

EXPERIMENTAL INVESTIGATION OF UNMANNED AERIAL VEHICLE (UAV) FOR REAL-TIME MONITORING, PROVIDING WIRELESS COVERAGE, REMOTE SENSING, SURVEY AND MARKING

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ABSTARCT

It is a project which is used in civil sector for land surveying. This project is used for precise survey and mark the required area. Here we are using unmanned aerial vehicle (UAV) for real-time monitoring, providing wireless coverage, remote sensing, search and marking. They provide eyes that can reach and hover above specific sites. Their height and cameras can be adjusted remotely and equipped with sensors they can measure, transmit instantly. We use total station prism in the drone so we can get relatively quick collection of information, multiple surveys can be performed at one set-up location, job done in the site quickly and efficiently. Single man can operate both total station reading and operation of drone.

INTRODUCTION

A hex copter is an aerial vehicle that uses four rotors for lift, steering, and stabilization. Unlike other aerial vehicles, the quad copter can achieve vertical flight in a more stable condition. The hexa copter is not affected by the torque issues that a helicopter experiences due to the main rotor. Furthermore, due to the hex copter's cyclic design, it is easier to construct and maintain. As the technology becomes more advanced and more accessible to the public, many engineers and researchers have started designing and implementing quad copter for different uses.

The aim of this project was to survey and marking hexa copter that can be used to collect GPS information of a surrounding area. This project was a great learning opportunity for us to apply our engineering knowledge. The thesis addresses the difficulties our group faced throughout the project. Choosing the hexa copter parts was not a simple process. In order to complete the hexa copter a battery, transmitter, receiver, GPS module, and micro SD adaptor was selected.

Drone means either miniature fixed wing airplanes or more commonly hexa copter and other multi bladed small helicopters. The drone is driven by an aerial vehicle which is operated to fly independently. The driving medium is a type of small representation unmanned aerial vehicle (UAV).

1.1 DRONE

1.1.1 HEXA COPTER

Unmanned Aerial Vehicle (UAV) is a type of aircraft which has no pilot or passenger on board. UAVs include both autonomously controlled (drones) and remotely piloted vehicles (RPVs) controlled via Radio transmitter. UAVs are commonly used in situations where there is high risk in sending a human piloted

aircraft or where using a manned aircraft is impractical. One of the early practices of UAVs was the “aerial torpedoes”, designed and built during World War I.

The history of multicolor aerial vehicle dates back to late 1920s and was known as Gyrocopters with four rotors. These were primitive UAVs, relying on mechanical gyroscopes to maintain straight and level flight, and flying until they ran out of fuel.

Later, due to the complications in control part and workload for pilot it was replaced by an aircraft with single rotor which is known as helicopter today. But, multicolor UAV have once again gained popularity among us due to its multiple application and structural integrity with perfect stability.



Fig 1 Drone view

More advanced UAVs used radio technology for controlled flight. Then the invention of integrated circuit led to UAVs that can be controlled via electronic auto pilots. Modern UAV are controlled with both auto pilots and manual controllers. This allows them to fly long safe light under their own control, and fly under the command of a human pilot during complicated phase of the mission. The number of propellers in a multirotor generally available are three

(trooper), four (quad copter), six (quad copter), and eight (octa copter). The size of the multicolor UAV product ranges from the simple CD to more than a meter in diameter. Unlike, standard helicopter, a multi-copter use fixed-pitch blades in its rotor and its motion through the air is achieved by varying the relative speed for each propeller.

1.1.2 Simulation Setup

We had to optimize the design of the frame and select the best material. This was done using the Simulation tool Mechanical APDL where we conducted the static structural simulation provided boundary conditions via experimental measurements and references, the objective being to observe the maximum stress concentration in various designs and optimize using the simulated result. Firstly, we were focused on frame manufacture using foam board because it was very light and economic

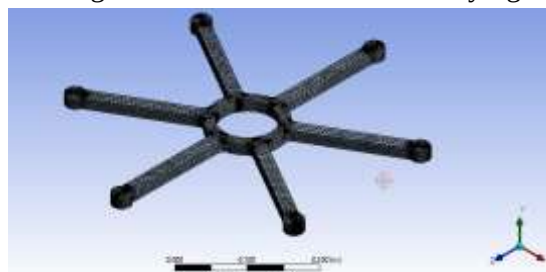


Fig 2 Analysis of Drone View

seemed to be strong enough. So, we designed two foam board frames in solid works; one with slots in the arms and another without slots. The created CAD files of the two designs were imported in Ansys for simulation using Mechanical APDL. We conducted static structural simulation of those frames. The designs were separately simulated to solve for the maximum deformation and maximum stress on the frame. Material Database was created for Polyisocyanurate Foam in Ansys Engineering Database.

We used patch confirming method with tetrahedral mesh for the modelling. Mathematical modelling was program controlled by mechanical APDL. The boundary conditions were defined as per the values obtained from measurements of weight and other material properties. Faces where boundary values needed to be provided were split in solid works and boundary values were provided and parameterized, and we were able to observe results in different boundary conditions and the results were interpreted accordingly. Boundary conditions applied were equal in both the designs and the results were compared at similar conditions.

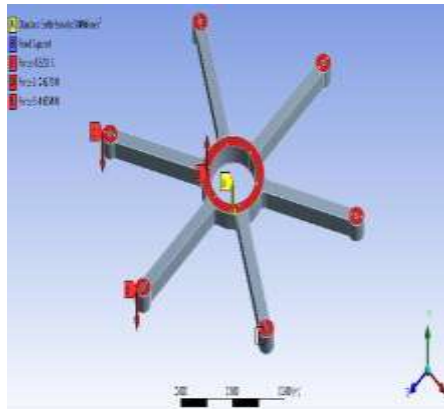


Fig – 3 Analysis view of drone

1.1.3 Electronic Speed Controllers

The DJI Naza mv2 quad copter kit came with four Hobby wing Fly Fun brushless ESC rated at 30 amperes. These ESC can be seen in figure 3.3. These ESC can push 30 amperes of current continuously, can push currents up to 40 amperes for ten seconds based on voltage output, and handle speeds up to 210,000 rotations per minute (RPM). One ESC was found to be malfunctioning during testing and extra ESCs were purchased. We will go into more details about this later in the document.

An electronic speed controller is an electrical circuit that controls the speed of an electric motor and the direction a motor rotates. A motor turns because of the magnetic forces created by the windings and the magnets within the motor.

1.1.4 Transmitter and Receiver

Our group came up with three different options for wireless communication system for our hexa copter. There are three main options to choose from which include a radio transmitter and receiver, a WiFi module, or a Bluetooth module. For our purposes we would need at least six channels to control our hexa copter. The six channels correspond to throttle, roll, yaw, pitch, one channel to switch between acrobatic mode and stable mode, and one or more channels for our auto-commands. More details of the of the two different modes will be discussed in a the PID tuning section. Below is a list of the options we looked at.

Our group decided to choose the 10channel transmitter and the 10channel receiver because it had the required amount of channels needed for our hexa copter purposes. The transmitter and receiver also had the greatest range of transmission was also easy to interface with our control board. If we were to interface the other WiFi module or the Bluetooth module, separate channels need to be programmed and large amounts of programming would be needed.

Therefore the 10channel transmitter and receiver was chosen and shown in figure 3.5. The 10channel transmitter and receiver were properly interfaced with the quad copter controller board male pins. The hexa copter kit that was purchased did not come with the necessary cables to connect these two components together



Fig – 4 Radio Frequency Control



Fig -5 Wireless Amplifier

Wireless telecommunication is the transfer of information between two or more points that are not physically connected. Radio is the transmission of signals through free space by electromagnetic waves. The frequency range in radio is from 3 kHz to 300 GHz [9]. There are different techniques used in electronic communication; which include Amplitude modulation (AM), frequency modulation (FM), DSSS, DSM, and DSM2. AM works by varying the strength of the transmitted signal in relation to the information being sent.

In the other hand, FM works by varying the frequencies of the transmitted signal. The binding process occurs a couple of seconds every time the system is powered up.

Once the transmitter and receiver locked together, the transmitted signal is spread out over a wide band before being identified, collected and re-assembled by the receiver.

1.1.5 FLIGHT COTROLLER

These products an autopilot system designed for serious multi-rotor enthusiasts providing excellent self-leveling and altitude holding, which completely takes the stress out of flying RC multi-rotors for both professional and hobby applications. Despite the system having a built-in autopilot system and our efforts in making the operation of the controller as safe as possible when the main power battery is connected, we strongly recommend users to remove all propellers when calibrating and setting parameters. Make sure all connections are good, and keep children and during firmware upgrade, system calibration and parameter setup.



Fig - 6 Components of Drone

1.1.6 Trademark

DJI and Naza-M are registered trademarks of DJI Innovations. Names of product, brand, etc., appearing in this manual are trademarks or registered trademarks of their respective owner companies.

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These products approved with quality standards such as CE, FCC and RoHS.

1.1.7 GPS

This is especially true in difficult weather conditions. A drone flying in autopilot mode is monitoring and adjusting its position thousands of times per second. Manual flying will never be able to achieve this flight accuracy.

For aerial photography, it is great to let the drone fly on autopilot on a given route, while you concentrate on working the camera capturing the best of video and stills.



Fig – 7 GPS View.

1.2 TOTAL STATION

A total station (TS) or total station theodolite (TST) is an electronic/ optical instrument used for surveying and building construction. It is an electronic transit theodolite integrated with electronic distance measurement (EDM) to measure both vertical and horizontal angles and the slope distance from the instrument to a particular point, and an on-board computer to collect data and perform triangulation calculations.[1]

Robotic or motorized total stations allow the operator to control the instrument from a distance via remote control. This eliminates the need for an assistant staff member as the operator holds the retro reflector and controls the total station from the observed point. These motorized total stations can also be used in automated setups known as Automated Motorized Total Station (AMTS).



Fig – 8 Theodolite

1.2.1 Total Station Prism

In surveying, a *prism* is a corner cube or retro reflector, normally attached on a surveying pole, used as a target for distance measurement using, for example, a *total station*. This article about a civil engineering topic is a stub. You can help Wikipedia by expanding it.

With the prism method, the total station sends out invisible infrared waves that are reflected by the prism, which is typically attached to a pole. By measuring the prism's position and knowing the precise angle and distance to that prism, the total station calculates the prism's location or coordinates.



Fig – 9 Recto Reflector

1.2.2 SERVO MOTOR MECHANISM

A powered mechanism producing motion or forces at a higher level of energy than the input level, e.g. in the brakes and steering of large motor vehicles, especially where feedback is employed to make the control automatic.

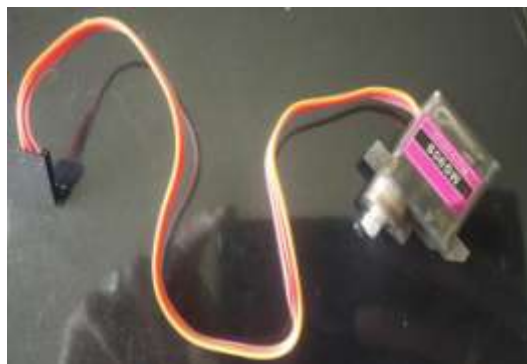


Fig –10 Servo Motor

1.2.3 Paint Sprayer Using Servo Mechanism

In control engineering a servomechanism, sometimes shortened to servo, is an automatic device that uses error-sensing negative feedback to correct the action of a mechanism. It usually includes a built-in encoder or other position feedback mechanism to ensure the output is achieving the desired effect.

The term correctly applies only to systems where the feedback or error-correction signals help control mechanical position, speed or other parameters. For example, an automotive power window control is not

a servomechanism, as there is no automatic feedback that controls position—the operator does this by observation. By contrast a car's cruise control uses closed-loop feedback, which classifies it as a servomechanism.

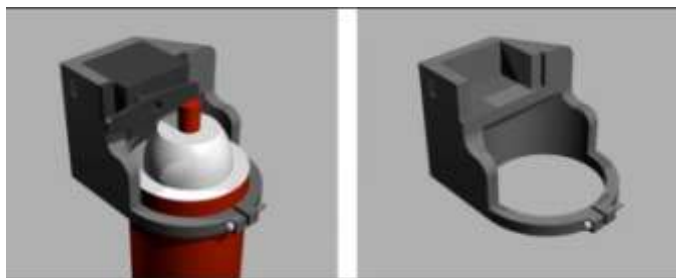


Fig – 11 Paint Sprayer – Analytical view

1.3 FPV CAMERA

Drone photography is the capture of still images and video by a remotely-operated or autonomous unmanned aerial vehicle (UAV), also known as an unmanned aircraft system (UAS) or, more commonly, as a drone. ... Drone photography often enables a first-person view (FPV) that would normally be impossible to achieve.

Unmanned aerial vehicle technology covers everything from the aerodynamics of the drone, materials in the manufacture of the physical UAV, to the circuit boards, chipset and software, which are the brains of the drone.

This UAV is ideal to explain drone technology because it has everything in one package. It includes the UAV, gimbals and camera and uses some of the top drone technology on the market today.

1.4 4S Lithium polymer battery

A **lithium polymer battery**, or more correctly **lithium-ion polymer battery** (abbreviated as **Li-Po**, **LIP**, **Li-poly**, **lithiumpoly** and others), is a rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid electrolyte. High conductivity semisolid (gel) polymers form this electrolyte. These batteries provide higher specific energy than other lithium battery types and are used in applications where weight is a critical feature, like mobile devices and radio controlled aircraft.



Fig -12 Lithium Polymer Battery

1.4.1 Li-Po battery charge

The voltage of a Li-Po cell depends on its chemistry and varies from about 2.7–3.0 V (discharged) to about 4.2 V (fully charged), for cells based on lithium-metal-oxides Charging (such as LiCoO₂); this compares to 1.8–2.0 V (discharged) to 3.6–3.8 V (charged) for those based on lithium-iron-phosphate (LiFePO₄).

1.5 SOFTWARE

1.5.1 DJI NAZA-M V2 ASSISTANT

There's no doubt about it, the NAZA M has been extremely successful with hobbyists all over the world. With its easy to use computer interface for setup, and simple all in one design, it remains one of the "go to" controllers for many multicolor enthusiasts.

While DJI have been working hard on other products, they didn't leave the NAZA M behind, they have revamped the controller into the V2 version. With the V2 version, they have added a few more items that will certainly look familiar to Working users, namely a separate PMU and a remote LED.

In addition to the new hardware, DJI have also improved the assistant software, making it even easier to setup the NAZA. DJI have also added some updated programming features, as well as adding some new ones; including an advanced and improved stabilization algorithm. It's everything we loved about the NAZA M, plus a whole lot more.

1.5.2 Software Configuration

Supporting six multi-rotor configurations, the Naza-M V2 Flight Controller with GPS from DJI acts as the brains of the aircraft, managing pilot input and interpreting data from the various sensors, helping maintain a stable flying condition.

Finally, a GPS receiver/compass combo is included, which enables a number of features, including Intelligent Orientation Control (IOC) and the Go Home failsafe.

CAN-Bus ports on the MC allow the Naza-M to interface with a number of DJI accessories, including the Ground Station System, the iOSD Module, or a gimbal control unit (GCU).

Supports 6 Multi-rotor Configurations

Quad I, Quad X, Hex I, Hex V, Hex Y, Hex YX

Supports DJI Ground Station

By adding the separately available Bluetooth Data-link to the flight control system, you can plot waypoint-based autopilot courses using an iPad app or Windows software.

Software-Based Aircraft Stabilization

The system works with or without GPS, and helps keep the aircraft stable and on course by taking data from gyros and other sensors and apply it to any pilot inputs. Naza-M V2 features GPS course correction plus GPS and compass interference monitoring, which combine to prevent the aircraft drifting off course due to magnetic interference that may throw off the compass (the GPS must be enabled and properly calibrated for this feature to work).

Takeoff Assistance

Helps ensure a stable, drift-free take off even on uneven surfaces.

Intelligent Orientation Control (IOC)

Because multi-rotors are virtually symmetrical, it can be easy to lose track of which end is the "front". IOC features two modes to help make flying more intuitive.

Core Lock: "Forward" is always the same as the direction the nose was pointing when the aircraft first took-off, regardless of the actual orientation of the aircraft

Home Lock: "Forward" is always away from the origin defined by the Home Point that was established during GPS calibration. In other words, "forward" will be away from the Home Point (pilot) and "back" always toward the Home Point. Moving the stick right or left will cause the aircraft to follow a circular path around the Home Point.

Motor Failure Protection

If a hexa rotor equipped with a Naza-M V2 suffers a single motor failure in flight while in attitude or GPS mode, it will maintain its altitude and rotate around the stopped motor. This allows it to fly safely back to home and land

Failsafe and Auto Go Home Support

If the connection between the multi-rotor and the remote control (transmitter) are disconnected during flight, a failsafe system will activate. Provided there was enough GPS signal at the time of the disconnection, the multi-rotor will fly back to its point of takeoff and land automatically. This feature can also be triggered manually using the One-Key Go-Home function activated using Assistant software

FINAL OUTCOME



Fig -13 Drone Total View

CONCLUSION

This work involves the development and integration of hexacopter using APM microcontroller to control the whole UAV movements. It also involves the integration and use of a UAV's camera to automatically construct a local map based on the images acquired from the UAV while flying through a dedicated area of interest. The results show a successful control for a hexacopter to fly using a ground pilot with RC flight control.

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