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# MULTIPURPOSE INTEGRATED QUADCOPTER (M-IQ)

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## Abstract

Nowadays, the Technology of science is developing rapidly. A quadcopter is not a new concept in this era of developing technologies. Quadcopters are used for video recording or image capturing in case of defence for surveillance. The "Multitasking Integrated Quadcopter" is used for observations in the agricultural fields and to carry some load from one place to another place and many other functions like search and rescue, security, inspection, surveillance, science and research, aerial photography videography, surveying mapping, unmanned cargo system, construction and pre-construction work, soil and field analysis, seed planting, crop spraying and spot spraying, irrigation monitoring and management, real-time crop livestock monitoring. Li-fi technology is used for receiving and transmitting data from Quad location to ground station. Emergency disaster announcement system for remote control areas, Li-fi can used in hotels and restaurant for order and serving food for people. All these functions can be used individually (one at a time). It requires minimal guidance for navigation and control system to be developed and tested. There are several methods to build the control of the quadcopters such as Zigbee, Wi-Fi, Radio, Bluetooth and GSM technologies. The assembly process of the quadcopter depends upon the requirement of the application and minimizing the complexity involved while performing the task individually. It has capabilities such as recognition and detection of obstacles and gives the notification to the transmitter. Quadcopter maintains a stable position when flying due to the gyroscope sensor. Quadcopter accepts a load disturbance up to 100g during hover condition. The approximate time of operation of the quadcopter is 15 minutes using 1500mAh Li-ion battery and operating time can be increased by using the largest battery capacity. This project of "Multitasking Integrated Quadcopter" is the efficient utilization of resources and reduces labour work. All the operations performed are based on microcontroller/Arduino Uno (Motherboard) which is master in doing operations in simplest way. This paper focuses on hardware and software levels of design aspects. The usage of the multipurpose integrated quadcopter results in the reduction of human effort and increases precession in work. The time consumed for every work is reduced which increases productivity in the work. To conclude, we understand that the multipurpose quadcopter is the future as we are able to access the places without traffic increasing the work done, with less power and fuel consumption hence helps in the fuel saving camping as well.

**Keywords:** Quad copter, Agriculture, Real-Time, Li-Fi Technology

**Acronyms/Abbreviations**

Unmanned Aircraft System (UAS), Multipurpose Integrated Quad copter (M-IQ), Electronic Speed Controllers (ESC), Flight-Controlled Board (FCB), Global Positioning System (GPS), Normalized Difference Vegetation Index (NDVI), Light Fidelity (Li-Fi)

## 1. Introduction

Ventures have been expanding to use electrical drive unmanned aircraft systems (UAS) in numerous regions, for example, reporting climate, parcel delivery, land analysis, and military missions. Regardless of whether it is indoor or outside, a UAS that is composed and manufactured for its particular environment applications can give a colossal measure of points of interest as far as safety, proficiency, dependability, simplicity of control, and negligible aggravations to its

environment[1][2]. The principle issue concerning an electrical drive UAS is its disappointing flight term utilizing regular batteries, contrasted with bigger flight systems that depend on carbon-based fuels. In this paper, we mainly focus on hardware and software levels of design aspects. The usage of the multipurpose integrated quadcopter results in the reduction of human effort and increases precession in work. The time consumed for every work is reduced which increases productivity in the work.

Contingent upon the mission goals, the types of UAS may differ. A UAS, for example, a quadcopter, is adequate for some engineering applications in which the mission requires the need to convey a particular load at a consistent movement and the simplicity of control in much smaller situations, contrasted with a plane which requires a lot bigger environment for take-off and landing just as an expansion in intricacy in controls because of aerodynamics features of the wings. Development industries have begun to utilize drones to monitor their advancement hands available by remaining fixed or flying out a couple of miles and catch progress being made on-site. A fuel-cell and battery hybrid power system, in which the battery goes about as a boost, for example, an enormous capacitor, might be advantageous for quadcopter missions that require a large power surge for short flight durations and a quick reaction to stack vacillations in power demand[3]–[7].

## 2. Multipurpose Integrated Quad-copter (M-IQ)

Autonomous flying Multipurpose Integrated Quadcopter, I'd like to tell you a little bit about the challenges in building these and some of the terrific opportunities for applying this technology it has accomplished 10-Application such integrated one design modifications and development have been achieved. Quads have been around for quite a while, they're so famous these days since they're precisely straightforward by controlling the rates of four propellers, these machines can move, pitch, yaw and accelerate along their basic direction. Quads are amazingly light-footed however this nimbleness includes some significant downfalls, they are intrinsically precarious, and they need some type of programmed input control so as to have the option to fly. The "Multitasking Integrated Quad-copter" is used for multipurpose in the agricultural, search and rescue, security, inspection, surveillance, science and research, aerial photography videography, surveying mapping, unmanned cargo system, construction and pre-construction work, Li-fi technology is used for receiving and transmitting data from Quad location to the ground station. Emergency disaster announcement system for remote control areas, Li-fi can be used in hotels and restaurants for order and serving food for people. All these functions can be used individually (one at a time).

Agriculture in countries like India establishes over 60% of occupation. It serves to be the foundation of the Indian economy. It is exceptionally fundamental to improve the profitability and productivity of agriculture by giving the safe development of the farmer. The different tasks like the showering of pesticides and sprinkling compost are significant. Despite the fact that the splashing of pesticides has become obligatory it additionally ends up being an unsafe methodology for the farmers. Farmers particularly when they shower urea, avoid potential risks like wearing proper outfit covers and gloves. It will maintain a strategic distance from any hurtful impact on the farmers. Keeping away from the pesticides is additionally not totally conceivable as the necessary outcome must be met. Henceforth front, utilization of robots in such cases gives the best of the answers for this sort of issue, alongside the necessary profitability and productivity of the item[8].

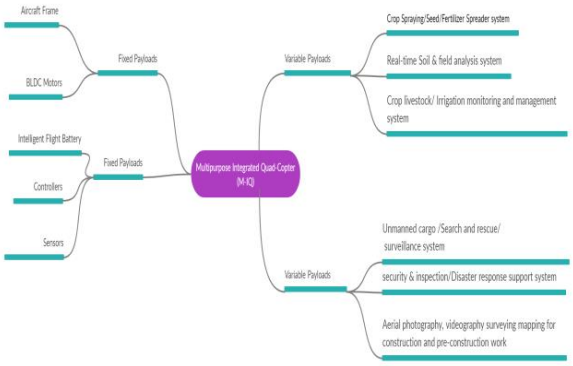


Fig 2: Block diagram of M-IQ

### *2.1. Design and Methodology*

The assembly process of the quadcopter depends upon the requirement of the application and minimizing the complexity involved while performing the task individually. The bulk of our research is algorithms it's a magic that brings these machines to life. So how can one design the calculations that make a machine competitor? We use something broadly called model-based design, we first capture the physics with a mathematical model of how machines behave, we then use a branch of mathematics called control theory to analyse these models and also to synthesize algorithms for controlling them. Onboard are also a battery, a computer various sensor, and wireless radios. Quads have been around for quite a while, they're so well-known these days since they're precisely straightforward by controlling the rates of four propellers, these

machines can move, pitch, yaw and accelerate along with their common orientation. Quads are extremely agile but this agility comes at a cost, they are inherently unstable, and they need some form of automatic feedback control in order to be able to fly.

M-IQ is engineered to be flexible for a flight with various payloads. We can easily attach and switch payload with a mounting panel with only one move with the intelligent Payload installation mechanism as shown in Fig 2.2, we will need less than 3min to prepare the drone for a flight. The flight controller is the primary load up in the UAV is implanted with the most developed firmware and liable for the genuine flight. Flight controller controls part of things at the same time during the flight or UAV. It worked with a main controller and communicates to the four brushless motors. BLDC motor associates with the rotors in bearings of the UAV setup model. These BLDC motors are constrained by the Electronic Speed Controllers (ESC). The UAV constrained by the Radio channel transmitter and receiver. Ever RC transmitter has a number of channels for singular action to control the UAV. The CAD Model of M-IQ of UAV's is given in below fig 2.1.

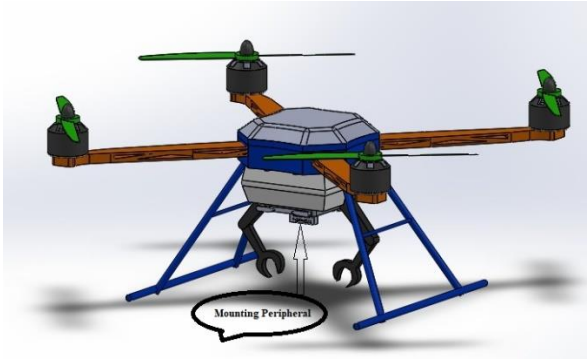


Fig 2.1: CAD Model of M-IQ

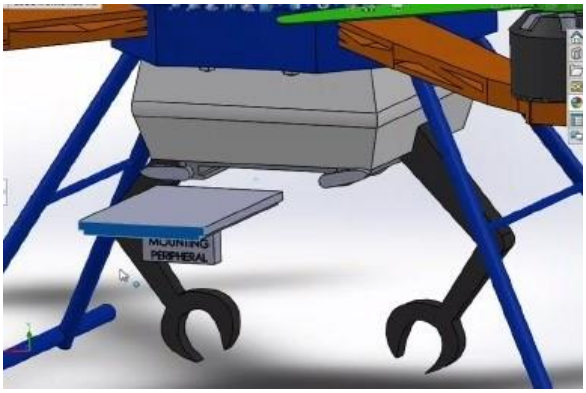


Fig 2.2: M-IQ Peripheral Drag Mechanism

## 3. Crop spraying/seed / fertilizer spreader

MI-Q quadcopter supports through a single remote controller, it reduces the operational cost and completing more tasks in a shorter time frame. The spraying system uses a composite material and resists corrosion and double surface life. A 5m coverage of M-IQ covers an average of 4 hectares per hour. Dual searchlight helps safe operation in low light with a wide-angle camera the M-IQ supports HD video transmission and displays a real-time information of the surrounding field while providing a reference for obstacle avoidance equipped with a wide-angle bi-directional RADAR system that inaugurates high precision and one obstacle avoidance radar. It can detect an object smaller than a half-centimetre to 15m away. An onboard FPV camera record waypoint during flight facility route planning and avoid the trouble of manual recording. It increases efficiency and saves time. It also analysis a terrain to adjust aircraft altitude to achieve safe operation. the radar system is protected by dual-band casing for all-weather durability and convenient maintenance. low altitude flight can be controlled from up to 2km away while ensuring stable communication in even complex operation environment also, it can act as a seed spreader or fertilizer scattering drone.

The Agriculture Drone System is designed by utilizing GPS where the consequently controlled drone dependent on an aerial pesticide sprayer essentially comprising of two sections the quadcopter and splashing instrument. At first, the quadcopter is gathered utilizing essential parts, for example, flight-controlled board (FCB), GPS, BLDC engine, ESC controller and battery, and so forth. Where the drone was acted at the required height, and afterward it is changed to altitude hold mode, which keeps up a similar height until it is switched back[10].

The balance of drones is kept up by sensors. GPS is utilized in just self-governing mode. As indicated by the adjustments in the estimations of sensors the motor speed is shifted. Siphon used to turn ON/OFF the water siphon which is utilized to splash[11]. With the assistance of the GPS, the framework can likewise share the information through a wireless medium[12].

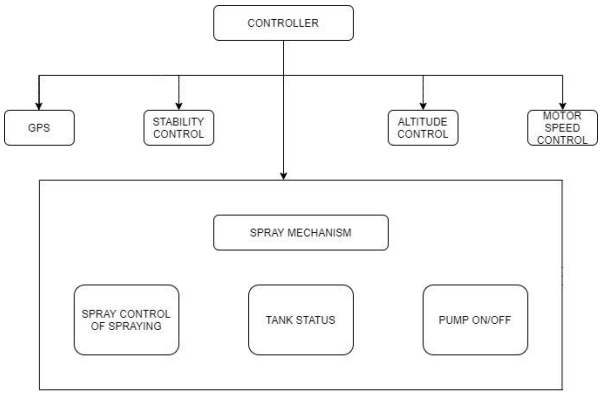


Figure 3: Block diagram of Agriculture Drone using GPS system

*3.1. Hardware Components*

There are different parts installed to the UAV, M-IQ is engineered to be flexible for flight with various payloads. We can easily attach and switch payload with mounting panel with only one move with intelligent Payload installation mechanism, the fixed and variable payloads are given in fig 3.1, for its movement control as indicated by the sensed environments. Various types of hardware and peripheral components are utilized in UAVs as delineated in table 2.

| Fixed | Variable |
|---|---|
| Aircraft Frame | High-Precision Radar Module |
| BLDC Motors | Spray System |
| Intelligent Flight Battery | Infrared Sensing System |
| Controller and Various sensors | Intelligent Flight Battery |
| | HD,RGB,30X Optical Zoom & Hyper/Multispectral Camera with 3-axis Gimbal |

Fig 3.1: Fixed and Variable payloads

Table 1: Hardware and Peripheral Components

| Components | Function |
|---|---|
| Accelerometer | For measure the acceleration |
| Gyro | For rotational motion |
| Magnetometer | To measure magnetic field |
| WSN | Sensing environment conditions |
| IMU | Measures angular rate and forces |
| GPS | Provides geo location of an object |
| Camera | To record visual images |
| Multispectral Camera | Images at specific frequencies |
| Hyper spectral & Thermal Camera | Images at narrow spectral bands and low light imaginary |
| Video Camera | Electronic motion of object |
| Laser scanner 2D | Captures shape of the object |
| Telemetry | To get live data from UAV |
| Altimeter | To measure altitude |
| Air Pressure Sensor | Measurement of gases or liquids |
| BLDC | To motion control |
| ESC | Regulates the speed of BLDC |
| Microsoft Kinect | To motion sensing |
| Barometer | For atmospheric pressures |
| Digital Temperature | Temperature detectors |
| Humidity indicator | Measures moisture in air |
| Water sensitive paper | For assessing spray coverage |
| Filter papers | To separate fine substances |
| Anemometer | To measure speed of wind |

## 4. Real-time Soil and field analysis/ Crop livestock/ Irrigation monitoring and management system

The M-IQ vehicle allow farmers to monitor crop and livestock condition consistency by air to find problem that would not be visible in ground level spot checks and of example the farmer can inspect his crop whether his crop is not been irrigated with time laps, it uses different sensors like multispectral sensors to basically fly over the crops and measure the reflectance of the light to see whether crops are healthier where they're struggling. This will measure another level of productivity in agriculture.

It is a concept based on observing and responding to intra field variation it relies a new technologies like satellite imagery GPS information technology and other geospatial tools, suppose we have 20 hectare and we are getting 100 tons per hectare of yield a remote sensing field of one's field shows the difference between the yield in various parts of the same ground. Areas marked in red show the yield of 20 tonne per hectare while area marked in blue show yield of 120 ton per hectare a difference of 100 tonnes or in other words not optimizing yield from these hundred tonnes is leading to loss in productivity, observing variability and crop is the first step of precise agriculture process, evaluating all

the information together can give us a better understanding of the causes of variability in farm, depending on evaluation we can manage our crop better sensors in field measure the moisture content temperature of the soil and surrounding air. The smart intelligent technology behind this in terms of how much water is there this is exactly how much water your crop needs and then tailor our irrigation system so it delivers just a right amount of water then we are not wasting water to unnecessary evaporation or percolation or whatever so in. this MI-Q project will help us to optimize the water use so that there is a sufficient food available for generations to come.

UAVs are fit for watching the crops with various records. The UAVs can conceal hectares of fields in a single flight. For this perception thermal and multispectral Cameras to record reflectance of vegetation shade, which is mounted to the downside of the quadcopter[13][14]. The camera takes 1 snap for each second and stores it into memory and sends it to the ground station through telemetry. For this wireless communication, utilizes the MAVLINK convention[15]. The photos are captures in the noticeable five brands with various wavelengths: for example (i) Blue wavelength 440-510nm, (ii) Green wavelength 520-590nm, (iii) Red wavelength 630-685nm, (iv) Red edge wavelength 690-730nm, (v) Near-infrared wavelength 760-850nm. The information originating from the multispectral camera through telemetry was examined by the Geographic indicator Normalized Difference Vegetation Index (NDVI) [16][17]represented in equation 1.

$$\text{NDVI} = (R_{INR} - R_{RED})/(R_{INR} + R_{RED}) \quad \text{-- (1)}$$

Where, $R_{\text{INR}}$ = Reflectance of the near infrared band,

$R_{\text{RED}}$= Reflectance of the red band.

The calculations give the values - 1 to +1; close to 0 (ZERO) demonstrates no vegetation on the harvest and close to +1 (0.8 to 0.9) implies the most elevated thickness of green leaves on the yield. In view of these outcomes, farmers effectively recognize the handle where can splash the pesticides. The inbuilt GPS module keeps up the GPS directions of each captured picture. At that point, the GPS directions of that photos are put away in UAV to shower pesticides naturally without manual control[18].

### *4.1. Sprinkling System*

Generally, the sprinkling system is appended to the lower area of the UAV which as a nozzle underneath the pesticide tank to sprinkle the pesticide towards downstream. The sprinkling system as two modules one is the sprinkling system itself and the second one is Controller. The sprinkling system contains the showering content (pesticides or manures) and a nozzle for splashing. The second one is the controller used to initiate the nozzle of the sprayer. A pressure siphon is a segment of the sprinkler system which pressurizes the pesticide to course through the nozzle. A motor driver integrated circuit is utilized to pressure the siphon according to the necessity[9]. Investigation of various spraying velocities and nozzles utilized in UAVs for splashing have appeared in Table 3.

Table 2: Analysis of different spraying systems.

| Sprinkling Speed | Nozzle Type |
|---|---|
| Depends on immersible pump | - |
| Depends on Communication between UAV and WSN | - |
| 1.15 ha/h | Flat fan |
| 4.45 m/sec | - |
| 0.4 ha/min (1 acre/min), 2.2 m/s | Micron air ULV – A+ |
| 47 l/ha | Flat fan |
| 1 l/min | Universal |
| 0.6 – 1 l/min | Centrifugal |
| 13.61 g/30s | Micron air – A+ |
| 0.2 MPa (Pressure) | Flat fan |
| 0.3 MPa (Pressure) | Fan shaped (electrostatic) |
| 0.3 – 0.8 l/m | Flat-fan, Centrifugal and cone |
| 1.25 l/min | Conical |
| 850 ml/min | Electric centrifugal |
| 850 ml/min | Rotary atomizer |
| 0.2-1.0 MPa (pressure) | Flat fan |

## 5. Aerial photography videography surveying mapping for construction and pre-construction work

For mining to construction topographical surveying is essential for getting the chart right the rise of drone technology is changing the way surveying done making it accessible to a wide scope of ventures, drones offer colossal open doors for assessors and GIS experts with the assistance of drones it is conceivable to complete overviews and measure and convey surveying data in a timely accurate and safe way, using drones for surveying and mapping has many advantages: Time-saving, traditional surveys can take days if not weeks with a power of drones survey can be completed in powers and collected data and imagery can be processed on the same day this means that we spend less time in gathering data and taking right decisions.

Cost-Effective acquisition and operating cost of drone survey is much lower than that of the survey through satellites and manned aircrafts the technical requirements for the site and personnel are also low and the daily maintenance is simple, these factors eventually reduce the cost of data acquisition accessibilities with the help of drones we can easily survey those areas that otherwise difficult or even impossible to access for terrain and other areas where conventional surveying is challenging and time-consuming drones offer a great advantage.
Accuracy: some of the most important parameters of surveying are spatial resolution and low altitude multi-angle shooting, the spatial resolution can reach decimetre or even centimetres and can be used to construct accurate digital models and 3D landscape maps. Safety: land surveying can be risky jobs drones eliminate the need for surveyors to explore unknown terrain.

X-frame quadcopters furnished with different VIS and IR cameras are new appealing instruments for quick recognition of defects responsible for execution debasement. Then again, the design, assembling, and development of UAV got well known because of quickly developing open-source data and low costs of segments[19]. Discussions and exchange of practical experience with convention further quicken the scattering of good practices. In the solar research areas, these new opportunities can be applied for cutting edge instrumentation preparation for on-field PV testing[20].

Airborne photo mapping is well-developed satellite technology yet for low-elevation, low-financial plan self-sufficient flying stages it is as yet a test[21]. It has gotten a lot simpler to capture, scan, and process pictures and 3-D scenes from the air with light-weight cameras and gadgets[22]. It is no longer needs to recruit plane or delta plane to take aerial photographs in light of the fact that the scene can be shot with UAV at different statures, with greater adaptability and decreased expense.

### *5.1. LOW-ALTITUDE FLIGHT INSPECTION – visual and infrared*

#### *5.1.1. Instruments*

The IR cameras producers radically have marked down the cost and opened the firmware for IR sensors fans. Presently, SDK libraries and IR sensor sheets for Apple OS and Android OS got alluring for UAV applications, including IR review of PV modules. Our testing IR board depends on a few minimal effort IR cameras and FLIR sensors for the I-phone5 connection.

In view of open–source tools, quadrotor UAV is intended for self-ruling flights with the ability of video stream transferring to Ground Control Station IR still-pictures shooting. Sensors on-board the quadrotor UAV are 3-axis gyros, accelerometers, 3-axis magnetometer, barometer, and a solitary channel GPS receiver.

#### *5.1.2. Image processing procedure*

The pipeline of the cycle incorporates flight arranging picture procurement and picture post-processing. the photographs are masterminded and situated naturally as indicated by comparability in detail. at that point, a thick surface 3d model is produced. a general grouping of the cycle is planning of aerial photograph ortho revision orthophoto 3d model. an automated coordinating strategy for invariant focuses on pictures is applied in a few stages. the covering in nearby pictures is a significant factor that diminishes mismatching and optical noise. along these lines, the software makes a 3-D visibility map in a shorter computational time.

## 6. Unmanned cargo /Search and rescue/ surveillance, security & inspection/Disaster response support system

The M-IQ can transport all sort of payload to long distances its maximum carrying capacity is 2kg with a payload of 1kg drone cover a distance of 10km and
with a payload of 2kg drone cover a distance of 5km. The flight control system allows setting a flight along the route or given point and it also change the route during flight. And also it can combines manual control and autopilot. Its Payload disposal system allows delivering a payload to within 3ft, M-IQ is compact and easy to transport. we can easily attach a payload with mounting panel with only one move. we will need less than 3min to prepare the drone for a flight.
1. Among the most advantage of drone is: Battery versatility, M-IQ drone can use all batteries of all brand with required parameters 24V.
2. Balanced frame, M-IQ drone has a frame that can carry heavy loads, this fact positively influences all parameters and construction durability. It is equipped with a fault free automatic disposal system and deliver cargos to hard to reach places and remote localities.

## 7. Conclusion

We understand that the multipurpose integrated quadcopter (M-IQ) is the future as we are able to access the places without traffic increasing the work done with less power and fuel consumption hence helps in the fuel-saving camping as well. The presented model designs were tested only with design simulations. A genuine trial model of a quadcopter ought to be developed to accomplish more practical and solid outcomes, despite the fact that the development of a real quad copter and the assessment of the apparent multitude of model boundaries are relentless assignments a real quadcopter would carry critical advantages to the exploration. with a real model, the hypothetical system and the simulation results could be contrasted with real-life measurements. This paper did not include these highlighted matters in the study but presented the basics of quadcopter modelling and control and accomplished ten real-time applications such integrated one design modifications and development have been achieved. This paper can thus be used as a stepping-stone for future research in more complex modelling of the quadcopter.

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