective pitch helicopter, you should bear in mind that these actions will lower control authority. And reducing control authority will make your helicopter less sensitive to commands during an emergency (e.g. when there is a sudden gust of wind). Therefore, you should take precautions and fly with these settings when the wind is still.

Put Weights on the Flybar

Slide a shaft collar on the two sides of the flybar to reduce cyclic sensitivity. You can slide the shaft collars into or out of the head. As you slide the shaft collars away from its head, the flybar's inertia will increase and cause the

cyclic to become less sensitive. To ensure that the flybar is not unbalanced, ensure that you place the shaft collars at an equal distance from the center.

The extra weight should not be kept on the flybar indefinitely. As soon as you become more proficient at hovering, move the weights towards the center for a while and then take them off. Once you can hover easily without the weights, you can proceed to forward flights. You may also use heavier flybar paddles instead of adding weights.

Lower the Swashplate Mixing

Cut down the elevator/aileron mixing percentages. You can do this on your radio transmitter using the swashplate mixing menu. Don't reduce it by more than 20% of the total so you don't lose the vital cyclic control you need to act fast in an emergency.

Reduce the Headspeed of the Rotor

Apart from improving stability for learning, reducing headspeed will allow you to fly for a longer time and cut down on the damage to your helicopter, if it crashes. You can still fly your collective pitch helicopter at a headspeed of about 1400 rpm.

How to Improve Helicopter Stability in Windy Conditions

When you attempt to fly in slightly windy conditions, you will notice that your helicopter could become a bit more difficult to control. For instance, when you turn your aircraft's nose into the wind, it will gain altitude, but turning away from the wind makes the helicopter drop very fast. To bring your helicopter under control and avoid crashing, you should use the ground effect and add some collective so you can land safely. However, if you turn into the wind you should lower your collective since the wind will naturally push the helicopter up. You can also lower the speed by pulling on the elevator. Finally, make sure you set up your pitch curve properly.

Conclusion

Attaining helicopter stability requires patient and persistent practice. After you have the basic knowledge on how to maintain stability, you should practice your hovering using settings that make your aircraft less sensitive and then return to a more sensitive cyclic when you are proficient in basic flying techniques.

Module 4: Modify Your Copter

Chapter 16

Tools and Supplies. (What You Need On Hand)

When you start assembling, modifying or maintaining RC helicopters, you will need to have three very important things: a spacious work area, a collection of vital tools, and adequate supplies. Some of the tools are basic while others are specialized tools made for setting up RC helicopters. Having proper tools, equipment and supplies makes the job of assembling and setting up your helicopter faster, easier and more rewarding. In this chapter, you will be given valuable tips on how to set up your work area. Then we will introduce the most important set of tools and supplies you need to start off and become proficient in your RC helicopter hobby.

Many beginners tend to overlook the importance of tools and supplies. In fact most people do not budget for this when they are estimating the cost of owning a new helicopter. But without acquiring all the important tools for assembling and setting up your aircraft, you will end up with a machine that will not fly properly or end up crashing during your first flight session. Even if you purchase a ready to fly helicopter, you will still require several tools for maintenance and repairs.

Set up Your Work Area

Before you attempt to open your helicopter kit, you should set up a suitable work area. Your work area should have a proper work bench. This work bench should be fairly large (at least 6 ft. by 4 ft.). It must be a flat top without any holes or cracks that can trap dust or accommodate small screws and other helicopter parts. Several good work benches are available at hardware and home improvement stores. Preferably, you should get a work bench that can easily be dismantled when it is not in-use.

Set up your work bench in a place that has sufficient lighting. You will be working with several tiny parts so you must make sure that you can work without unnecessary eye strain. In addition to your work bench, you should also have wooden or plastic shelves and drawers where you can keep some of your tools, equipment and supplies and helicopter parts. Make sure your storage facility will not be visited by children or pets. You should also get a very comfortable chair that is sturdy and allows you to work efficiently at the table.

Basic Assembly Tools

Drivers: RC helicopters have several screws, fasteners, bolts and nuts. Therefore you will need to have various kinds of tools to loosen and tighten them including:

- Complete screw driver set including Phillips heads and flat heads
- A metric socket driver set that includes sizes 4.0B to 7.0B
- Metric Hex drivers and Allen wrenches (including 1.5 to 3 mm), preferably with hardened ends. (e.g. the Turnigy basic hex driver set or the set offered by E-flite – manufacturers of the Blade brand of RC helicopters

Pliers: You will need two special types of pliers: the needle nose pliers and the ball link pliers. Ball link pliers are specialized pliers used mainly for RC helicopters. Don't fall into the temptation to substitute needle nose pliers where the ball link pliers are required; it will damage them and you will end up spending more money to replace them. If you have a model that uses snap-rings, you will also need snap-ring pliers.

Other vital tools you should acquire include:

- Hobby knife with different blades (e.g. the X-Acto knife)
- Electric drill with a set of drill bits. More advanced pilots should acquire the Dremel tool set that provides tools for drilling, grinding and cutting.
- Metric steel ruler
- Basic Tweezers
- Soldering Iron and Rework Station
- Assembly Towels (for trapping small screws and component parts and preventing them from getting lost)

Supplies for Helicopter Assembly/Modification

The following supplies and accessories will be required for effective and efficient assembly of your model helicopter kit. You will also need these supplies when you need to maintain, repair or make modifications to your aircraft.

- High quality medium-sized rubber bands (to hold wires and battery packs together)
- Tri-flow oil (to provide light lubrication for parts that slide during operation)
- Bearing grease (to lubricate various ball bearings)
- Velcro ties (these thin adjustable plastic straps are used to secure wires and avionics)
- Nylon zip ties (also known as cable ties, perform the same function as Velcro ties)

- Two-sided adhesive tape (also known as foam mounting tape)
- Thread locker (e.g. medium strength blue loctite to prevent screws and nuts from becoming lose due to vibration)
- Instant cyanoacrylate (CA) glue
- Foam wrap (to enclose sensitive electronic components and prevent damage by vibration)
- Epoxy glue with a metal base
- Epoxy with medium speed (that sets within 20 to 30 minutes)

Tools for Helicopter Setup

In the chapter on flight setup, we described various setup procedures that are essential for safe and smooth flight. Here are some of the tools you need to carry out most of the recommended setup procedures.

- Blade tracking tape (to adjust the center of gravity of a pair of rotor blades and ensure that they are perfectly aligned)
- Small bubble level (to check that surfaces are straight, or perpendicular)
- Pitch gauge (to measure and set the pitch of rotor blades in collective pitch helicopters)
- Digital calipers (to obtain precise and accurate measurement)
- Rotor blade balancer (makes it easy to balance rotor blades with greater accuracy)
- Thermometer (to check the motor temperature)
- Tachometer (used to measure the speed of the motor in revolutions per minute)
- Watt meter (used to measure voltage, current, power, peak current and peak power, energy, charge and temperature in real-time). It enables you to assess the efficiency of your electric motor and help you to fine tune your helicopter and improve its performance.

A watt meter allows you to measure the current flowing through the electronic speed controller (ESC). You can also use it to estimate the total running time of your battery and measure the efficiencies of the motor, battery eliminator circuit and ESC.

Conclusion

Several vital tools and supplies have been listed in this chapter. It is important to note that you should acquire the best quality tools that you can afford now. Then as you progress in this hobby, you can replace them with higher grade tools. Remember that you do not necessarily have to buy each and every one of these tools as brand new from the store. You could get some of them from more experienced pilots, flight instructors, and members of flying clubs.

Chapter 17

Battery Choices.

The main battery pack on your helicopter is a very vital component of your helicopter's power system. A battery pack is usually made of a group of storage cells. A storage cell stores electrical charge and then releases it later at a specific voltage. It is important to choose the right type of battery for your helicopter because your battery will determine the amount of power that will be available to fly your helicopter. It will also limit the amount of time that your helicopter can spend in the air. Therefore, this chapter will provide information to help you to understand basic battery terminology as well as some vital information on how to make the best choice from all the on-board batteries available for RC helicopters.

Basic Battery Terminology

Here is a brief introduction to the common terms you will come across as you shop or do more research on RC helicopter batteries.

Current Capacity Rating

A battery's current capacity is measured in Ampere-hours (Ah) or milliampere-hours (mAh). 1000 milliamperes is equal to 1 Ampere. One Ampere-hour can be defined as the capacity to release one ampere for a single hour. Therefore, 3 Ampere-hours is the capacity to release one Ampere for three hours, or 3 Amperes for one hour, or any other equivalent combination. Experience has shown that a battery's efficiency is reduced as you draw higher amounts of current. For example, a 5000mAh battery can supply 500 mA for about 10 hours, but it may supply up to 5000 mAh for just 30 minutes. Hence, the actual capacity for any battery is specified at a current that is fixed by the manufacturer.

Battery Series/Parallel Rating

Some helicopter batteries have specifications like "4S2P 5000 mAh 10C". The first part of this specification: "4S2P" represents the series/parallel configuration of the battery. In this example, it means that there are 4 batteries arranged in series and then 2 sets of these are arranged in parallel to give a total of 8 cells.

As explained earlier, the total capacity of the battery will be 5000 mAh. Since there are 2 sets of batteries arranged in parallel, the individual capacity of each battery is 2500 mAh. This illustration shows that you can increase the current capacity of batteries by arranging them in parallel. For example,

- 2 sets of 1800 mAh arranged in parallel gives a total capacity of 3600 mAh

- 3 sets of 2100 mAh arranged in parallel gives a total capacity of 6300 mAh

Discharge Rate and Internal Resistance

Every battery, regardless of its chemical composition, has a certain amount of internal resistance. This internal resistance determines the battery's highest continuous discharge rate. For Nickel-based batteries (NiCad and NiMH), the unit of internal resistance is milliohms (m?). A high resistance provides less current while a lower resistance delivers higher current.

To estimate the highest discharge current possible, you can divide the internal resistance in milliohms by 125. For instance, a battery with an internal resistance of 3.5 milliohms will supply 125/3.5 = 35.7 amps of continuous current. For LiPo cells, the maximum discharge rate is specified as the C-rating. Typical specifications include: 10C, 12C, 15C and 20C. The C-rating is the current capacity rating of the battery in milliampere-hours. So if the discharge rate is given as 10C, the battery will be able to provide a maximum discharge current of:

2500 * 10 or 25000 mA or 25 Amps.

Discharge Cycles

Every battery can be charged or discharged for a certain number of times before they begin to lose charge rapidly and fail. This is commonly referred to as the number of charge/discharge cycles or the battery lifespan.

Types of Batteries

RC batteries are categorized based on their chemical composition. There are three main types of batteries available for RC helicopters.

1. Nickel-Cadmium (NiCad)

2. Nickel-Metal Hydride (NiMH)

3. Lithium Polymer (LiPo)

Nickel-Cadmium Batteries

Nickel-Cadmium batteries are the oldest and most durable of all three battery types. They are known to be rugged and they show great tolerance in adverse conditions such as vibration and overcharging. NiCad batteries are less prone to damage during crashes. This type of battery offers the highest number of

charge/discharge cycles (usually more than 200). They usually supply 1.2V per cell and they can be re-charged at a rate of 2C with simple battery chargers.

Drawbacks: NiCad batteries are quite heavy so they increase the weight of the helicopter. They use round cylindrical cells which consume more space. They also contain cadmium which is toxic to the kidney and lungs. When compared to the new types of batteries, NiCad batteries have a lower maximum current capacity and therefore they offer shorter run times.

Nickel-Metal Hydride Batteries

NiMH is similar to NiCad batteries but they have the capacity to supply more energy than NiCad batteries. However, they have a much shorter lifespan. Most NiMH batteries cannot last beyond 100 charge/discharge cycles and they are less resistant to crash-damage, vibration and overcharging.

Lithium-Polymer Batteries

This is the most recent out of the three main types of RC helicopter batteries. They provide over 3 times the energy capacity of NiCad batteries. Typical lithium polymer cells have a 3.7 Volts rating. And they offer much longer flight times. These batteries use flat-pack cells instead of cylindrical cells so they are much lighter than Nickel-cadmium cells. However, they are not very durable and they easily get destroyed due to crashes. They must be handled with care while charging. You should never overcharge a LiPo battery pack or charge them unattended. Lithium metal is volatile and it ignites easily when it is exposed to air.

How to Select a Suitable LiPo Battery

Despite the higher cost, fragility and risks of getting ignited, lithium polymer batteries are now the most widely used type of RC helicopter battery today. This is due to their lower weight and higher discharge rate. Here are some points to consider when choosing a LiPo battery pack:

Shape: The LiPo batteries come in a various shapes and series/parallel configurations. Some are even designed for specific helicopters. So ensure that you are aware of the exact shape of battery that can fit properly into your model aircraft without the need for unnecessary modification.

C-Rating: A high C-rating will provide more power at a faster rate. But this usually comes at a higher price. As a beginner you may be comfortable with 20C or lower. But more advanced pilots may opt for more powerful batteries that can deliver up to 35C for faster maneuvers during aerobatic stunts.

C-Rating for Charging: The charging C-rating determines how fast your batteries will be charged. You should choose a battery pack with 4C rating or higher. This will enable you to get the battery charged in 15 minutes or less with the specialized chargers that are now available.

Current Capacity: This is a very important factor to consider because it determines how long you will be able to fly on a single charge. A higher current capacity (in mAh) will keep your helicopter flying for a longer time. But you should also bear in mind that higher capacity batteries will be heavier and more expensive.

Conclusion

RC helicopter battery technology is poised to improve at a very fast pace. Several new types of lithium batteries are being tested such as the Lithium-Iron (LiFe) and lithium-air. However, you should always ensure that you take all required safety precautions and use the best charger you can afford to preserve the life of the battery and avoid any hazards.

Chapter 18

Helicopter Motors.

Electric motors drive the rotor blades that enable your RC helicopter to fly. One of the most significant improvements/modifications you can make to your RC helicopter is to use the most suitable electric motor. The motor you choose should be powerful enough to fly your helicopter the way you want and still be as energy-efficient as possible. It should also provide the kind of performance you need for all the flight conditions you will encounter. In this chapter, we will describe the major types of electric motors available for copters. We will also provide tips on how to choose a suitable motor for your model aircraft.

Two major varieties of electric motors are available for RC helicopters - brushed and brushless electric motors. A good understanding of how these motors function will make it easier for you to set them up, fine tune or troubleshoot problems when they occur.

How Electric Motors Work

Electric motors make use of the forces of attraction and repulsion that are inherent in magnets to create rotation. Electric motors have two main parts – a rotor and a stator. The stator is the part of the motor that remains static. It is usually made up of a coil of wires that serves as an electromagnet. The rotor is the part that moves (or rotates) and it is usually a permanent magnet that connects to the visible shaft of the motor. The shaft sticks out of the motor to connect to the main rotor of the helicopter.

The rotor's permanent magnet has a north pole and south pole. The coils in the stator are controlled in pairs and they are used to create a north pole and south pole on either side of the motor. As current flows through the coils, the north and south poles of the rotor will be attracted or repelled based on the polarity the coils. Therefore, the rotor will be forced to rotate to bring about repulsion or attraction. Both brushed and brushless motors work on this principle.

Brushed Motors

In brushed motors, the current is re-directed between the groups of stator coils through mechanical means. A device known as a commutator connects the external wires (bringing in the current) to each set of coils through a conductive brush.

Today, brushed motors are usually found in most beginner hobby-grade helicopters and in most micro and toy-grade helicopters. They are also found

in a few helicopter kits and large helicopters. Brushed motors are categorized into fixed and non-fixed models. Fixed motors cannot be adjusted, tuned or modified. But non-fixed motors have replaceable brushes. They can easily be modified and cleaned.

Brushless Motors

A brushless motor uses the same working principle as the brushed motor. But it does not use the mechanical commutator to redirect current; instead it uses an electronic commutator. In the electronic commutator, the rotor is turned by applying a current to the winding at the right timing with the aid of an electronic speed controller.

There are two main kinds of brushless motors: inrunner and outrunner. This classification is based on the position of the stator and rotor. An inrunner motor has a stationary coil and a permanent magnet on the motor shaft that rotates within the coils. On the other hand, the outrunner motor has a stationary coil in the center while the permanent magnet rotates around the coil. Inrunner designs have higher KV ratings so they are ideal for flying RC helicopters at high speeds. They are usually coupled to gear boxes. Outrunners are however lighter and more efficient at giving off heat and they have a direct drive.

Brushed vs. Brushless Motors

Brushed motors have just two connection wires while brushless motors have three. Since brushed motors have mechanical brushes, they wear out with use and they eventually fail. But brushless motors don't wear out easily and they offer a longer operating lifespan. Similarly, brushed motors produce friction and heat so they are less energy-efficient while the brushless motors deliver higher efficiency and greater speed. However, brushless motors require sophisticated electronic speed controllers and they cost more than the brushed motors. Today a brushless motor is the preferred choice for most electric RC helicopters except the smallest ones.

How to Choose an Electric Motor for Your RC Helicopter

1. **Follow the helicopter manufacturer's recommendation**. Check out the helicopter kit's specification sheet for any recommended electric motor ratings. If you are planning to upgrade from a brushed motor and you can't find the specifications for a brushless motor – for a corresponding weight, size and function - you should simply ask the manufacturer for their suggestions.

2. **Understand basic electric motor specifications.** The most important technical specifications you need to know include:

    - **RPM** – revolutions per minute; the measure of how fast the motor can rotate

- **KV Rating** – the speed constant of the motor, specified as revolutions per minute per volt. This number allows you to calculate the number of volts required to produce a given RPM. For example, an 800 KV motor powered by 12V will spin at 800 RPM/V x 12V = 9600 RPM without any load.

- **Io** – the amount of current the electric motor consumes when it is running without any load. You can use this factor to calculate the efficient operating range for a particular motor. A good rule of thumb is to allocate 10% of the hovering current for Io. For example, if a particular helicopter requires about 4 amps to hover, you should choose a motor that has an Io of about 400 ma. A higher Io will not be energy efficient. In general, higher quality motors have a lower Io.

- **Watt** – a measure of the power consumption of the motor (i.e. how fast energy is used)

- **Motor Weight** – Since you will have to contend with the natural pull of gravity, you should choose the lightest motor that will give you the required power. If you choose a lighter motor, it will require less energy to fly.

- **Motor Efficiency** – You should always choose a motor with a higher efficiency. The amount of heat and wasted energy generated by less efficient motors can adversely affect the performance of your aircraft. A reduction of 5 to 10%, in motor efficiency, can double the losses due to heat.

3. **Consider your flying style.** If you desire to fly at higher speeds, you should choose a motor with a higher KV rating, but if you want to maneuver your model helicopter slowly and perform stunts, you may prefer a lower KV motor.

Conclusion

Choosing the most suitable and efficient motor for your helicopter will improve its overall flight performance. It will give you more flight time per battery charge and make your hobby more rewarding. To select the best electric motor for your helicopter, consider all the factors given above and pick the most suitable one that fits your budget.

Chapter 19

Electronic Speed Controls.

The electronic speed control (ESC) is the device that controls the amount of power that flows into the electric motor. This device could stand alone or be an integral part of the helicopter's receiver. The main purpose of the electronic speed controller is to interpret the signals coming in through the receiver and then regulate the speed and direction of the motor. The ESC may also function as a form of braking mechanism. ESCs are available in various sizes with different kinds of features. This chapter focuses on how ESCs work and what you should consider when you want to choose a suitable one for your RC helicopter.

The Purpose of the Electronic Speed Control

ESCs work on the principle of pulse-width modulation (PWM). To appreciate how brushless and brushed ESCs perform their function, you need to understand PWM. Here is an illustration that can help you to visualize low PWM works.

First, visualize a valve-controlled water pipe. This pipe can be fully shut or completely opened. Imagine that when this valve is fully opened, it allows water to flow at a speed of 20 liters per minute. But when you close the valve, the water flow ceases. Consequently, you can achieve a water flow rate of 10 liters per minute by opening the water valve for 10 seconds, then closing it for 10 seconds and repeating the process for several minutes. The average flow rate will be reduced by half since you have kept the water valve open for exactly 50 percent of the time. This is equivalent to a flow rate of 10 liters per minute.

Similarly, if you need to obtain an average flow rate of 4 liters per minute, you may keep the valve open for 4 seconds and then close it for 16 seconds and then keep repeating this for several minutes. The average flow rate is determined by this formula:

Average voltage = Allowable voltage * Time on / (Time on + Time off)

The average flow rate will be 4 liters per minute but the highest flow rate achieved will still be 20 liters per minute.

Electronic speed controls work in a similar manner. ESCs have a maximum current that can flow through them but they can provide a lower current through PWM. The current provided is directly proportional to the amount of power delivered by the electric motor. If you send a throttle signal of 40% from your radio transmitter to the receiver, the ESC will provide maximum

power to the electric motor for exactly 40% of the time. But if the throttle stick is raised to 80%, then the ESC will provide maximum power to the electric motor 80% of the time.

How to Select a Suitable ESC

If your RC helicopter's ESC needs to be replaced, there are some important things you need to consider. First, you should focus on the basic features before you focus on price, brand or quality. Here are some of the most basic features to consider:

Current Rating

Always choose an ESC that has a higher current rating than the maximum amount your motor can draw. Make sure you know the maximum current that your motor will draw at full throttle. If the electric motor will drain 15 amps, a 30 amps rated ESC will be a more suitable choice than a 15 amps rated ESC. Remember that the pulse-width modulation principle indicates that when you are flying at 50% throttle, you are simply using the full current 50% of the time. Your ESC and battery are actually delivering 30 amps of current for 50% of your flight session. So using an ESC with 15 amps or less will cause overheating and your helicopter will shut down if you attempt to increase the throttle.

Type of Electric Motor

Select the appropriate ESC for the type of electric motor you have. There are two types of motors: brushless and brushed. You can easily identify the type of motor you have by the number of wires sticking out of the motor. Brushless motors have three wires while the brushed version has just two. You should use a brushed ESC for a brushed motor and a brushless one for brushless electric motor. Sometimes, it may also be beneficial to choose an ESC that was designed by the same manufacturer of the electric motor.

Voltage Rating

Carefully examine the voltage on the ESC you want to use. Every ESC has a specified voltage limit. Some ESCs are designed to provide power for the receiver and servos. This type of ESC will have a second voltage rating based on their BEC – battery eliminator circuit.

Three categories of ESC exist with respect to their voltage rating: high voltage, mid-range, and low voltage. The high voltage ESCs usually have a voltage rating above 25V. The mid-range ESCs have voltages of between 13V to 25V. Those with voltages less than 13V are classified as low voltage ESCs.

The voltage rating of the ESC you choose should match the voltage of the battery you will connect to it. Connect a low voltage ESC to a low voltage battery and a high voltage ESC to a high voltage battery.

Programmable ESCs

Many ESCs are like “plug-and-play” devices. You simply connect the ESC to the battery and electric motor and it will perform its function. However, there are ESCs that have programmable features. You can program them to provide unique throttle profiles. This type of ESC can be programmed using a USB cable and proprietary computer software.

Over-discharge Protection with Auto-Shut Off

It is important to choose an ESC that can prevent your battery from being over discharged. The voltage in lithium polymer batteries should not be allowed to become too low. If the battery voltage drops below a safe threshold, the batteries may become permanently damaged. In fact, some lithium polymer batteries can catch fire due to over-discharge. A good ESC will shut down the electric motor before the battery runs down completely and give you an opportunity to have a safe landing. The auto-shut off feature usually works with a battery eliminator circuit.

Conclusion

Electronic speed controls play a very important role in the power system of an RC helicopter. It connects the motor to the battery and regulates the speed and performance of the electric motor. It receives input from the receiver and even provides power for the receiver in certain model helicopters. To choose the most suitable ESC for your helicopter, you should ensure that the ESC has the fundamental characteristics required to power your motor and fly your helicopter safely and effectively.

Chapter 20

Electronic RC Radios.

RC radio is the most important component you must have after the actual RC helicopter. As you advance in this hobby, you will discover that the quality of your RC radio transmitter and receiver determines how well you can fly your helicopter. It is the radio transmitter that sends your commands to the receiver in the helicopter; the receiver then interprets the signals and uses them to control the components of helicopter.

In order to develop excellent flying skills, you should invest in the best radio that you can afford. Since one good radio can provide excellent service for several kinds of helicopters for several years, it is vital for you to know how to make the best choice. In this chapter, we will provide several helpful tips on how to choose a radio transmitter for your helicopter.

How to Choose an RC Radio

If you have bought a helicopter kit for a hobby grade collective pitch helicopter or you simply need to replace an old RC radio, you need to carefully select a new RC radio transmitter and possibly a new receiver. Before you select your RC radio, you should do a little research and get sufficient information about the type of RC radio that can meet your present and future needs. Here are some points to consider:

Transmitter Mode

Currently, there are four distinct transmitter modes. The major difference in modes is linked to the function of the left and right joysticks. Here is a brief description of each mode:

Mode 1: The right joystick regulates the throttle and collective (by moving up/down) and it controls the left and right cyclic (by moving left/right). The left joystick regulates fore/aft cyclic (by moving up/down) and it controls the left and right yaw (by moving left/right).

Mode 2: The right joystick regulates the fore/aft cyclic (by moving up/down) and it controls the left and right cyclic (by moving left/right). The left joystick controls the collective and throttle (by moving left/right) and it controls the left and right yaw (by moving left/right).

Mode 3: The right joystick controls the throttle and collective (by moving up/down) and it regulates the left and right yaw (by moving it left/right). The left joystick controls the fore/aft cyclic (by moving up/down) and controls the left/right cyclic (by moving left/right).

Mode 4: The right joystick operates the fore/aft cyclic (by moving up/down) and it controls the left/right yaw (by moving left/right). The left joystick regulates the throttle and collective (by moving up/down) and controls the left/right cyclic (by moving left/right)

Mode 2 transmitters are the standard in the United States, Canada and some countries in Europe while Mode 1 transmitters are commonly used in Asia and Europe. Mode 3 and Mode 4 transmitters were introduced more recently. Several pilots have started using them for more advanced flying techniques and 3D flight.

It is important to note that on some transmitters (particularly those which can be used for both RC airplanes and helicopters), left/right yaw is equivalent to rudder, fore/aft cyclic is equivalent to elevator and left/right cyclic is equivalent to aileron.

Number of Channels

A channel is basically a stream of numbers (or digital signals) sent from the transmitter to the receiver. Generally, transmitters and receivers have a specific number of channels that they can send or receive signals from. The stream provided by each channel can regulate various parts of the helicopter. For example, it can be used to transmit a throttle command to the electronic speed controller, to regulate the movement of one or more servos, or to perform other important functions on the helicopter.

Many beginners who are planning to buy their first RC radio usually want to know the number of channels it should have. You should choose the number of channels on your transmitter based on the type and complexity of your RC helicopter.

Four Channels: This is the least you should buy for hobby grade helicopters. If you are just starting this hobby and you are flying a micro coaxial helicopter that has cyclic controls or a fixed pitch helicopter with tail rotor or a multi-rotor helicopter, a four channel transmitter is the minimum you can use. One channel each will be allocated for throttle, yaw, left/right and fore/aft cyclic movements.

Five Channels: If you are planning to fly collective pitch hobby grade helicopters, the minimum number of channels you need is five. The fifth channel will be used for collective pitch control of the main rotor.

Seven or More Channels: If you really love flying helicopters and you plan to continue this hobby for many years, you should invest in a transmitter with 7 or more channels. You can use this type of transmitter for all your model helicopters. It will enable you to program and save control settings for all the helicopter models you have or plan to acquire in future.

Type of Modulation/Protocol

Several types of modulation technologies have been used in the RC world to transmit radio frequencies including: amplitude modulation (AM), frequency modulation (FM), pulse position modulation (PPM) and pulse code modulation (PCM). These are all narrow band transmission systems. However, virtually all RC radios, today, use the 2.4 GHz spread spectrum technology. This technology prevents interference between signals from several radio transmitters within the same vicinity.

Two major brands of spread spectrum technology are DSM from Specktrum and the AFHSS from HiTec. The DSM protocol is used in several Specktrum receivers and clones. Therefore, it is very economical to use a Specktrum transmitter when you are just starting out. The AFHSS protocol developed by HiTec works with more durable and robust hardware and it offers greater protection from interference. However, these HiTec transmitters are far more expensive than the Specktrum counterparts so they are more suitable for those who are well established in the RC helicopter hobby.

Programmable or Standard Radio

Two kinds of radio transmitters are available: the computerized transmitter and the standard transmitter. The standard transmitter has the left and right joysticks as well as some other knobs and switches. But using a standard transmitter does not give you adequate room to create new settings and program your own joint cyclic movements.

On the other hand, the computerized radio has a small display and buttons that allow you to create, save and re-load configurations. Therefore, when you are using your transmitter for more than one model aircraft, you should use a computerized radio. Computer radios also provide templates for different types of model helicopters.

Brand

Several brands of RC radios are available from major retailers. When you are choosing a brand, you should look beyond the marketing hype and focus on choosing a durable, top-grade computerized radio which will provide safe and hassle free flying with high compatibility with most receivers and helicopter models. Four brands stand out clearly for their quality and versatility. So you can begin your research by focusing any of these radio brands: Specktrum, HiTec, JR and Futaba.

Other Specific Features

RC helicopter radios have some unique features that set them apart from other radios used for flying airplanes and other aircraft with fixed wings. That is why you should not attempt to fly a hobby grade collective pitch RC helicopter with a standard RC airplane radio. However, there are computerized RC radios that can be used to fly both airplanes and helicopters.

You simply have to select the type of aircraft you want to fly and it will provide all the channels and controls you need. Some of the functions you should look out for in a hobby grade RC helicopter radio include:

- Throttle hold
- Flight modes/idle up
- Programmable throttle curve
- Programmable pitch curves
- Revolution mixing/tail rotor compensation
- Cyclic collective pitch mix

Conclusion

Choosing an RC radio for your model helicopter is a very crucial decision. As a beginner, who is serious about the RC helicopter hobby, you should choose a radio with adequate channels, with robust hardware, and good programming features that will allow you to use it for more than one model helicopter.

Chapter 21

Blades and Other Body Parts.

Every RC helicopter pilot cherishes a perfectly responsive helicopter as it hovers and flies smoothly in the sky. However, once in a while, you may experience a crash. Apart from crashes, you will need to keep your machine in good working condition through regular maintenance. Even if you are currently flying a ready-to-fly model, you will eventually need to replace the blades and other body parts and accessories. Here is a brief discussion on some of the important helicopter body parts.

Rotor Blades

The main rotor blades are an extremely important part of the helicopter. They are very prominent due to their position on top of the main body of the helicopter. The blades are connected to the main shaft which transmits power to it from the electric motor. The blades rotate to provide both lift and thrust. They are usually made of carbon-fiber or wood.

In collective pitch helicopters, rotor blades play a very crucial role. They lift the helicopter in two ways: by rotating faster and by changing their pitch (or angle of attack). Therefore, you should make sure you use the most suitable blades when you are replacing the original.

Rotor blades get damaged very easily even when your helicopter is involved in a minor crash. It is important to replace any damaged rotor blades promptly so that they do not explode in mid-air. That is why you should endeavor to have extra rotor blades available on hand so you can keep on flying with little disruption. When you are planning to buy a new set of rotor blades for your helicopter, here are some important points to keep in mind:

- Buy the correct diameter of rotor blade for your helicopter. If you are beginner, simply stick to the original diameter that came with it.

- For collective pitch helicopters, make sure you buy rotor blades that have symmetrical airfoils. This is essential for successful inverted flight. Fixed pitch helicopters can make use of asymmetrical airfoils.

- Choose a durable name brand. Examples of well known brands include: Syma and Edge.

There are two main categories of rotor blades based on the choice of material. Wood blades are cheaper; but they are not very power efficient. So they can't be used for very high speed flying. On the other hand, carbon/fiberglass blades are more power-efficient. Therefore, the helicopter can perform high-

stress maneuvers and the helicopter's controls will be more responsive. However, they can cost as high as six times the price of the wooden variety. If you are a beginner and you are just learning how to hover, fly forward and do simple aerobatics like rolls and loops, wooden blades may still meet your basic needs.

Servo

A servo is a device which converts electrical commands from the receiver into physical movement. It usually consists of a single electric motor (which drives an output shaft) and an electric circuit for power connection and to control the electric motor. Servos are used to move the swashplate and other important components to a specified position. And they hold this position until another command is given.

RC helicopter servos are controlled using three wires. Two of the wires supply the direct current electricity for the motor while the third one sends the control signals. The receiver communicates with the receiver through a series of pulse signals.

Servos usually need to be changed when they wear out or as a result of a major crash. Here are some of the characteristics you should look out for when you want to replace a servo:

Size: Typically, there are 3 sizes of servos: micro, standard and 1/4 scale. These sizes cover all the RC models in operation as well as all the applications that are required on a helicopter.

Torque: This is a measure of the strength of the servo. It is a product of the angular force and the radius over which it acts. This torque provides the maximum rotational force that can be applied at 90 degrees to the servo arm. In most servo specifications, torque is either measured as ounce inches or kilogram centimeters. For example if a the torque of a servo is specified as 120 ounce inches (oz-in), it means that if the servo arm was 1 inch long, the servo arm will provide a 120 ounce pull or push force at 90 degrees to the servo arm.

Speed: The speed specification for most servos is given as the amount of time it will take it to turn 60 degrees. The smaller the speed value the faster the servo will be. So if the speed is specified as 0.12, it will take the servo arm 0.12 seconds to turn 60 degrees.

Gyro

A gyro (short form of gyroscope) is a device designed to make a helicopter's tail more stable. It senses any unwanted tail movements and corrects them automatically. These unwanted movements can be caused by the natural tendency of the helicopter to spin in response to the torque exerted by the main rotor. It may also be due to the force of a gusty wind. Without using a gyro, controlling the tail's servo will be very difficult, even for experienced pilots.

Two major types of electronic gyros exist: the rate gyro and heading-hold gyro. The rate gyro tries to stabilize the tail without knowing the actual position of the helicopter's head. Hence, its correction is not very accurate. But the head holding gyro continually tracks the position of the head of the helicopter. Therefore, it can effectively apply the exact amount of movement required to keep the helicopter on course. However, this device is more expensive than the rate gyro.

Tail Rotor

The tail rotor is designed to keep your helicopter from spinning in the opposite direction due to the torque of the main rotor blades. But its position makes it susceptible to frequent damage. For you to enjoy smooth flight, you need to ensure that you have excellent tail rotor control.

Three types of tail rotor controls exist: belt, electric and shaft drive. The belt and shaft drives are quite similar. Electric tail rotor drives have a separate motor for the tail rotor while the belt/shaft taps power from the main electric motor. For beginners, the belt drive is cheaper and more resistant to crashes than the electric drive. Generally, you should avoid a collective pitch helicopter that has an electric or fixed-pitch tail rotor.

Conclusion

It is very important to anticipate your need for spare parts in advance and start acquiring them even before you actually need them. You should buy the most durable parts you can afford. Remember that some parts may not always be available at the local hobby store. But virtually all parts will be available online although you need to spend extra on shipping and wait for a few days for the parts to arrive.