MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
SUMY STATE UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE

MASTERS THESIS

On the topic
“INFORMATION TECHNOLOGY OF AUTONOMOUS DRONE CONTROL SYSTEM DESIGN ”

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Supervisor **Oleksiienko G.A.**

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Task of Masters Thesis

Masters student, group IH.м-05ан specialty "Informatics" Leeroy A Bananga

Topic: "INFORMATION TECHNOLOGY OF AUTONOMOUS DRONE CONTROL SYSTEM DESIGN"

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Contents Explanatory Note: 1) An analytical review of the literature; 2) Statement of the problem; 3) The choice of methods for solving the problem; 4) Develop an information web resource; 5) Conclusions.

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ABSTRACT

Note: 40 pages, 6 figures, 10 sources literature, 1 app.

Object of study – Autonomous Quadcopter

Purpose – Developing a simple face following quadcopter

Research methods – system, deductive and inductive analysis, computer experiment

Results – A working quadcopter was developed which is able to follow a face autonomously.

KEY WORDS

Quadcopter
Face recognition
OpenCV
Python

Content

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INTRODUCTION

Throughout history, fear of change and therefore the unknown has often caused heightened anxiety to countless many of us within the general public. But if we glance closely at history, this fear is usually not borne out of outcomes. In fact, the past is riddled with stories of change that were feared within the early stages eventually becoming accepted as a necessity, a comfort, or an option. One good example came in the 19th century, when electricity was invented and would become an important tool in today's life. The masses were normally used to lighting candles and having open flames to light up the night with very little to no concern of the dangers of fireside. But for many, the thought of a whole home being electrified created a replacement fear of electrocution. In one case, it's said that albeit President Harrison had electricity installed within the White House, he and his wife wouldn't touch the switches for fear of electrocution, often leading them to sleep with the lights on. Clearly within the case of electricity, popular opinion has changed dramatically, as is true of numerous other cases of societal change. Even though initial fear followed by acceptance may be a known phenomenon, these standard feelings are still very powerful today, especially with our times changing so quickly. One societal change that's occurring today that seems to be following an equivalent path are the emotions surrounding the increase and use of unmanned aircraft systems, or UASs. For many, their only experience with these vehicles comes from media reports about them getting used by the military for intelligence gathering and defence. Those images, including privacy and safety concerns, is causing some to fear using them back here reception . Many on the front lines of the UAS revolution see tremendous advantages by using these devices in civil applications like farming, package delivery, wildfire detection, border security, and various other uses. Only time, lawmakers, and popular opinion will answer the broader societal questions, but one thing is for sure; the technical challenges surrounding these vehicles got to be answered now. [1][2]

What exactly is a drone? Some will tell you a drone is a tool used by the military of a nation meant to watch over and protect the nation others might say it's an innovative invention mainly used for delivery purposes, even more probably will tell you a drone is a lethal machine lurking in the skies above us. In the past decade drones have become synonymous with airstrikes aimed at eliminating terrorist groups or mostly in combat. The bureau of investigative journalism reports that between 2004 and 2014 the US CIA organised close to 400 drone strikes in Pakistan alone killing more than 3000. It's no wonder why these machines are associated with war and military in the minds of millions because they have captured the curiosity and fear of the world over. One big question which stands now is where do these phantoms of the sky come from but to find out we will need to look back almost 100 years.

Modern day drones or unmanned aerial vehicles work through a system of sensors, you can think of it as a basic remote controlled vehicle only with much longer range. The exact origin of drones is hard to pin point. World war 1 saw the first introduction of planes into combat though things like balloons and kites had been used for decades before, these were some of the first drones. At the end of world war 1 the United states army worked on aerial torpedoes, small biplanes like the Kettering bug that would essentially work as Kamikaze drones but they were never used because the war ended before they were deployed.

1915 during the battle of Nova Chapelle de France saw the British using aerial imagery to capture well over 1,500 aerial view maps of the German trenches. This ushered in a new era of using aerial imagery for complex coordinated operations. For the first time artillery on the ground were able to carry out attacks with advanced knowledge of the enemy infantry positions. In the early stages of WW2, the US of A made the first remote controlled plane (drone) called the radio plane OQT.

Unmanned surveillance operations continued to a play prominent role throughout the course of the Cold war and global conflicts in general. In 1973 Israel

Made the Mastiff UAV and after that they made the IAI Scout which were both unmanned used for surveillance and recon operations. In 1986 US and Israel joint forces on a project to produce the RQ to pioneer the reconnaissance drone. Fast forward

to the fall of 2000, the first Predator drone a modified version of the Gnat 750 drone, was flown over Afghanistan in hunt of Osama Bin Laden.

In 2014 Amazon proposed using drones which are much simpler and smaller than those used by the military for delivery purposes. Real estate agencies have begun using drones for promotional purposes and some DIY organizations have started creating their own smaller machines for entertainment purposes, other have used them for anti-poaching, rescue missions in Africa. Facebook is in the process of making huge solar powered drones that can fly as high as 50 000ft and provide internet into remote areas of the world.[3]

1. INFORMATION REVIEW

1.1REVIEW OF KNOWN SOLUTIONS

In 1917 one Charles Kettering made one of the first UAV called the Kettering bug consulted by Orville Wright one of the 2 Wright brothers who made the first plane. Charles was the founder of Dayton Engineering Laboratory Company (DELCO) which is an electronics company which developed the first reliable battery ignition systems and the first practical automobile self-starter.

The Kettering bug was designed to fly for a designated amount of time before the engine would stop therefore creating a stall then dive towards the ground exploding or at times releasing mustard gas. The airplane had a biplane design that was similar to the Wright brothers original airplane design.

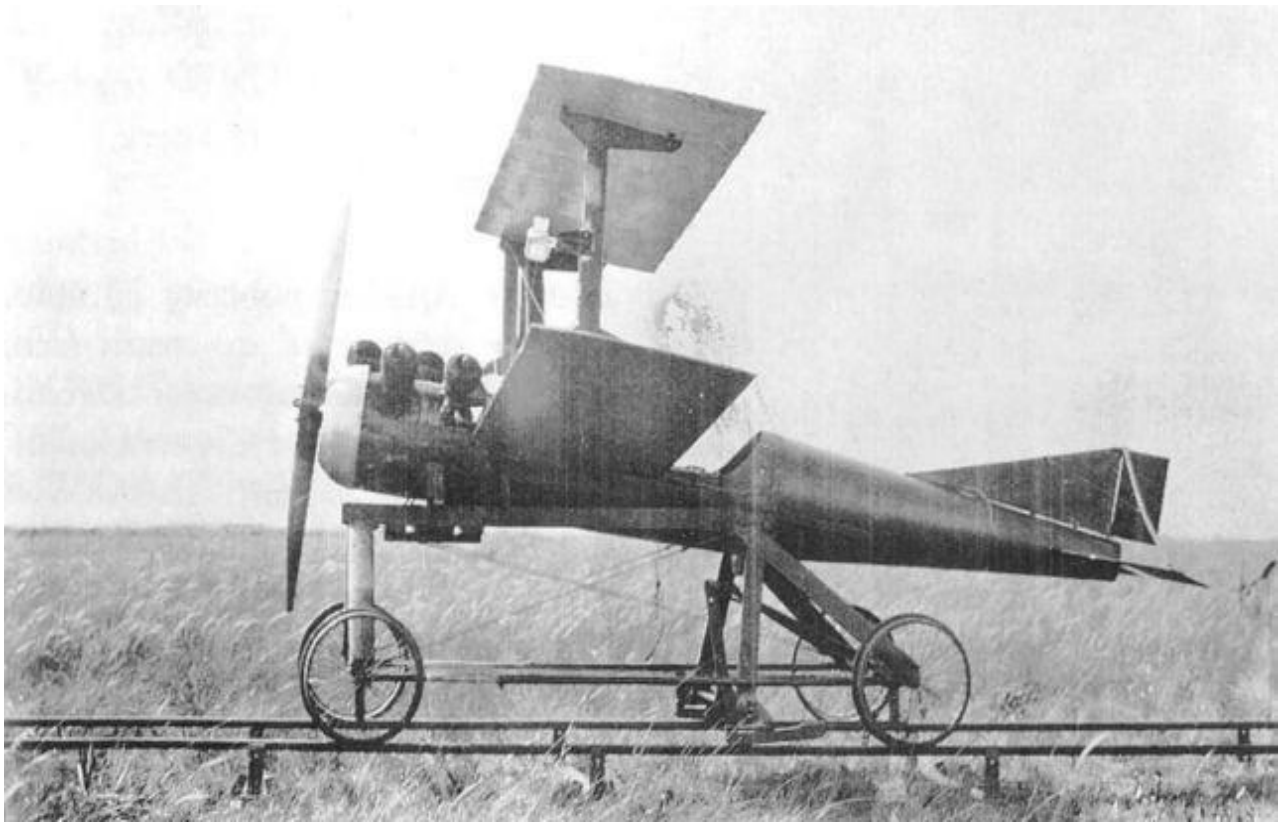
The Kettering bug had high explosive load of 180 pounds (81.6466 kgs). After reaching its designated speed it would detach from its base then it would take to the sky. It was capable of reaching targets 121 km away and it had a speed of 80km/h, the Kettering bug is the blueprint of the modern day cruise missile.

A wing and motor assembly was fitted onto the warhead. For a runway a short section of dolly track. The first prototypes crashed a lot before the Kettering bug finally flew. It had gyroscopic stabilizers to stabilize the flight. It also used an odometer to count the number of spins before stalling the engine and diving. Amazingly WW1

ended before the Kettering bug was used but nevertheless the Kettering bug is still the first UAV known to man though it was unreliable, suffered may failed take-offs and it only flew in a straight line. Later on operators with joysticks were able to steer planes from a much greater distance using a transmitter to send radio signals to a radio receiver on the remote controlled plane that would control a motor that would turn the steering controls pressed flight control buttons but they had some draw backs. The controller had to fly behind the drone itself in a mothership or a big plane so as not to lose signal with the UAV. Control systems for these UAVs were being developed in a hurried fashion and they were very new so people had little knowledge on how they would actually work hence they didn't perform very well in their early stages. Travelling in motherships posed a threat as well as they were big and easily detectable by enemies rendering them useless for covert operations and reconnaissance missions. Operators also had a hard time controlling the drones since they were observing from a distance even though they had new tv sets installed in the motherships the video quality was very very low.

Modern day drones and do airstrikes with point blank precision a far cry from their predecessors and this is mostly possible thanks to the use of computers which improved the capabilities to an extent that all the drone technology before is obsolete, really there is no comparison effort. [4]

The Kettering Bug



The second solution is the Hewitt-Sperry Automatic airplane. Just like the Kettering Bug the Hewitt-Sperry Automatic Airplane was also the brain child of today's ariel torpedo or cruise missile. It was developed by Elmer Sperry of the Sperry Gyroscope Company in 1918 and its sole purpose was for military use as was with all the drones developed in the 20th century.

When it was developed planes had been around for a little over 8 years but the idea of using radio signals to control aircrafts had intrigued a number of inventors to give it a try, one of them being Elmer Sperry who managed to arouse the American Navy interests in unmanned airplanes. Elmer had been working with the navy for some time before hand making gyroscopes for naval use ever since the 1896.

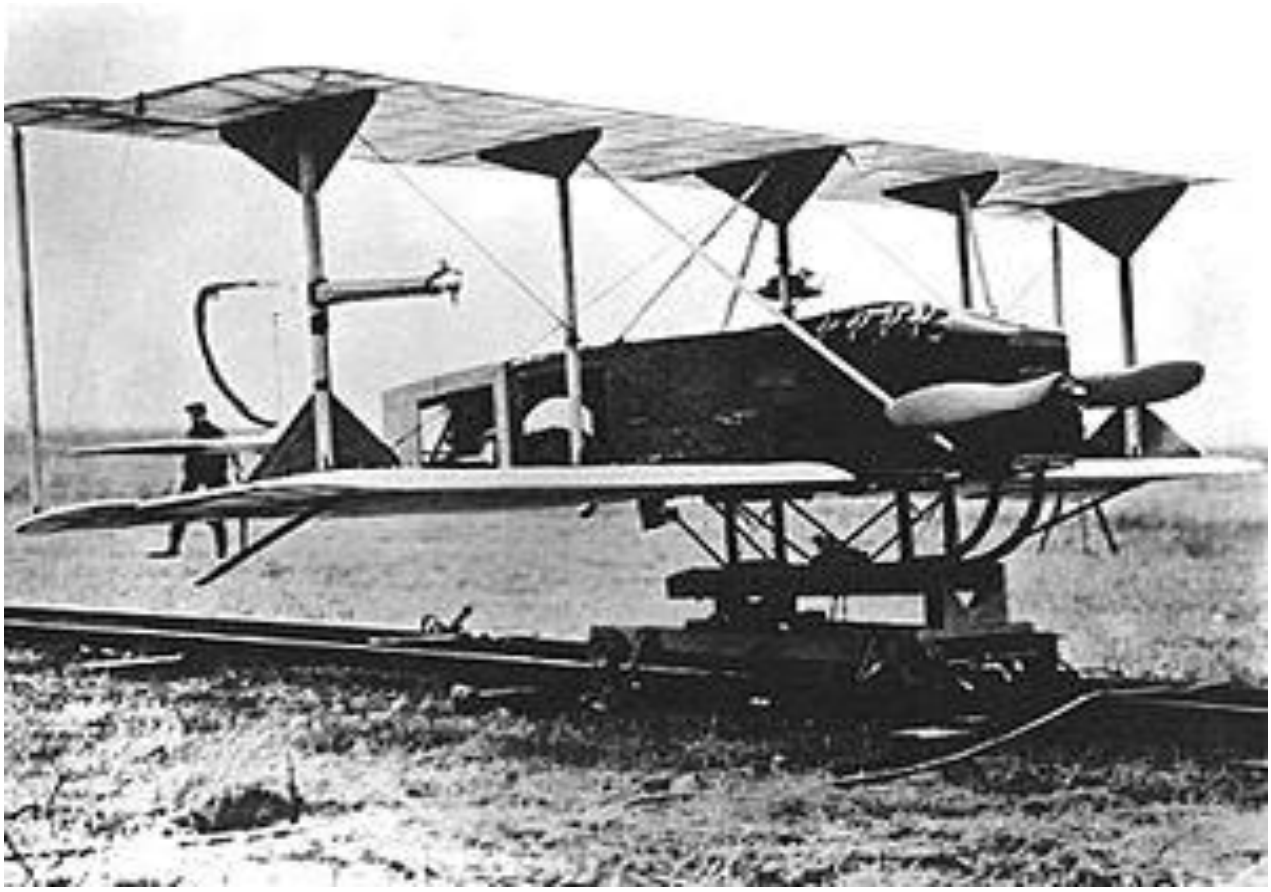
Elmer noticed that for the radio controlled plane to be effective and stable there was need for automatic stabilization which was his speciality as he used to make

gyroscopes for the navy so he adopted the gyro stabilizers which he developed for the navy which were used on destroyers.

The system of the Hewitt Automatic Airplane had a gyroscopic stabilizer for stable flight, aneroid barometer which was used to adjust the altitude of the UAV, it also had some servo motors which were used to control the moving surfaces of the UAV which were the rudders and the ailerons, a directive gyroscope to control the direction of the drone (yaw and roll) and a device for distance gearing of the Hewitt Airplane. These instruments were concealed in a plane that would be shot from a sling or catapulted or it can be flown from the water and the Hewitt Automatic Airplane would ascend to a predefined altitude and fly a predetermined course, after it reaches its predefined distance the Hewitt Automatic Airplane would drop the bombs which it would be carrying or it would simply dive to the ground just like the Kettering Bug.

Though it's technology was light years ahead of its time the Hewitt Automatic Airplane was not so accurate but it caught the attention of the military because it could travel a distance of 80 km to 160 km, compared to drones nowadays which can fly for more than a 1000 km, the range was greatly remarkable at that time. It's maiden flight was in September of 1917. The maiden flight was carried out with a human onboard to fly the Hewitt Automatic Airplane for take-off. By November of that year the automatic system of the Hewitt Automatic Airplane flew from launch to its target which was 48 km away and the device which was used to measure the distance would drop one bag full of sand withing a radius of 3 km to the target. It wasn't accurate but workable with.[5][6]

Hewitt Automatic Airplane



The third solution RAE Larynx was another UAV developed by Royal Aircraft Establishment. It was a pilotless aircraft used by the British Navy as an anti-ship weapon, guided anti-ship weapon. Realized in September of 1925 it was once again a one of the early cruise missiles which was flown by autopilot. As you can see most early drones were used as weapons of mass distraction hence why most view them as military weapons or ghosts in the skies waiting for an attack.

The RAE Larynx was a 200 horse power, 150 kW monoplane powered by an Armstrong Siddeley Lynx IV engine which was catapulted from a ship. It was an improved and advanced UAV and cruise missile than its predecessors. It could reach speeds of 320 km/h which was faster than some of the contemporary fighters of those days.

The autopilot principles were developed by Professor Archibald Low. The autopilot was used before by a radio signal controlled plane called the Ruston Proctor AT which was a biplane just like the Kettering Bug that the British army wanted to use against the Zeppelin bombers of German. It had a warhead installed and it was very precise when it came to hitting targets which was made possible by the use of a. magnetic compass. It had a steering gyro compass as well to monitor the direction of the missile and an altimeter was used to mark the path the UAV would take.

It was launched from destroyers at sea as a projectile and was the first surface to earth missile which made a successful flight. During the first successful flight the RAE Larynx flew for 170 km before the crew lost contact with the UAV due to attenuation. This made the RAE Larynx the precursor for the modern day winged missile.

Control of the RAE Larynx was carried out from a ship or from land via the use of radio transmitters and receiver present on the RAE Larynx and at the control station. If there was to be loss of signal the RAE Larynx would continue to fly thanks to the gyroscopic autopilot which worked together with the magnetic compass onboard the RAE Larynx. The max range of the RAE Larynx was 190 km and it had fuel onboard for it to fly for approximately 20 minutes.

The British stop development of the RAE Larynx in 1929 with the fear that the technology would be used by the enemy against them, but besides that the RAE Larynx became outdated as there were new fighter aircrafts that were more effective at bringing down targets accurately. Even though the RAE Larynx was dead accurate the British just feared the RAE Larynx technology would bring advantage to the enemy but the technology still lives on even years after it was decommissioned.[7]

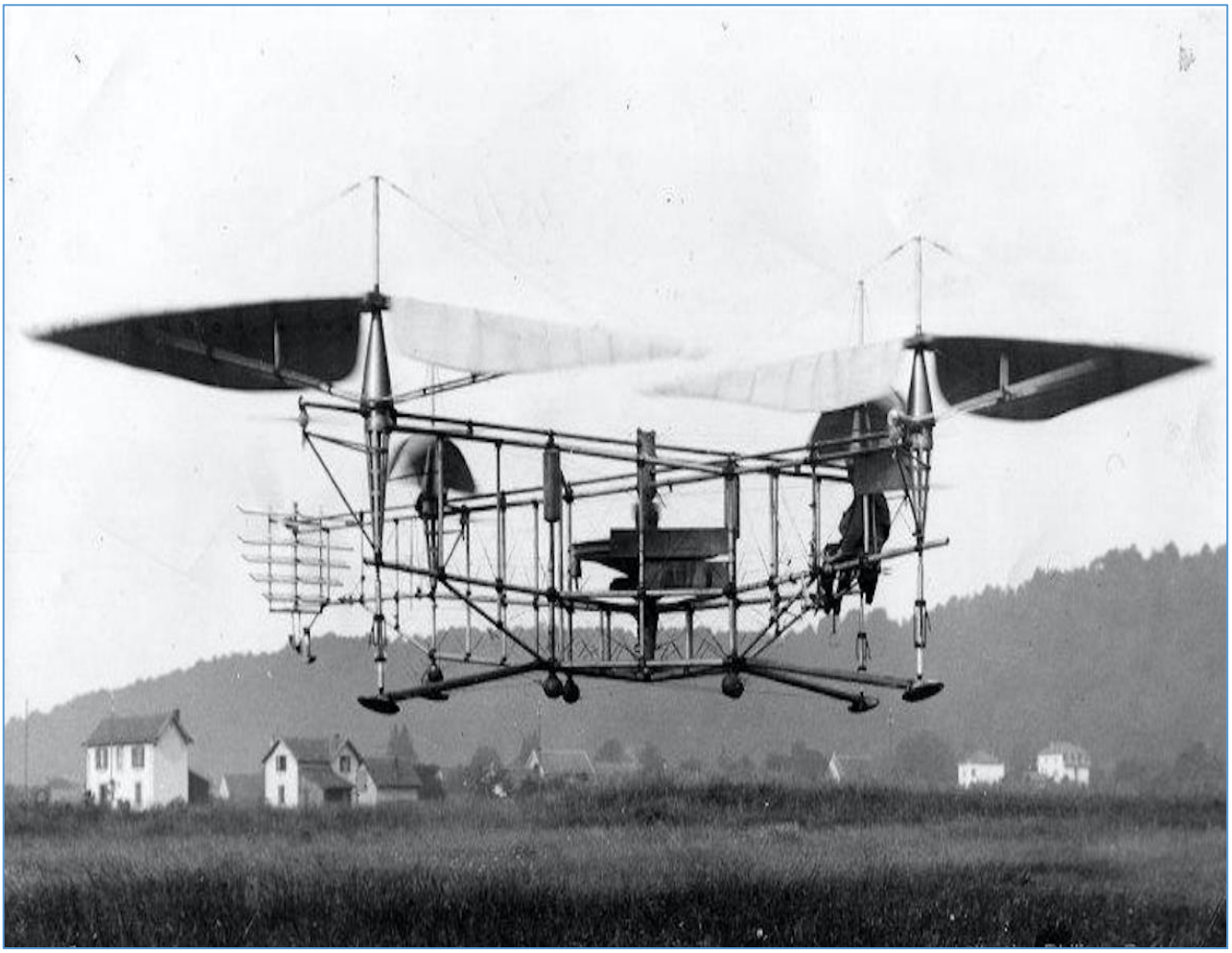
RAE Larynx

Let’s move to quadcopters. Quadcopter were the first vertical takeoff and landing vehicles better known as VTOLs. The early helicopters used tail rotors to counterbalance the torque caused by the rotating force of the main rotor blade which was not efficient. To solve this problem engineers invented quadcopters therefore solving problems pilots had with vertical flights.

The first quadcopter developed by one Etienne Oehmichen was the Oehmichen 2 in 1922 and 2 years later he managed to fly the quadcopter for one kilometer at 40 km/h. It has 5 propellers which served to stabilize the quadcopter. One propeller was mounted on the nose of the quadcopter was for steering the quadcopter in the desired direction. The remaining propellers worked as pusher propellers for propulsion purposes. Oehmichen wasn’t exactly satisfied with the height at which the Oehmichen

2 was able to fly so from his 3rd invention going forward he used one main propeller which was accompanied by other 2 smaller anti torque rotors. [8]

Oehmichen No 2



Now technology has advanced quadcopters dramatically. These days quadcopters are small and advanced, They use state of the art computer technology to control the flight of the quadcopter, aerial photography and for aerial videography.

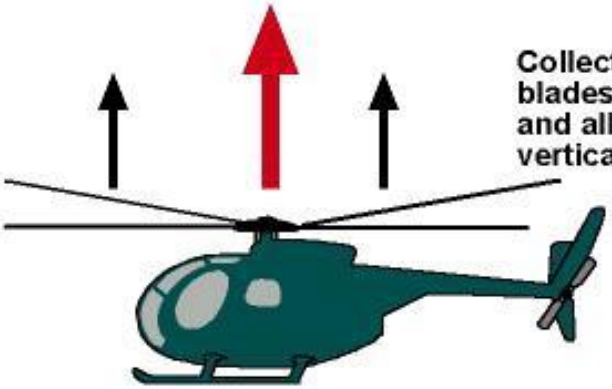
From 2019 to 2021 alone the adoption of quadcopters in many different industries has increased by 75.1% and it is estimated it will rise to 122% by 2023. Drones for commercial use are still in their infant stages in terms of being adopted and use on a large scale but their impact has changed the face of many industries and how they work these industries include the film industry, real estate industry where we are seeing realtors using quadcopters to make promotional and advertisement videos on the properties they have for sale, the farming industry where quadcopters are now being used to inspect crops in the field with the use of artificial intelligence

and drone technology combined, for delivery purposes as we now see many companies like amazon and DHL researching on how they can use this drone technology along with artificial intelligence to make autonomous quadcopters to help with the delivery of parcels, Facebook too is working on a project which will use powerful drones which will fly at around 50 000ft which they are planning to equip with communication devices so as to provide internet to some remote areas I the world (dead spots).

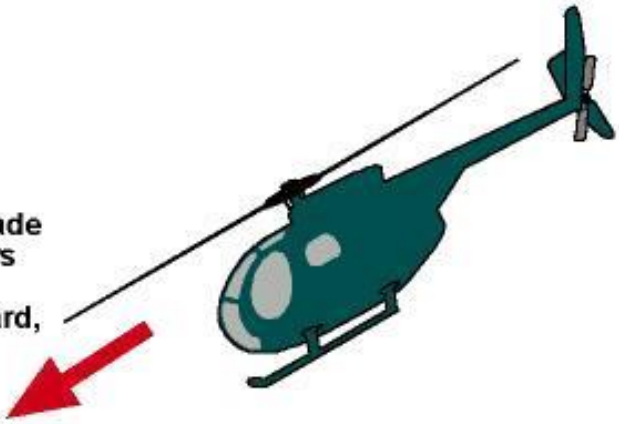
Drones have the functionality of many different helicopters. A helicopter can either be pitched or coaxial. Coaxial helicopters the ones with 2 layers of rotors are more stable compared to the pitched ones, while pitched helicopters are wind resistant and very agile. Quadcopters are a perfect combination of both. With the 3 axis gyro technology on quadcopters they are very stable during flight and easy to manoeuvre. Their advantage of being steady and agile makes them very ideal for aerial photographs and videography.

Coaxial Helicopter

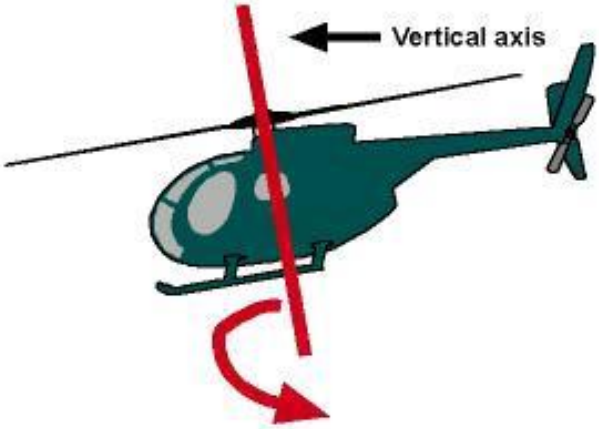
Pitched Helicopter



Collective pitch control angles all blades equally and simultaneously and allows the aircraft to rise vertically.



Cyclic pitch control allows each blade to be angled individually and allows the aircraft to move forward or backward, nose upward or downward, and roll from side to side.

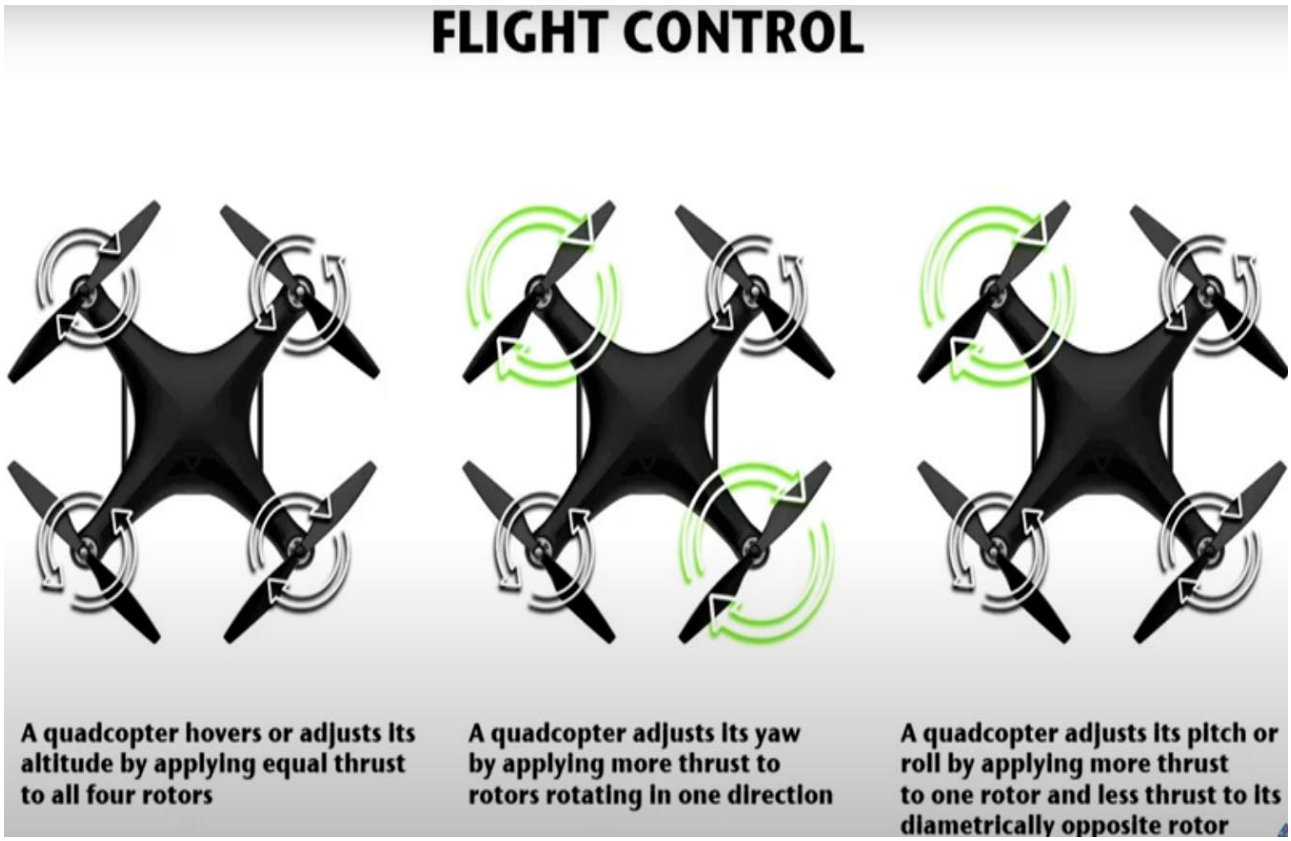


Differential collective pitch control allows the pitch of one rotor to be increased over the collective pitch of the other rotor. It controls the yaw of the aircraft--the rotation of the craft around its vertical axis.

Quadcopters of today are just like drones from 100+ years back, they are controlled by a remote control which sends signals (radio signals) to a receiver on the quadcopter which in turn translates the signals to move the quadcopter in accordance to the received signal.

A remote control transmitter transmits the control signals to a receiver on the quadcopter. The receiver will then process the received commands from the pilot. The pilot's instructions plus the output of the altitude sensor on the quadcopter will then be sent to the flight controller onboard the quadcopter which will then signal the electronic speed controller of the quadcopter which will then move the quadcopters rotors.

A quadcopter does not use the same aerodynamics as a normal aircraft to fly. If we take a look at Newton's third law of motion which states that "For every action, there is an equal and opposite reaction". On a quadcopter there are two rotor which rotate clockwise and two which rotate anti clockwise, these rotors are diagonal to each other. The rotation of these rotors eliminate any torque on the body of the quadcopter preventing it from spinning out of control, stabilizing the movement of the quadcopter and its function.[9]



1.2STATEMENT OF PROBLEM

A quadcopter is to be configured to work autonomously. The quadcopter will first try and detect a human face or a red ball then it will adjust its flight controls to follow the human face or the red ball.

For the quadcopter to achieve this it will be equipped with a camera which will act as the eyes of the quadcopter.

In the case that the quadcopter does not recognise a human face or a red ball the quadcopter will use its yaw to rotate and try and find a human face or a red ball in case the human or the ball is behind the quadcopter. All this is done while the quadcopter hovers over a certain altitude.

With the use of a mobile app the we will be able to see what the quadcopter is seeing and one can switch to manual mode in case the quadcopter isn't behaving well so as to avoid the quadcopter from crushing into walls. As of now the quadcopter doesn't have any anti-collision sensors to prevent it from bashing into walls or object which will be a upgrade which will come with the next version of the quadcopter.

Such quadcopters can be used for crop inspection in a field to identify sick crops in the field or they can be used for criminal investigation to find a specific person in a crowd of people, the applications are endless.

2. SELECTION OF INSTRUMENTS OF SOLVING

2.1 SELECTION HARDWARE

For this project I used a ready to fly quadcopter the X22W Syma which is a small Quadcopter the size of an average human palm but did a little bit of tweaking to it. It is equipped with a camera and the flight is very steady considering its size of the quadcopter. Let's get into the components.

Syma X22W Motors: The quadcopter comes with four small motors, 2 A motors and 2 B motors. These light weight motors are the ones to provide the torque of the quadcopter, the thrust so that the quadcopter can take off and maintain flight. The motors together with the blades provide the quadcopter with tremendous stability during flight.

The A motors which rotate clockwise should be placed diagonal to each other and the B motors which rotate anti clockwise should be placed likewise. This is done like this so that the quadcopter does not spin in one direction, this is where the Newton's third law of motion comes into play "For every action, there is an equal and opposite reaction" that's why the A motors will rotate the blades clockwise and the B motors rotate the blades anti clockwise providing anti-torque in the process which prevents the quadcopter from spinning out of control in one direction. This acts like a tail rotor on a helicopter which spins in the opposite direction of the main rotor.

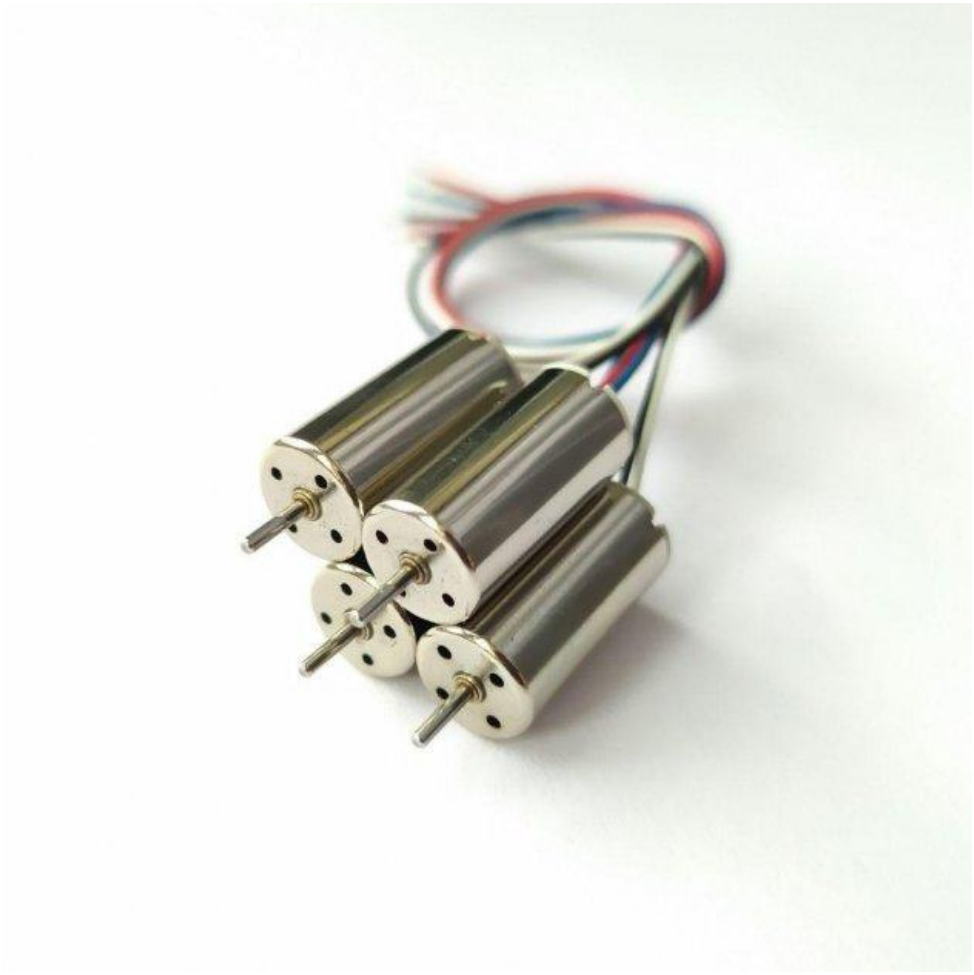


Fig 1.1– X22W quadcopter motors

These are DC motors but specificlly for quadcopters. They are powered by the DC current which will be provided by the batteries which are the main power supply for powering the whole quadcopter. The motors have whats called a commutor which is a component that reverses the direction of the current each time thw rotor rotates through a half turn. The rotor wouldn't continue to rotate without this because the magnetic field will change the direction.

The speed of the blades is determined by the flight controller on the quadcopter. For eample for the quadcopter to lift off the ground, the command from the remote is received by the receiver in the quadcopter which then sends this signal to the flight controller which then in turn sends electrical signals to the motors to spin fast so that the quadcopter can lift off. Basically the rotors or motors they just rotate in a predetermined direction which can be clockwise or anti clockwise but the speed is determined by the flight controller depending on the signal sent by the pilot.

The roll, yaw and pitch of the quadcopter is provided by these motors , how they spin depends on what you want the quadcopter to do roll, yaw or pitch.

Syma X22W Receiver is the brains of the quadcopter. The receiver works as a signal receiver and flight controller as well. As a flight controller the X22W receiver is responsible for the rotation of the rotors and their speed.

The receiver receives the signal or commands from the pilot it them translates these signals and then send the signals as electric signals to the rotors either to increase the rpm to take off or to reduce the rpm to land the quadcopter or even to do other functions like 360 degree spin which the quadcopter can perform or to roll or yaw the quadcopter.

The X22W receiver is equipped with a WIFI card. The WIFI card allows the user to connect a mobile device to the quadcopter through the WIFI which the quadcopter will provide. This allows the user to access the camera of the quadcopter so that they can see what the quadcopter is seeing when in manual mode, it also allows the user to control the quadcopter using the mobile application which can be installed on the mobile device android or iOS device the application supports both operating systems.

The receiver has a 6 axis gyro. This 6 axis gyro provides incredible stability during flight. This enables the quadcopter to hover at a certain altitude without applying throttle to the quadcopter also providing easy control of the quadcopter. Functions on the quadcopter such as auto take-off and landing are possible through this 4 axis gyro allowing for a stable take off and landing.

The receiver operates at 2 different frequencies one for the remote controls and the other for controls using the mobile app. This ensures that the remote controls and the app controls don’t contradict as in the case when they are both using the same frequency which might cause the quadcopter to be confused and crash when both the remote and the application are running concurrently. It is also the circuit board of the quadcopter where everything is connected.

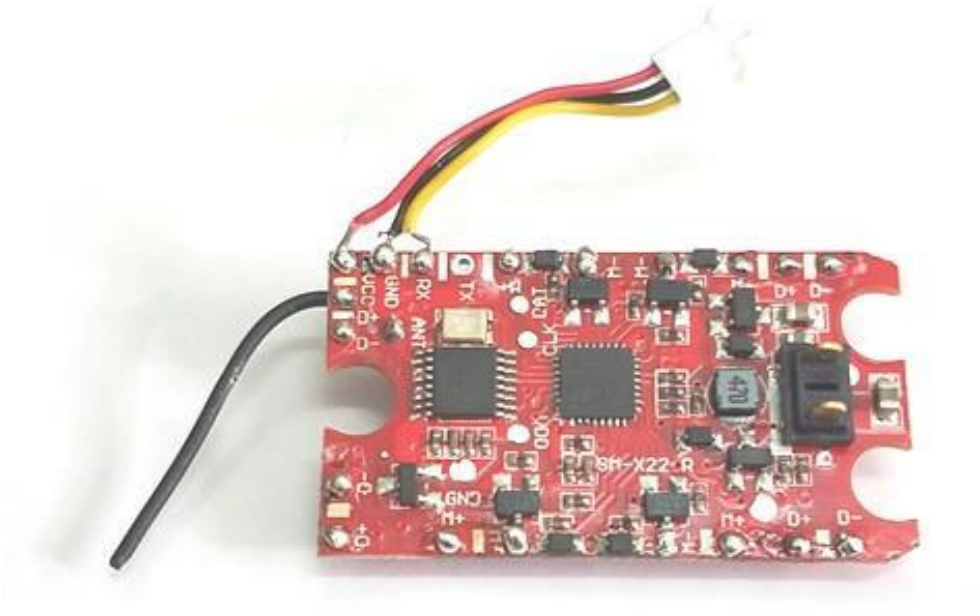


Fig. 1.2– X22W Control Receiver board

Syma X22W Battery. The quadcopter is powered by a 3.7V/400mAh battery specially made for this quadcopter. Everything from the camera, the control receiver/ flight control to the Wi-Fi card on the quadcopter and the 4 rotors are all powered by this battery. This is a small light weight battery which is not big or heavy but powerful enough to power up everything the quadcopter needs to function. The reason why the battery is small is quiet obvious, this is so that the quadcopter can support its weight during flight. If the battery was going to be bigger the quadcopter wouldn't be able to take off as the weight will be too heavy for the quadcopter to fly, plus the quadcopter is small so it is more sensible to use such a small battery.

The battery has a drawback though. The battery needs to charge for approximately 90 minutes for It to reach 100% but even at full capacity the battery can only make the quadcopter fly for 5 minutes max. This means that the quadcopter will only work for 5 minutes before the battery requires a recharge of 90 minutes.

Fig. 1.3- Syma X22W Battery

Remote controller. The quadcopter can be controlled by a remote controller as well. The remote controller transmitter works at a frequency of 2.4 GHz. This low frequency allows for the control of the quadcopter over great distances. For this specific quadcopter it can operate within the range of 25 meters to 100 meters.

The controller has a user friendly interface with one button press for auto take off or auto landing. There is also one button which when pressed the quadcopter can perform a 360 degree flip but this is just for entertainment purposes.

The controller is also used for calibration of the quadcopter which is the only way to calibrate the quadcopter. With the use of the 2 joysticks on the quadcopter one can change the default direction of the quadcopter through what's called headless mode. In this mode we can change the front direction of the quadcopter, the roll and yaw of the quadcopter. This for users who might want to use inverted controls when flying the quadcopter in manual mode.

The controller is powered by 4 double A batteries which will power the remote controller and the transmitter so that manual control of the quadcopter is made possible.

Fig1.4 – Remote Controller

Camera. For video streaming. To be able to provide the user with the sense of vision where the quadcopter is, a camera is used to give the user a video feed of the environment in which the quadcopter is. A small 5 Megapixel camera will be used for

this. It will be able to provide a not so high resolution pixel high definition video recording but enough for the quadcopter to identify faces. A fisheye lens can be fitted in-front of the camera to provide a 3D visual of the area.

The quadcopter will stream the camera feed to the mobile app as well just like the controls. This will allow the quadcopter to be used by any mobile device from any platform making the quadcopter platform independed like the controls. To get the

If the use so desires they can put the mobile phone in a VR casing which will provide the user with the sense of feeling as they are in a cockpit there for providing the First Person View experience to the user/ pilot.

Fig1.4 – Camera module

2.2 SELECTION LANGUAGES

PYTHON. Is a high level programming language which has an object oriented approach. Python code and be dynamically typed.

It supports multiple programming paradigms which include procedural programming (structured programming), functional programming and object-oriented programming.

The main focus of the programming language is the ease of use. Python is an interpreted meaning it is not compiled into machine code rather a python interpreter will interpret the instructions at runtime. This allows the same code to be used on different machines.

Python is one of the most popular programming languages in robotics mainly because Python and C++ are the 2 main programming languages which ROS (Robot Operating System) recognises. Python has also a large number of free libraries which will prevent us from reinventing the wheel when we are implementing some functionality in our quadcopter.

Python was used in this case mainly for the facial recognition function of the quadcopter. For the quadcopter to follow the face it first has to understand what's a human face. After that the quadcopter has to put some bounding box on the face after it recognise one and keep it at the center of the screen. Before all that we have to use what's called a cascade classifier in OpenCV which will enable us to train our model using a few examples of a particular object in this case human faces and red ball. When the classifier is trained we can then apply it to our quadcopter for it to recognise faces when it's flying .

A little bit more tweaking needs to be done for the quadcopter to know how to fly when the faces are detected in which case we will use python again to map the controls to the specific movement the drone is supposed to do. For example if the face is too close fly back a little, it its more to the left fly left etc. For the flying part training will be done using a different program not python which will be explained later on in greater detail on how is actually done that's where the autonomous function will actually come into play.

2.3SELECTION API

These are rules and features existing inside a program that allows us to interact with the program through software and not through human user interface. It is a contract between the application which is providing the API and other software or hardware using it.

PYGAME. These are python modules which are designed for video game programming. Because of its wide use, pygame is compatible with every operating system and platforms.

Pygame is open source released under the LGPL licence and it can be used to create open source, shareware and free commercial games under the LGPL license.

It is a wrapper for the Simple Direct Media Layer library (SDL library) which provides access to the system hardware components such as keyboard, joystick, video, sound and mouse which are used in gaming mainly.

Pygame has a cross-platform nature which means it can be used to write games and applications which can run on any platform which supports them.

Pygame has functions which allows a program to get button events from connected joysticks and manipulate the behaviour of a program just like a game.

Pygame has key mappings in it which are general for all games. These key mappings are in a dictionary which can be used to customise how the buttons of different game pads do different functions other than the general functionalities.

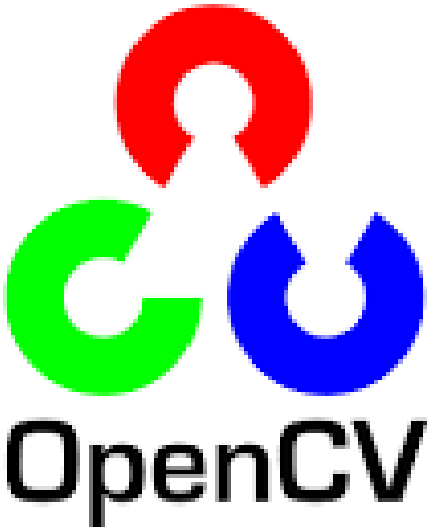
One developer by the name Damia Fuentes used pygame to enable him to control a Tello drone using computer and the program works very good with fast real time response from the drone. So I contacted him and asked him for his help and he was able to explain how he managed to make key strokes to be able to fly the Tello drone. Using this knowledge I was able to get the controls of the quadcopter how to make it pitch, yaw or roll which wasn't very easy to do but with his help I managed to do it.[10]

2.4SELECTION OF LIBRARY

OpenCV. OpenCV is a open source computer vision library with a whole host of functions mainly for real time computer vision. Most programs use this for object detection, face recognition, object recognition, manipulating pictures etc. These are just some of the functions included in the library.

OpenCV has what's called a cascade classifier which can enable us to train using only a few samples of a what we want to train in our case faces. So using a few lines of code i managed to plug in the OpenCV code and used the haarcascade frontal face classifier which recognises front of human faces. This enabled the quadcopter to detect faces it sees using its camera.

OpenCV has a wide range of cascades in it. There is one where it can allow a program to detect smiles only, another one to detect curves only. OpenCV is now being used in many artificial intelligent system which require real time computer vision and it is greatly useful which will prevent us from reinventing the wheel.



3 PROJECT REALIZATION

3.1 PROJECT MODELLING

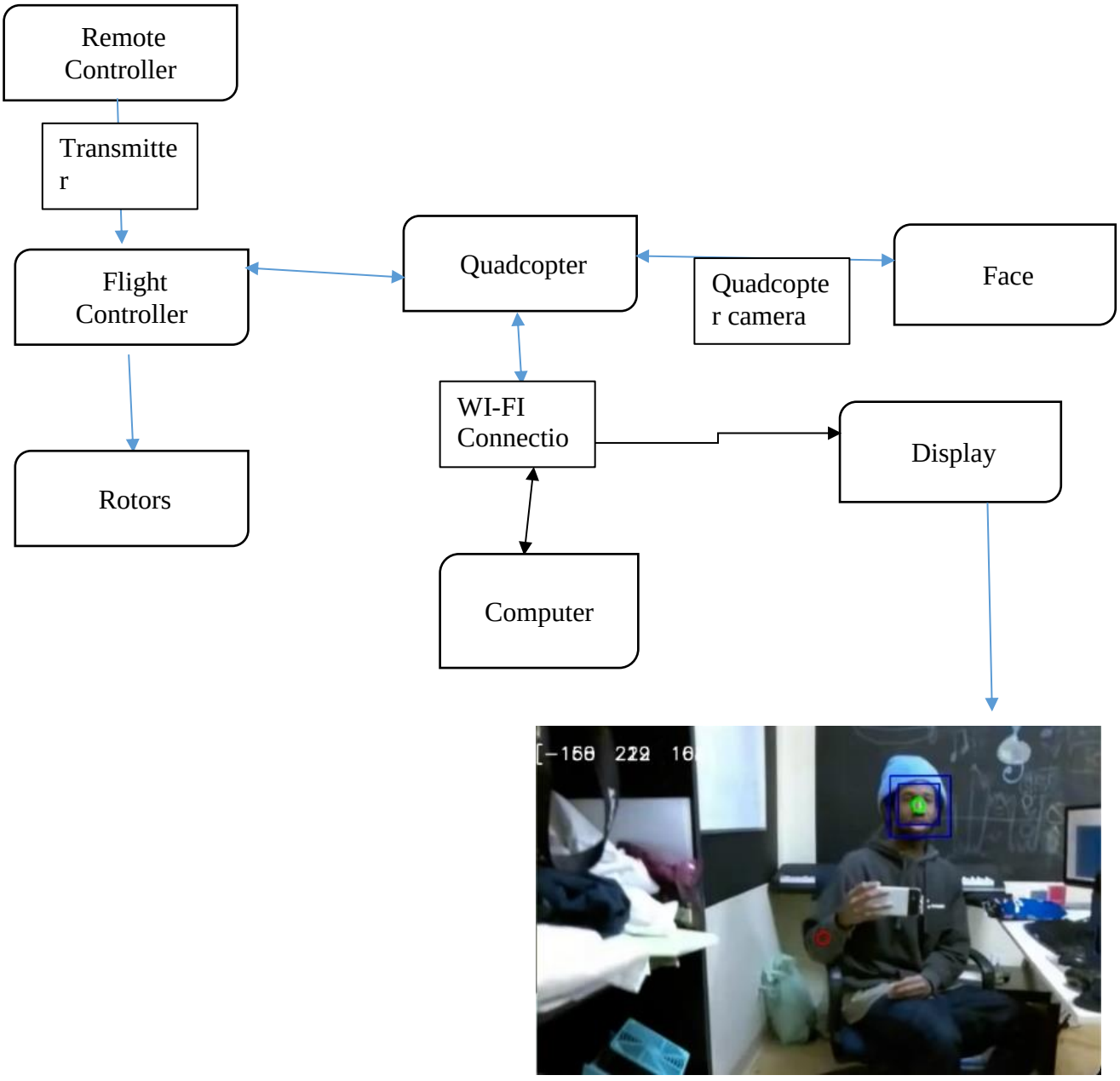


Fig 3.1 – Quadcopter Model

The above is an illustration on how the quadcopter works. With the help of pygame we can use key strokes from the computer to control the quadcopter as well without using the remote controller of the quadcopter.

The Wi-Fi transmitter on the quadcopter will allow the computer to connect to the quadcopter. Once connected we will be able to see what the drone is seeing through

its camera and also control the quadcopter manually using the key strokes from the keyboard which was made possible with pygame. Also the Wi-Fi connection will all us to initialise the necessary programs required to make the quadcopter autonomous as well.

Now the autonomous part of the quadcopter works as follows. Once the program is initialized the quadcopter will fly to a certain altitude then it will yaw clockwise or anti-clockwise searching for a face. Once a face is acquired the quadcopter will then maintain that position then it will put bounding boxes on the face. Now using the given parameters the quadcopter will determine whether to fly forward or backwards, roll or yaw depending on the position of the face. If the bounding box is smaller than the set size the quadcopter will fly forward, if the bounding box is bigger than the set size the quadcopter will fly backwards. If the face is more to the left the quadcopter will fly to the left if the face is more to the right the quadcopter will fly to the right.

In the case where the face is lower than the trained position the quadcopter will fly up and if the face is above the quadcopter will fly up.

For the quadcopter to fly up or down left or right it is determined by the position of the face. Depending on what its seeing from its camera the quadcopter will then send the appropriate command to the flight controller which will then send the correct signals to the rotors so that they rotate in accordance to the required throttle.

The remote controller can also communicate with the quadcopter in manual mode by sending signals to the quadcopter receiver through the 2.4 GHz transmitter on the remote. The received signals are interpreted by the flight controller which will then make the quadcopter behave in accordance to the received signal from the remote controller.

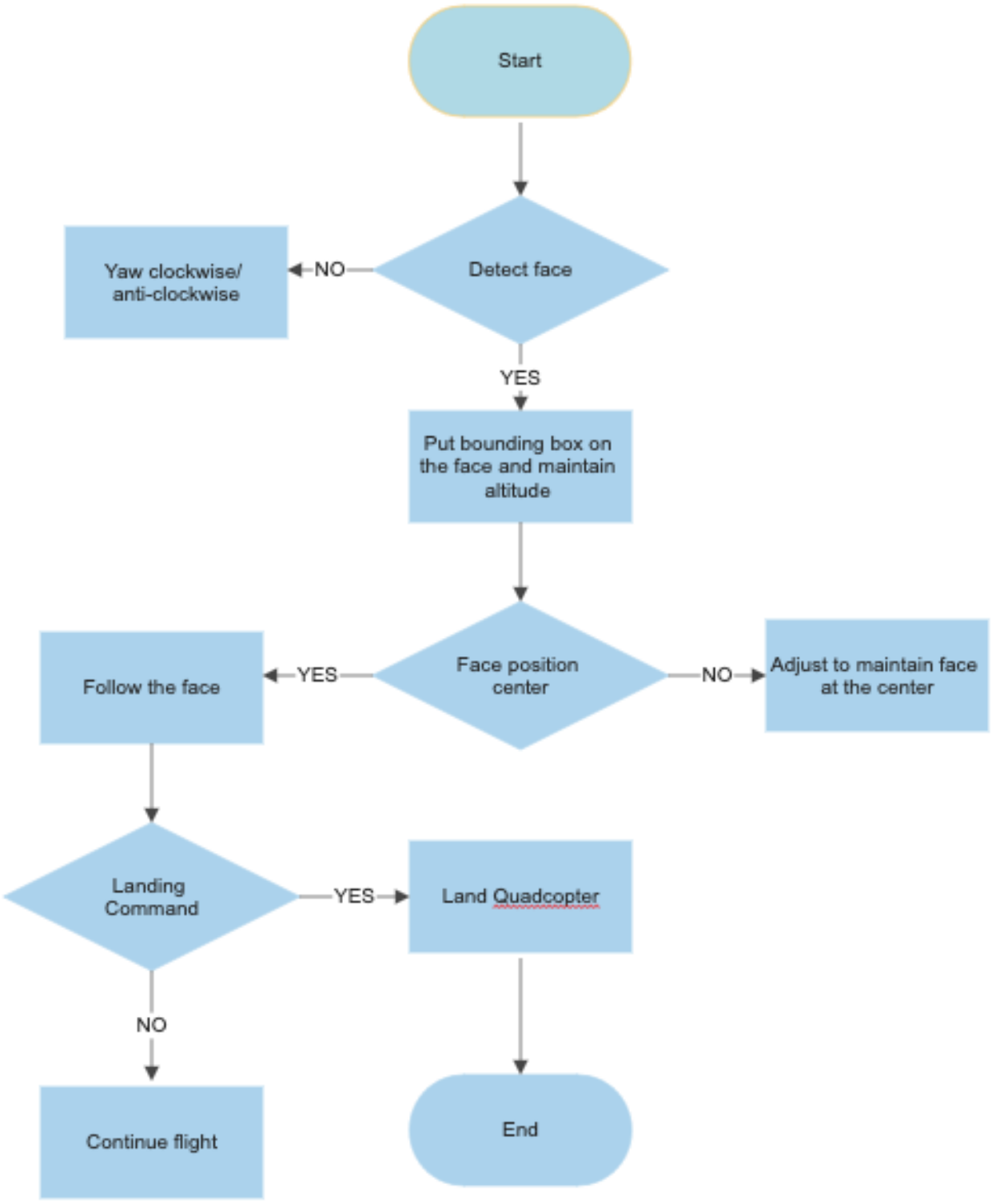


Fig 3.2 – Simplified Algorithm of the quadcopter

CONCLUSION

In conclusion the approach was useful to show that there is a wide range of quadcopter/drone implementations using Ai and OpenCV. The implementations are endless as long as the quadcopters or drones are properly programmed t perform specific tasks. Now we are seeing drones being used for search and rescue, in emergency situations and in some cases in farms where drones are being used to inspect crops in the field, they can also be used now to fight crime by finding a specific criminal amongst a large number of people. Quadcopters and drones have now advanced greatly and are not just used for military purposes as before but now are being used in various industries and revolutionizing them every step of the way.

This is a clear example of technology which was feared before but now being used as a necessity (ADOPTION).

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APPENDIX 1.

APPENDIX 2.