

# DEVELOPMENT OF A LOW COST ENVIRONMENTAL SENSING QUADCOPTER

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## ABSTRACT

Unmanned Aerial Vehicles are finding useful applications in many sectors. The accessibility to remote areas can be assured with the help of UAV's and this can help to use them for surveillance and data collection. Mining industry is one such sector which needs explorations to deep caves and underground places. Conventional methods of exploration are very time consuming and dangerous leading to loss of lives of many human beings working in mining industry. Development of sensors which can sense the atmospheric conditions and gases present in the locations have been used and an environmental sensing quadcopter was developed. The developed quadcopter was tested in different locations and found out to be successfully working. Further research scopes include attaching Ground Penetrating Radar (GPR) to know the underground geological details.

## INTRODUCTION

Small scale Unmanned Aerial Vehicles are used in many application recently. Demand for aircrafts with more maneuverability and hovering capacity gave way to the research on Quadcopters. Quadcopters are one among the successful vehicles with Vertical Take off and Landing facility. The small size permits quadcopters to fly everywhere, even through narrow spaces. Now adays. Quadcopters are used for a number of applications like surveillance, faming, food delivery etc.

The fact of less damage of UAVs, they are widely used in almost every sectors. Mining is the process of extracting valuable minerals from the earth. Mining is a dangerous activity and has been a sector reporting many hazard to human life. Advancement in electronics permits us to produce light weight flight controllers, accelerometers, GPS and wireless environmental sensors. Hence, it makes sense to use a Quadcopters in the form of a First-Person View (FPV) drone for mining explorations. UAV drones are used nowadays in environmental sensing also, which can be adopted in mining and exploration. Temperature, gas and pressure sensor can be used in environmental sensor. In mining environmental sensor is used to detect the earth's surface by UAV flyovers and comparing surface data to previous scan. Environmental Sensing UAV's can easily find caves, hills, steepness and valleys. The sensors can measure gas, pressure, dust, temperature and noise.

For the developments of a Quadcopters, there are thousands of different permutations that can be used. After a detailed analysis of various them ranging from a simple tri-copter to an octocopter, a Quadcopter design was unanimously selected as it provides elegant support in the form of control, structure, reliability, cost, size, etc. Most important of them being size and structure. Mines can be constricting places and a wide frame may become very difficult to control inside such enclosures.

The present study was conducted to develop a low cost environmental sensing quadcopter for mining and surveying, to detect the temperature, pressure, humidity and the gases present in the earth surfaces.

### **METHODOLOGY**

Traditional methods of pressure and temperature analysis in caves are very expensive and time consuming for the mapping process and final output deliverables. The developed technology can ease the operation in short on-site times, and rapid automated processing for superior mapping data – with significant cost savings.

Sensor network in conjunction with UAVs are often implemented in research setting to expediate the process of data collection and to increase the breadth of data that may be collected over a graphical area. Once a data is transmitted and stored, the UAV safely carries it back to ground storage.[1].

Environmental monitoring system deal with various factors which needs to be measured, mainly focusing on temperature, humidity and pressure. The environmental monitoring system consist of 4 sensors DHT 11 used to measure temperature and humidity, BMP280 measures absolute barometric pressure. MQ 7 used to detect carbon monoxide and MQ 135 is used to detect smoke.[2]. The gas monitoring system is able to measure the concentrations of greenhouse gases namely carbon di oxide(CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), water vapor (H<sub>2</sub>O) and ozone(O<sub>3</sub>) at different altitudes.

A device made up of sensors that will not only provide the farmer with more information than just the temperature, but at a much lower price-point[3].

A prototype of the first, original model of the proposed product was developed.

### **Components of the prototype:**

#### **1. Propeller:**

A propeller is a revolving device with radiating blades set at a pitch to form a helical spiral that, when rotated, performs an action similar to that of an Archimedes screw. It converts rotational power into a working fluid like water or air. By establishing a pressure difference between the two surfaces, the rotating motion of the blades is transformed into thrust, and a given mass of working fluid is accelerated in one direction while the ship moves in the opposite direction. Bernoulli's principle and Newton's third law are the theories behind this.

Propellers of size 15inches was used. These propellers are specially designed for multirotor use and for use with “panicle” multirotor motors. They are constructed from high quality carbon fibre, they are stiff, yet extremely light in weight(14.5grams).



**Fig 1: Propeller**

### 2. 40amp ESC:

An electronic speed controller is an electronic circuit that controls and regulates the speed of an electric motor. It may also provide reversing of the motor and dynamic braking. Miniature electronic speed controls are used in electrically powered radio-controlled models. Full size electric vehicles also have systems to control the speed of their drive motors.

The main features are smooth linear throttle response, thermal over loaded, signal loss protection, low voltage cut-off and user friendly.



**Fig 2: 40 amp ESC**

### 3. 650mm carbon fibre frame:

Carbon fiber is high strength. It is low weight. It is cost efficient. It is characterized by high stiffness. It is conductive to electricity and is one of the most corrosion and heat resistant materials available for commercial use. Carbon fiber is versatile. It has the ability to work with an assortment of different materials, including other fibers, plastics, metals, woods, and concrete. It can be manipulated into a variety of forms. It can be dyed, treated, and augmented to meet the requirements of any application.



**Fig 3: 650 mm Quadcopter Carbon fibre frame**

#### 4. Pixhawk 32bit flight controller kit with GPS telemetry sensor:

A decade ago, “Pixhawk” was a student project at ETH Zurich. little did the team know that it would end up having such a large influence on the drone industry.

The Pixhawk was originally developed by hobbyists to control model aircraft and rovers and has evolved into a full featured and reliable autopilot used by industry, research organisations and amateurs. During this time the team created MAVLink, Pixhawk px4, and ground control-which are today's most used standard for flight control hardware and autopilot software in the drone industry.



**Fig 4: Pixhawk flight controller for quadcopter**

#### 5. Brushless BLDC motor 810 kv:

A brushless BLDC electric motor also known as electronically commutated motors, are synchronous DC motors, are synchronous motors powered by direct current (DC) electricity via an inverter or switching power supply. Which produces electricity in the form of alternating current (AC) to drive each phase of the motor via a closed loop controller. The controller provides pulses of current to the motor windings that control the speed and torque of the motor.

The construction of a brushless motor system is typically similar to a permanent magnet synchronous motor (PMSM), but can also be a switched reluctance motor, or an induction motor. They may also use neodymium magnets and be outrunners or inrunners.

The advantages of a brushless motor over brushed motors are high power to weight ratio, high speed, electronic control and low maintenance. Brushless motors find applications in such places as computer peripherals, hand held power tools and vehicles ranging from model aircraft to automobiles. Modern washing machines use brushless DC motors which have replaced rubber belts and gearboxes with a much simpler and more reliable direct drive design.



**Fig 5: Brushless BLDC motor 810 kv**

## 6. Environmental sensor:

Environmental sensor is used for measuring, monitoring and recording environmental parameters such as measuring temperature, humidity, heat losses, and detecting food spoilage using the gas sensors. Environmental conditions have a major impact on our well-being, comfort, and productivity. These sensors provide a detailed and reliable data on key environmental parameters such as volatile organic compounds (VOCs), particulate matter (PM2.5), CO<sub>2</sub>, dust concentration and noise based on raspberry pi/Arduino custom sensors that are open source, low cost, accurate, and durable. Environmental sensing opens up new possibilities to create smarter devices that improve our comfort and well-being as well as increase energy efficiency in a wide variety of applications.



**Fig 6: Environmental sensor**

## 7. LIPO battery:

Orange 8000mah 6s 25c/50c LIPO battery are known for performance, reliability, and price. It's no surprise to us that orange lithium polymer packs are the go-to the pack for those in the know. The orange batteries deliver the full rated capacity at a price everyone can afford. LIPO battery are equipped with heavy-duty discharge leads to minimize resistance and sustain high current loads. Orange batteries stand up to the punishing extremes of aerobatic flight and RC vehicles. Each pack is equipped with gold plated connectors. All orange lithium polymer batteries packs are assembled using IR match cells.



**Fig 7: LIPO battery**

## 8. RC Transmitter with FS-IA68 receiver -6CH FLYSKY FS-I6X 2.4GHZ:

A radio control system is made up of two electrons, the transmitter you hold in your hands and the receiver you put inside your drone.

Dramatically simplifying things here your drone transmitter will read your stick inputs and send them through the air to your receiver in near real time. Once the receiver has its information it passes it on to your drone's flight controller which makes the drone move accordingly. A radio will have four separate channels for each direction on the sticks along with some extra ones for any auxiliary switches it may have.



**Fig 8: RC Transmitter with FS-IA68 receiver -6CH FLYSKY FS-I6X 2.4GHZ**

#### **Assembling the components and developing the prototype/product:**

The quadcopter frame is made up of the carbon fibre frames with foldable arms due to this it is very compact in size. With the help of the GPS technology we can locate the quadcopters location and navigation details. The mission planner software is used to control the quadcopter. The landing gears used in our quadcopter will avoid the damage to both the sensors and quadcopter while landing. This quadcopter can be used to explore any areas because it have Vertical Take Off and Landing [VTOL] system. The transmitter and receiver is used to communicate with the quadcopter.

The quadcopter was assembled and tested working of every part individually. After that the environmental sensors were attached and also ensured it is working properly. After assembling and testing the parts of quadcopter and environmental sensors, the data collection about temperature, pressure, humidity and which are the gases present in the atmospheric condition over different location were done. The collected data are analyzed and the percentage and composition are also calculated.

#### **RESULTS AND DISCUSSION**

The mining industry in India is one of the core industries of the economy. It provides basic raw materials to many important industries. The mining industry is characterized by large number of small operational mines and produces 95 minerals which includes 4 fuels, 10 metallic, 23 non-metallic, 3 atomic and minor minerals.

The development of new technologies transforms mining into a safer and more productive industry. The technology allows the operator to carry out exploring and gathering information from a remote location without entering hazardous areas. So, the need for the new technologies to explore the hazardous areas like caves, underground pits or some remote areas without entering directly into them is increasing day by day. Because new ores are increasingly being identified deep underground inside the cave also.

The increasing number of death of employers in mining industry is due to the lack of information above the places. Workers are being trapped inside the tunnels and many other dying inside the hollow underground pit by inhaling dangerous gas coming from the ores. And many more workers are dying inside the caves due to lack of oxygen.

To overcome this problem, we need some advanced technologies to explore the areas without entering directly entering into them. So, to meet the need of miners we have developed the ENVIRONMENTAL SENSING USING QUADCOPTER. Which provides the miners the information about the temperature, pressure, humidity and other gases present in the particular atmosphere and also miners can view real-time video transmission of the areas by installing the run camera in our product.

We designed and developed the environmental sensing quadcopter in such a way that all the environmental sensors like temperature, pressure sensors, humidity sensors, different gas sensors and also the run camera are also assembled in a single quadcopter. The developed prototype was successfully tested in different locations and found satisfactorily working.



**Fig 9: Environmental sensing Quadcopter final prototype**

Fig. 9 shows the final prototype. The LCD display if shown in Fig. The prototype was tested in different locations and the sample results are tabulated in Table.1.



Fig: 10 LCD Display

Sl.no	Parameters	Sensor	Result
1	Temperature	DHT11	36-degree Celsius
2	Pressure	BMP280	977 hPa
3	Gas	MQ 135	033 PP
		MQ 2	051 PP
		MQ 5	035 PP
4	Humidity	DHT11	50

Table 1. Sample results from a test location

## CONCLUSION AND FUTURE WORK

The developed environmental sensing using quadcopter is very eco- friendly, wont causes any pollution. It is also very easy to use, miners can gather the information very quickly and efficiently. The images, videos recorded by the run camera will be very useful to the miners to take precautions. The foldable frame work of quadcopter is very durable and water proof. So, it will have a long-life span.

This product can help not only miners but also the people who are engaged in environmental monitoring process. The details about different environmental conditions in different areas can lead to further scientific studies in the future. Attaching Ground Penetrating Radar (GPR) is another scope which can help especially for ground penetrating purposes. It can penetrate up to 50-100m.

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