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Design and Development of Aerial Landmine Detection System

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Research Paper

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ABSTRACT

Aerial mine detection systems represent an advancement in mine detection beyond the limitations of landbased methods. The system uses the best capabilities of unmanned aerial vehicles (UAVs) and includes advanced technology, especially metal detectors, to detect and report landmines quickly and efficiently. Thanks to the use of drones, the system can cover large areas at unprecedented speeds and reduce the time and costs associated with exploring mining projects. This general method not only increases safety by reducing the risk to human life, but also works in difficult areas such as forests and mountains where there is not enough fear from the ground. Build a quadcopter equipped with a complex metal detector mechanism controlled by Arduino programming. Thanks to good modeling, assembly and operating methods, this quadcopter becomes a powerful tool for identifying and detecting buried mines. After detection, the machine pulls the machine to facilitate the initial search, allowing workers to quickly inspect and, if possible, manually remove or disperse mines. The necessity of the sexual impact of land mines also demonstrates the important role of technology in protecting life and timely intervention by soldiers. The system has the potential to revolutionize the world of land surveying, ushering in a new era of safety and security for the

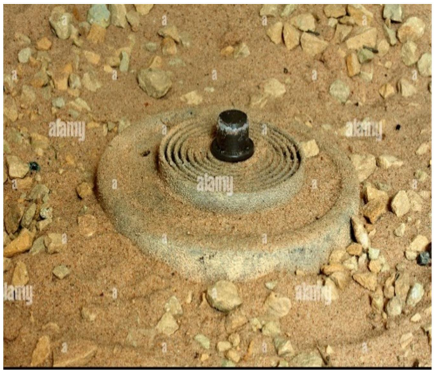
international community.

Introduction

It has subsurface dirt that poses a threat to human life and safety and that will explode if it comes into contact with a person or a vehicle. Historically, finding and getting rid of deadly weapons has been a challenging and risky task, frequently carried out by refugees at great personal risk. But as unmanned aerial systems (UAS) evolve quickly, new possibilities in the monitoring and detecting space open up. a change in perspective. These aircraft offer the special capacity to investigate hazardous or unreachable regions from a secure vantage point, lowering the risk to human demining crews. In recent years, the field of mine search has evolved due to the use of drone-based approaches equipped with cutting edge equipment like ground covering radar (GPR), hand-held metal detectors (MD), and demining probes. The need for monitoring systems increases since there are an estimated 100 million landmines buried worldwide, and these mines can still endanger civilian lives years after the end of a conflict. Hand metal detection, one of the conventional mine detection techniques, puts refugees at serious risk because they are never able to finish, which could result in an explosion. The significance and features of mines. Anti-personnel and anti-tank mines are the two main categories of mines; each has a unique mechanism and potential hazards. Unexploded ordnance (UXO), which includes bombs and other explosives that cannot be set off after delivery, is another ongoing hazard. Thousands of victims are reported annually by the International Campaign to Ban Landmines, highlighting the critical need for innovative approaches to solve this threat to human health. Drones with specialized sensors have been used in research to develop efficient aerial mine detection systems. Using drones and cutting-edge sensor technology, the program seeks to decrease the amount of time that people spend in minefields while increasing the effectiveness and safety of mine detection. In order to help the globe become soilless, this research will look at the device's contents and air detection techniques in great detail. a positive step toward preserving human life and lessening the destructive effects of landmines globally. We wish to clear the path for communities impacted by this grave threat to go toward a better and more secure future by working together and utilizing new technologies.

TYPE	UXO	ATM	APM
Target	Unspecified	Armed personal	Human
Weight	Various	Heavy (6-11 kg)	Light (0.1-4 kg)
Size (in diameter)	Various	Large (13-40 cm)	Small (6-15 cm)
Case material	Mostly metal	Metal, plastic	Plastic
Detonation pressure	Unpredictable	120 kg	0.5 kg

Different types of mines



Buried Landmines

Objectives

The primary goal of the project is to create an aerial system for landmine detection that will boost detection accuracy and speed.

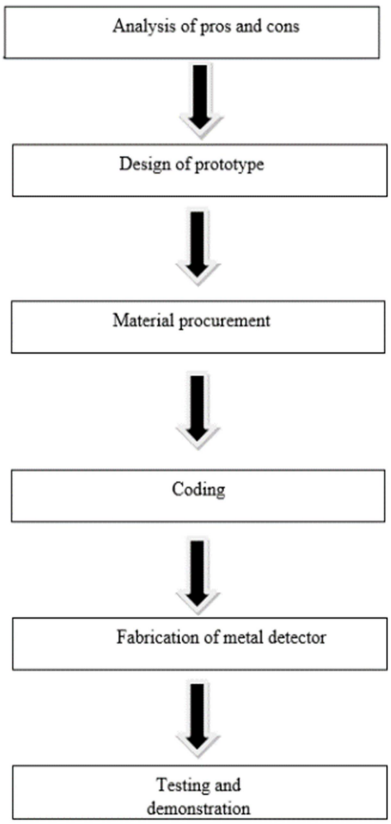
To reduce the amount of false negative and positive results in landmine detection.

To reduce the possibility of human harm or death to those engaged in landmine clearing and identification.

To be mechanically easy in comparison to other mechanism variations

To allow operation or operation in remote places.

Methodology



Flow chart of Methodology

Calculation

PARTS	WEIGHT(g)
Frame+ landing gear	595
Battery	175
Motor(4)	208
ESC(4)	484
Propeller	88
GPS module	26
Flight Controller	80
Metal gear servo	56
Power module	24
Metal detector mechanism	300
TOTAL	1592

Components weight data sheet

The total weight of the quadcopter is calculated by adding the total weight and weight. Overall weight = Payload + weight of components

= 300 + 1292

= 1592

Using the following formula to calculate the thrust of the engine and propeller combination

Pitch speed = (2*pitch*RPS) /60

Pitch is 4.5 inches to convert it to meters divided by 39.37

Pitch (m) =4.5/39.37

= 0.1143 m

The RPM (Revolutions per minute) is gives as 850 KV to convert it to seconds (RPS) by 60

RPS =850/60

= 14.1667 RPS

Pitch speed (m/s) = 0.1143*14.1667

= 1.61925 m/s

Thrust (N) = 750*0.00981

= 7.3575 N

The motor constant is a factor that relates the electrical properties of the motor to its mechanical properties.

Motor constant = Thrust / (voltage * RPM)

= 7.3575/ (11.1 * 850)

= 0.000779

Each motor produces 7.3575 N of thrust

Total thrust of 4 motors

Total thrust = 4* 7.3575 N

= 29.43 N

Total thrust (kg) = total(N)/9.81

= 29.430/9.81

= 3 kg

= 3000 grams

Thrust to weight ratio = Thrust produced / total weight of quadcopter

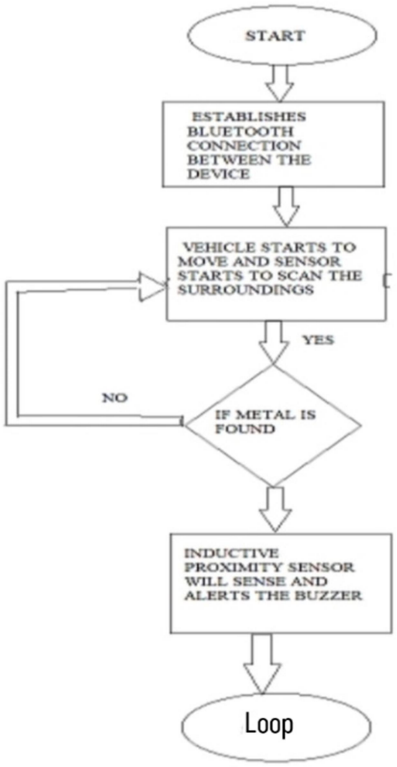
= 3000/1592

= 1:8:1

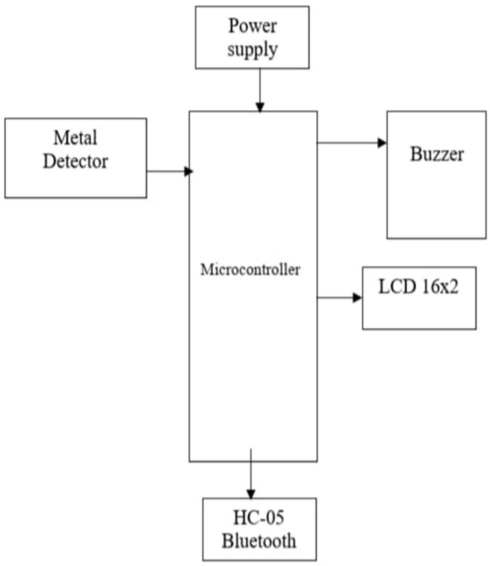
A quadcopter with a thrust to weight ratio of 1.8 can produce thrust force that is 1.8 times larger than the entire weight. The thrust to weight ratio needs to be more than 1:5:1 in order for the drone to lift off; after computation, we find a ratio of 1:8:1.

Working of metal detector

This system uses a metal detector, which is connected to the microcontroller, to identify metal things, in this case steel or iron. It will alert the controller when it detects metal on metal, sound an alarm to let the smart device know about the detection, and relay the status data to the device using Bluetooth.



Flow chart for metal detector mechanism



Circuit connection

Design and Fabrication

Design in Solid Works

Solid Works is a potent computer-aided design (CAD) program used to model and develop drone designs.

The actions that need to be taken in this procedure are:

1. Parametric Modeling : Physical functions can be used to build parametric models, which implies that modifications to one model will automatically alter its effects. This cuts down on mistakes and adjusting time.

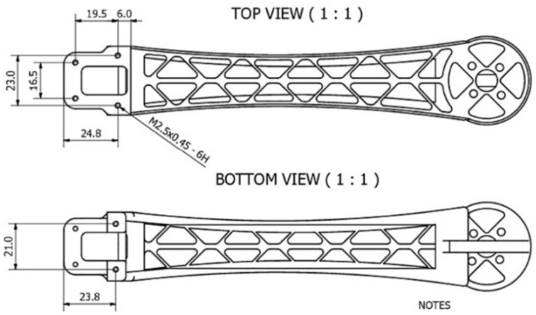
2.Product Design offers a wide range of effective tools for creating discrete components that must be assembled to completion in assembly design.

3. documentation and drawings: Product Study enables you to generate the documentation and drawings required for assembly and manufacturing. Product Works also offers electronic tools for container assemblies and bills of materials (BOMs).

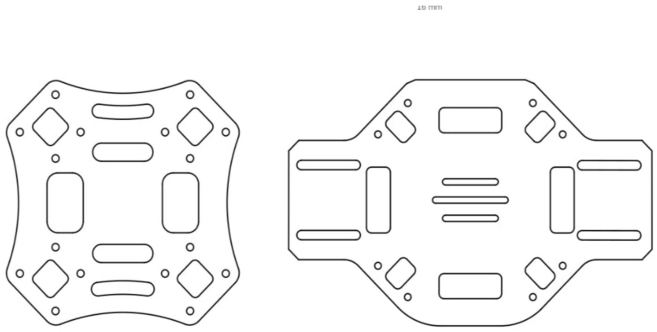
Arm Drafting and Modeling Frame Board

Solidworks software was used to design the quadcopter arm's three-dimensional model. There is a motor atop each of the quadcopter's four arms.

Content 110 mm in length and 180 mm in width is the working frame plate design. It is used to immobilize weapons and shield delicate electrical components from harm. Arms are fastened to one another crosswise.



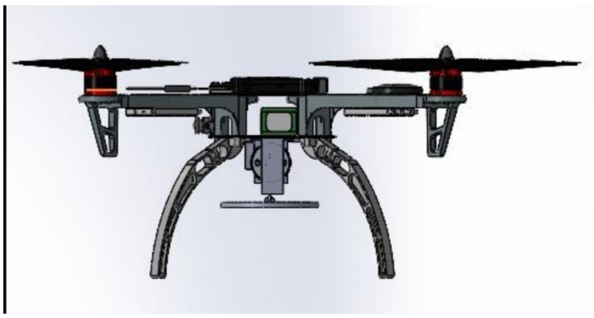
Arm Drafting



Frame board Drafting

Pulley Mechanism System

Create a pulley machine in which the metal gear servo is fixed to the plate with the assistance of screws and toothed plates; the metal gear is connected to the rope that rolls it; the metal gear servo and pulley can rotate in both clockwise and counterclockwise directions.



Quadcopter with pulley mechanism

Fabrication

In quadcopter design, estimating the payload comes first. The right number of arms must be created for the quadcopter, along with its length and payout application. Next, the necessary thrust must be

computed, and the motor, ESC, technology flight control, GPS, and battery must be mounted in the landing gear of the quadcopter on top of its fuselage frame. It is joined to the bodily structure.

Result and Discussion

Fabrication Result

We utilize the F450, an effective, lightweight, and robust drone composed of fiberglass and ABS components, to save weight. The drone's parts have been trimmed down, leaving only the space needed for the drone, and its electronics are mounted in the lowest possible area. Integration of drones with metal testing groups has been beneficial. Replacing the receiver fixes issues that arise during receiver calibration. The drone runs on a 2300 MAh 2s battery and 10-inch propellers. An 850 KV motor is included with this battery. 350 grams of force are produced by the 7.4-volt battery. The drone can thrust up to 1400 grams. Due to the load's 1200 grams of weight, this is not very helpful. three-second battery attached.

Calibration

Stabilization test

We attempted to connect the metal detector during the model, but were unable to do so due to its length of approximately 60 cm, incompatibility with our landing gear, and lack of any safety issues. This is the initial assessment. We attempted to operate the towing apparatus in our second test by attaching the metal detector to the traction we were able to obtain after the drone repaired us. The towed drone was observed to be more steady after two safety checks.

Mechanism of metal detector

To create the wire or metal belt, the metal gear servo is attached to the roller metal catch mechanism. It makes use of a metal gear wheel with a 3 kg load capacity and clockwise and counterclockwise rotation.

The detector employs a coded circuit to obtain a continuous output of the screen and is connected to both the buzzer and Bluetooth. The person controlling the drone, the person turning to look at the drone when the sound is generated, or the person when metal is identified and appears on the screen must manually verify whether the metal being detected is mine or whether another metal has been located. Authorities must act to remove the drone or remove the mine if one is discovered.

Conclusion

In addition to helping the military look for mines in impacted areas and employ positive feedback where Arduino is designed to offer continual output, the idea of using drones for aerial mine detection can help enhance reaction capacity and minimize the time required to monitor the area. The appropriate parts should be chosen and designed for the drone and its parts. An option to land surveying could be to install drones equipped with metal detectors. Drones for mine detection have been created and deployed in the field with success. Drones and other products are needed to accomplish the program's objective of saving the lives of both military personnel and civilians.

Reference

Zoltán Kovács, István Ember, “Landmine detection with drones”, “Land Forces Academy Review”, Vol. XXVII, No. 1(105), 2022

Peter Ngan, Sean Burke, Roger Cresci, Joseph N. Wilson, Paul Gader, K. C. Ho, Elizabeth Bartosz, Herbert Duvoisin, “ Development of Region Processing Algorithm for HSTAMIDS: Status and Field Test Results”

Lekshma N, Samyuktha P, Swedha P M, Vigneswari P, “Detection and Demining of Landmines using Artificial Intelligence”, “International Advanced Research Journal in Science, Engineering and Technology” ,Vol. 8, Issue 6, June 2021

S. Dinesh Tharun, P. Siva Kumar, “Robust Estimation by Drone for Surveillance and Bomb Detection using Actuators”, “International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958”, Volume-8, Issue-6S3, September 2019

S. Dinesh Tharun and P. Siva Kumar, “Metal detection by drone for surveillance using actuators”, journal of critical reviews ISSN- 2394-5125”, VOL 7, ISSUE 04, 2020

Yunes Sh.Alqudsi, Abdulhameed S.Alsharafi, Abdulwahed Mohamed, "Unmanned Aerial Vehicle-Based Approach", "A Review of Airborne Landmine Detection Technologies", 978-1-6654-1224-7/21

María garcía fernández, Yuri avarez lópez , Ana arboleya arboleya,Borja gonzález valdés yolanda rodríguez yaqueiro, Fernando las-heras andrés ,and antonio pino garcía, "Synthetic Aperture Radar Imaging System for Landmine Detection Using a Ground Penetrating Radar on Board a Unmanned Aerial Vehicle", "IEEE", VOLUME 6, 2018

Ruben Antuna Herrero, "Drone design", "Dumlupinar university industrial engineering",

Ian T. McMichael, Member, IEEE, Eric C. Nallon, Vincent P. Schnee, Waymond R. Scott, Jr., Fellow, IEEE, and Mark S. Mirotznik, Senior Member, IEEE, "EBG Antenna for GPR Colocated With a Metal Detector for Landmine Detection", IEEE geoscience and remote sensing letters, vol. 10, no. 6, november 2013

Pushkar Gaur, Tanishq Choudhary, "Aerial Landmine Detection", "International Journal of Engineering & Technology", 7 (3.34) (2018)

R.Pandy Rajan, Arun prakash.J, Tamil selvan .S, K.Ragapriya, "Landmine detection using unmanned helicar", "International Journal of Innovative Science, Engineering & Technology", Vol. 1 Issue 3, May 2014

Nouman Hassan, Zeeshan Haider, Shahzad Anwar, Shamaraz Firdous and Chen Yi Hong, "Sensor for Landmine Detection using Unmanned Vehicle Metal Detector and Mobile Computing Technology", "Open Access Journal of Environmental and Soil Sciences", ***Volume 4-Issue 4,2020***