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Gesture Controlled Quadcopter

Ankith Shetty, Archis Shinde ,Jatin Patel & Nirav Panchal,
Guided by: Prof. Martand Jha
K.J Somaiya Institute of Engineering and Information Technology
Department of Electronics and Telecommunication, Mumbai, India.

Abstract- *In this project we present an approach to control a Quad copter by merely using hand gestures. It helps us to propose a way to accomplish Human Computer Interface. The idea is to extract an old techniques of controlling a Quad copter using joysticks, computer controlled etc. with more intuitive technique, that is, by controlling the Quad copter with the help of hand gestures, which will make it more user friendly, as the user would not have to study or learn about different instructions to control different parameters of a Quad copter, because these parameters will be controlled and adjusted with the help of algorithm interfaced to the hand gesture inputs. Here we propound an approach to achieve the illustrated idea by employing image processing technique using webcam. Simple video camera is used for computer vision, which helps in monitoring gesture representation. This approach consists of following modules:-*

- *A real time hand gesture formation monitor and gesture capture*
- *Feature extraction*
- *Pattern matching for gesture recognition*
- *Command determination corresponding to shown gestures and performing action respectively*

Real time hand tracking technique is used to control the quad copter in real time. If hand gesture is shown in front of camera, the camera captures the gestures. Object of interest is extracted from the background and the portion of hand representing the gesture is cropped out. Extracted hand gestures are matched with the stored data base of hand gestures using pattern matching. Corresponding to the matched hand gesture action is performed by the quad copter.

I. INTRODUCTION

The multicolor helicopter also known as a quadrotorquadcopteris equipped with four rotors to create lift. It is a true helicopter in that lift force is created by narrow-chord horizontally rotating air foils. The quad copter design has been in existence since the 1920s when an early manned version named the De Bothe at helicopter was built and successfully flown. First developed and prototyped under a U.S. Army contract, the De Bothe at helicopter. It first flew in October 1922 at what is now known as Wright Field in Dayton, Ohio.

The helicopter actually started with six rotors, but eventually two were deemed unnecessary and were eliminated. It made more than 100 flights over a period of years but never flew more than 5 meters into the air and never with any lateral movement. This was due to the complexity and difficulty of simply trying to maintain level flight, never mind moving in a lateral direction. This lateral movement control was to be the bane of multirotor helicopters until the invention and use of computer-assisted flight-control systems that would lessen the pilot workload. The U.S. Army eventually lost interest in the De Bothezat project and discontinued it in the early 1930s, after spending more than $200,000 on the program.

Helicopter development languished, at least in the United States, from the early 1930s to the mid 1940s. With the ending of World War II, development work did resume, but the focus was on more conventional designs that employed a main rotor with a tail rotor or the use of coaxial main rotors. The armed forces that initially funded helicopter development apparently believed that any possible advantages of using quad rotors were far outweighed by their complexity and ill-mannered flight characteristics.

The U.S. Army eventually developed and successfully fielded a heavy-lift, tandem-rotor helicopter named the Chinook, model CH-47, which despite being designed in the 1960s, is still in wide use today. It has undergone many updates and upgrades to keep it fully compatible with today's environment.

The U.S. Department of Defense also sponsored the development and production of a hybrid, dual-tilt-rotor aircraft named the Osprey, model V-22. It takes off and lands as a dual rotor helicopter, but flies as a traditional airplane with the wings tilted to a level position while it is operating in cruise mode. Figure 1.2 is a picture of the pilot's station in the V-22, showing all the incredible technology available to the pilot.

Both the Chinook and Osprey take advantage of computer-assisted flight-controlsystems that significantly reduce pilot workload and make it practical to safely fly aircraft that would otherwise be nearly impossible to fly.

The development of true quad-rotor helicopters turned out to be delayed until the early 1990s when a small-scale, radio-controlled(R/C) system named the Gyro Saucer 1 was developed and marketed in Japan. This is the earliest instance that I could find in my research for the appearance of a practical quadcopter, with or without an onboard pilot. It used mechanical gyros for stability and fairly small electrical motors to turn the props.

The first modern, widely available multirotor system was the Draganflyer, which was designed and manufactured in the early 2000s by Draganfly Innovations Inc. Draganfly has since superseded that early design with later models that are much more sophisticated and come equipped with a variety of functional capabilities. Figure 1.4 is a picture of their X-8 model, which is quite a remarkable and stable platform.

The X-8 quadcopter has four booms with a motor attached to each one and a pair of propellers attached to each motor, thus making for a total of eight propellers on the craft.

This quadcopter is just one of dozens of models available for purchase at the time this book is being written.

Most small-scale, R/C multirotor helicopters have four rotors; however, there are models with as few as three to as many as eight, with a few outliers with even more. There is also a start-up company named e-volothat plans to build a manned aircraft with 18 rotors named the Volocopter.This book will focus only on building and flying an R/C small-scale quadcopter because it is the most representative and reasonably priced of the current selection of multirotor helicopters.

II. FLIGHT DYNAMICS

Before learning about the flight dynamics let us learn about a few quadcopter motion terminologies. The motion on the Quadcopter is controlled by three main things, the Yaw, Pitch and Roll along with Uplift and Downfall. These terms are definitely important to know before you start flying quadcopters because, Quadcopters are fun to fly if you know what exactly you are doing.

YAW: Yaw is the deviation/Rotating the head of the quad copter either to right or left, Yaw can be controlled through the throttle stick, also called rudder, making it to rotate either to the left or right. See the below animation to understand more.

PITCH: Pitch is the movement of quad copter either forward and backward. Forward Pitch is achieved by pushing the aileron stick forward, which makes the quad copter tilt and move forward, away from you. Backward pitch is achieved by moving the aileron stick backwards (towards you), making the quad copter, come closer to you. See the below animation to know more about the Pitch movement in quad copter

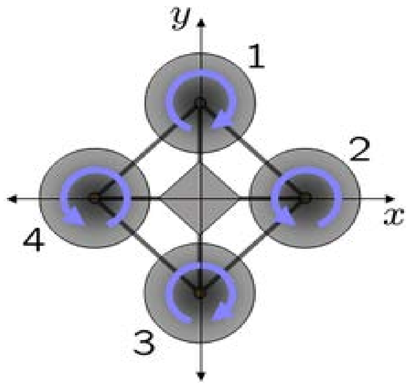
ROLL: Most people get confused with Roll and Yaw, Roll is making the quad copter fly sidewards, either to left or right. Roll is controlled with the aileron stick, making it move left of right, if you move the aileron stick to the left, the quad copter will fly left, if you move the aileron stick to right, the quad copter will fly right.

UPLIFT: Uplift is simply making the quad copter fly high from the ground/sea level. The elevation can be controlled using the throttle stick, by pushing it forward, making the quad copter fly high.

DOWNFALL: Pushing the throttle down, makes the quad copter come down to the ground which is called downfall.

Now as we are familiar with the flight terminologies let us learn about the flight dynamics.

Each rotor produces both a thrust and torque about its center of rotation, as well as a drag force opposite to the vehicle's direction of flight. If all rotors are spinning at the same angular velocity, with rotors one and three rotating clockwise and rotors two and four counterclockwise, the net aerodynamic torque, and hence the angular acceleration about the yaw axis, is exactly zero, which mean there is no need for a tail rotor like on conventional helicopters. Yaw is induced by mismatching the balance in aerodynamic torques (i.e., by offsetting the cumulative thrust commands between the counter-rotating blade pairs).



Quad rotor flight dynamics

Schematic of reaction torques on each motor of a quad copter aircraft, due to spinning rotors. Rotors 1 and 3 spin in one direction, while rotors 2 and 4 spin in the opposite direction, yielding opposing torques for control. A quad rotor hovers or adjusts its altitude by applying equal thrust to all four rotors. A quad rotor adjusts its yaw by applying more thrust to rotors rotating in one direction. A quad rotor adjusts its pitch or roll by applying more thrust to one rotor and less thrust to its diametrically opposite rotor

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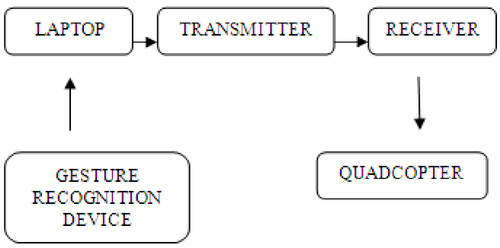
III. GESTURE CONTROLLING

There are various ways to control a quad copter using a joystick, an android application, etc. But as our title suggest we are going to control our quad copter using hand gestures. The reason we are using hand gesture controlling, is to learn about few basic aspects about human drone interaction. To accomplish this, we have to take into consideration various aspect of quad copter controlling as well as hand gestures. We have to look after real time response of the quad copter depending upon the given hand gesture. We are using a Arduino as a programming platform for our hand gestures and a KK 2.1.5 flight control board for the quadcopter.Both the boards have to be interfaced using a Transmitter Receiver module. We are planning to build a predefined database of hand gestures which can be used to control the Quad copter.

The below shown block diagram gives a basic idea about the flow of instruction from hand gesture to the respective action performed by the quad copter.



IV. APPLICATION

1) Research platform

Quad copters are a useful tool for university researchers to test and evaluate new ideas in a number of different fields, including flight control theory, navigation, real time systems, and robotics. In recent years many universities have shown quad copters performing increasingly complex aerial manoeuvres. Swarms of quad copters can hover in mid-air, fly in formations, and autonomously perform complex flying routines such as flips, darting through hula hoops and organizing themselves to fly through windows as a group.

There are numerous advantages to using quad copters as versatile test platforms. They are relatively cheap, available in a variety of sizes and their simple mechanical design means that they can be built and maintained by amateurs. Due to the multi-disciplinary nature of operating a quad copter, academics from a number of fields needs to work together in order to make significant improvements to the way quad copters perform. Quad copter projects are typically collaborations between computer science, electrical engineering and mechanical engineering specialists.

2) Military and law enforcement

Quad copter unmanned aerial vehicles are used for surveillance and reconnaissance by military and law enforcement agencies, as well as search and rescue missions in urban environments. One such example is the Aeryon Scout, which is a small UAV that can quietly hover in place and use a camera to observe people and objects on the ground.

3) Commercial use

The largest use of quad copters in the USA has been in the field of aerial imagery. Quad copter UAVs are suitable for this job because of their autonomous nature and huge cost savings. As quad copters are becoming less expensive media outlets and newspapers are using drones to capture photography of celebrities. Nowadays, even pizza and new paper companies are looking towards use of a Quad copter for delivery purpose as it is cost effective and can be continuously monitored.

IV. CONCLUSION

Thus, this paper proposes an approach to control a quad copter using gestures. This paper outlines an approach for controlling a Quad copter using gesture preconisation using an arduino and KK2.1.5 board. It also helps in exploring one of the main aspects of a human drone interaction.

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