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LIDAR Based Micro-Drone for Birds and Rodents Repellent System

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ABSTRACT

This project deals with the creation of micro drone that is used as a Birds and Rodent's repellent system. Rodents are the major vertebrate pests causing damage to various crops and commodities by feeding and indirect damage by spoilage, contamination and hording during on-farm and post-harvest stages. First and foremost, they are disease carriers and cause physical damage to structures. The analysis of the reviews on pre harvest losses indicates a range of 5-15% damage to cereal crops like rice and wheat. During 2001 it was reported that the overall losses of grain to rodents in India were approximately 25% in pre harvest and 25-30% in post-harvest situations bringing the loss to at least US $5 billion annually in stored food and seed grain in India. So, there is a huge need to rid the farm of the rat and mice infestation. In this project, we propose a microdrone with LiDAR technology to provide solution to the agricultural sector. The microdrone low weight, small in size and can be easily launched using our hands and does not produce much noise. By using appropriate way of disturbing the Birds and Rodent's movements in the field, the harvest losses shall be minimized to a reasonable level.

Keywords : LIDAR, Drone, Proximity sensor, Arduino

I. INTRODUCTION

Drones are today widely being used in a variety of fields. Applications of drones ranges from filming, thermal inspections and now in agriculture. The major issues of the drones is the cost. Generally speaking drones are costly purchase and there is a huge risk of damage while flying them that is why drones are still not a very common gadget.

Mostly large drones make a lot of noise and need a lot of clear space to fly. They cannot be flown in dense forests or areas with many trees. So here we build a micro drone with an obstacle detection feature using LIDAR sensor. Hence this drone helps you understand drone flying as well as how obstacle sensing can be done using drones. And, its small size and lower cost makes it less risky to fly it in dense forest of places.

The mini drone consists of 4 drone motors, propellers and Arduino Pro Mini F3 EVO controller and a lidar sensor and buzzer. IR used by the LIDAR sensor is for detecting any obstacles in front of it. If any obstacle is detected the lidar signal are decoded by controller to operate a buzzer and led for indication of obstacle in front of it. The user is constantly alerted with about the proximity by changing the led and buzzer frequency so drone can be controlled accordingly to avoid collision.

The small drone uses 4 motors to lift up and control the flight. The RC controller commands are interpreted and flight controller through the RF receiver to achieve desired flying movement. The drone makes use of a Arduino Pro mini to sense the obstacle using LIDAR and the operate the led and buzzer accordingly. Related Work

The use of drones in agriculture has grown exponentially in the last few years. The literature review will explore the use of drones in agriculture, their benefits and drawbacks and how they are used. Drones provide valuable data to farmers on crop health, soil quality, water levels and so on. They can also be used to monitor livestock. The drones can also be used for land surveying, which is helpful for mapping out fields or identifying any potential hazards that may exist on the land such as sinkholes or cliffs.

System Overview

The mini drone consists of 4 drone motors with propellers with Arduino Pro Mini F3 EVO controller and a lidar sensor and buzzer. The lidar sensor uses IR for detecting any obstacles in front of it. If any obstacle is detected the lidar signal are decoded by controller to operate a buzzer and led for indication of obstacle proximity alert. The user is constantly alerted with about the proximity by modifying the led and buzzer frequency as per proximity so drone can be controlled accordingly to avoid collision.

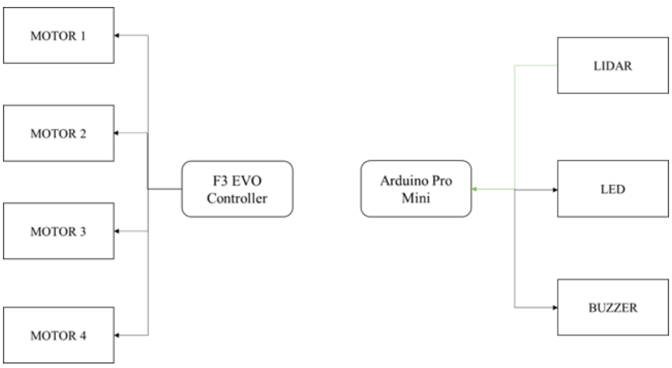

Figure 1 Block diagram of the system

Components Required

Arduino Pro Mini

The Arduino Pro Mini is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers.

A six-pin header can be connected to an FTDI cable or Spark fun breakout board to provide USB power and communication to the board. The Arduino Pro Mini is intended for semi-permanent installation in objects or exhibitions. The board comes without pre-mounted headers, allowing the use of various types of connectors or direct soldering of wires. The pin layout is compatible with the Arduino Mini. There are two version of the Pro Mini. One runs at 3.3V and 8 MHz, the other at 5V and 16 MHz The Arduino Pro Mini was designed and is manufactured by Spark Fun Electronics.

The Arduino project provides the built-in development environment (IDE) for the programming of microcontroller systems to allow code writing and uploading to the board. It runs on Mac OS X, Linux, and Windows. The code is written in Java, which is based on open-source software and processing. You can use this program on any board of the Arduino (Figure 3).

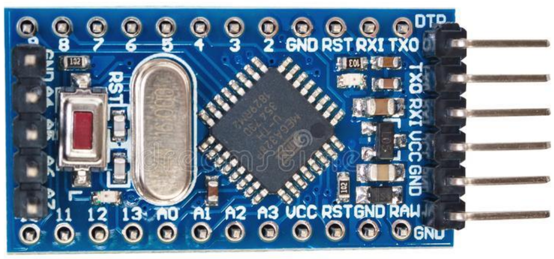

Figure 2 Arduino Pro Mini

Features:

- ATmega328 running at 16MHz with external resonator (0.5% tolerance)
- 0.8mm Thin PCB
- USB connection off board
- Supports auto-reset
- 5V regulator
- Max 150mA output
- Over current protected
- Weighs less than 2 grams!
- DC input 5V up to 12V
- On board Power and Status LEDs
- Analog Pins: 8
- Digital I/O: 14

F3 Evo Controller

The F3 Racing EVO flight controller has features that makes it the board of choice for your next multirotor (drone) racer build. It has been designed to give awesome flight performance in a stackable race ready package. It has the latest sensors, race timing and logging technology backed by excellent connectivity options, all this at a very affordable price. Featuring a race timing transponder system, the F3 EVO Pro has been designed with the serious racer in mind.

Analyze your race and flight telemetry/Blackbox logs using the built-in micro-SD card socket. The F3 EVO gives you all the features you need for the heart of your multirotor whether you are an FPV racer, aerobatic flyer or do aerial photography, it is the perfect choice.

The F3 Racing Evo runs the open-source clean flight control (FC) software which has an ever-growing community of friendly developers and users. Being open-source means that you too can contribute to the system. The hardware was designed by the lead developer of clean flight to be more capable than the previous generation of STM32F1 based boards. The F3 EVO uses a similar layout to the F3 Acro and Deluxe boards, the stack pins, ESC/Servo outputs and connectors are in the same location for maximum mounting compatibility with existing products.

In conclusion, the F3 EVO uses advanced processor, sensor, and software technologies to make your multirotor (drone) fly like it is on rails. The Clean flight software enables the precision flying you require for fast FPV racing. uses the ARM Cortex-M4 72Mhz CPU with Math co-processor (FPU) for efficient flight calculations that gets more done in less time. The gyroscope and accelerometer sensors are connected to the fast SPI bus, this enables the software to get more data even quicker to help stabilize your craft even better. The list of features and specs goes on and on, please look under the "Files" tab for the Manual and the Features list.

Figure 3 F3 Evo Controller

LIDAR Module

The LiDAR sensors are an essential component in GeoSLAM's mobile mapping solutions. Together with our SLAM algorithm, these two technologies are responsible for producing 3D pictures or "point clouds" of the environment. LiDAR technology has been around since the 1960's when laser scanners were mounted to planes. This type of airborne LiDAR emitted light beams towards the surface of the ground to provide distance measurements. LiDAR data became a useful tool for providing accurate geospatial measurements in the late 1980s. The introduction of commercially viable GPS systems made this possible. LiDAR is a remote sensing method. LiDAR technology uses the light from a laser to collect measurements. These are used to create 3D models and maps of objects and environments.

Light Detection and Ranging. The acronym LiDAR is often used to name this remote sensing method. It uses light to measure distances and is also known as laser scanning or 3D scanning. A LiDAR system calculates how long it takes for beams of light to hit an object or surface and reflect back to the laser scanner. The distance is then calculated using the velocity of light*. These are known as 'Time of Flight' measurements.

***The velocity of light is 299,792,458 meters per second**

Depending on the sensor used, LiDAR scanning units can fire hundreds of thousands of pulses per second. These light waves bounce off objects and return to the LiDAR sensor. The sensor uses the time it takes for each pulse to return to calculate distance (time of flight). Each of these pulsed laser measurements, or returns, can be processed into a 3D visualization known as a 'point cloud'. That's how a LiDAR sensor works explained in a nutshell.

LiDAR technology is the application of the remote sensing method described above. It is usually used to examine the surface of the earth, assess information about the ground surface, create a digital twin of an object or detail a range of geospatial information. LiDAR systems harness this technology, using LiDAR data to map three-dimensional models and digital elevation. From handheld to airborne LiDAR, there's a LiDAR system to capture the data you need. LiDAR mapping uses a laser scanning system with an integrated Inertial Measurement Unit (IMU) and GNSS receiver or in GeoSLAM's case, the SLAM algorithm, which allows each measurement, or points in the resulting point cloud, to be georeferenced. Each 'point' combines to create a 3D representation of the target object or area. LiDAR maps can be used to give positional accuracy – both absolute and relative, to allow viewers of the data to know where in the world the data was collected and how each point relates to objects terms of distance.

LiDAR data, in the form or a point cloud, can be used to map entire cities, enabling decision makers to accurately pinpoint structures or areas of interest in millimetre perfect detail. Features and objects such as road networks, bridges, street furniture and vegetation can be classified and extracted.

LiDAR maps can also be used to highlight changes and abnormalities such as surface degradation, slope changes and vegetation growth. There aren't many applications that wouldn't benefit from using LiDAR. From the games industry to Formula 1 teams – simulations based on 3D models are often used to give teams the edge before setting foot on a racetrack.

LiDAR mapping uses a laser scanning system with an integrated Inertial Measurement Unit (IMU) and GNSS receiver. In GeoSLAM's case, we use the SLAM algorithm to power our laser mapping technology. This allows each measurement, or point in the resulting point cloud, to be georeferenced. Each 'point' combines to create a 3D representation of the target object or area. LiDAR maps give absolute and relative positional accuracy. This allows viewers of the data to know where in the world the data was collected and how each point relates to objects in terms of distance. LiDAR point cloud data can map entire cities. Decision-makers can pinpoint structures or areas of interest in millimeter perfect detail. Features and objects such as road networks, bridges, street furniture, and vegetation can be classified and extracted. LiDAR maps can also highlight changes and abnormalities such as surface degradation, slope changes and vegetation growth.

Figure 4 LIDAR Module

Drone Motor

Drone Motors are an important component of the drone, since they help in powering up the drones. The propellers of the drone cannot rotate until and unless they are powered by a motor. The repetitive attraction and repulsion of the magnets helps in converting the electrical current into the mechanical revolution of the shaft that moves the drone. The drone is not going to move until you have integrated the best motor. This is the most important component of the drone. Motors are identified by different notations. For example, the kv rating denotes the motor velocity, as it depicts the number of revolutions per minute when a potential difference of 1 Volt is applied with zero load.

There are propellers specifically designed for quadcopters, depending on the purpose of use. The efficiency and the speed of the drone depends on the length of the propellers. If you opt for smaller propellers, you will be able to fly the drone with greater speeds, but the efficiency will be compromised.

Figure 5 Drone Motor

Drone Batteries

The most common batteries used in drones are lithium polymer (LiPo) batteries. LiPo batteries are composed of a lithium-based cathode and anode separated by a polymer electrolyte. LiPo batteries differ from other lithium-ion (Li-ion) batteries in that they have a solid polymer electrolyte component rather than a liquid electrolyte. Common polymer electrolytes may be dry, porous or a gel, and include poly (methyl methacrylate) (PMMA), poly(acrylonitrile) (PAN), poly (vinylidene fluoride) (PVdF), and poly (ethylene oxide) (PEO).

The science behind LiPo batteries is the same as in other Li-ion batteries: chemical energy is converted to electrical energy when electrons travel from the battery's anode to its cathode, creating an electrical current. The cathode contains a lithium metal oxide (such as lithium-cobalt oxide ($LiCoO_2$)), which provides lithium ions, whereas the anode contains a lithium carbon (such as graphite).

The anode and cathode are separated by an electrolyte that interacts with the anode to generate electrons, which creates a charge gradient in the cell. As the anode becomes negatively charged, the electrons travel along a conducting wire to the cathode. The whole system thus undergoes an electrochemical redox reaction (reduction/oxidation): the anode loses electrons and becomes oxidized while the cathode gains electrons and is reduced.

Figure 6 Drone Batteries

Arduino IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port.

Figure 7 Arduino IDE

II. Methodology

Drone Flying in air

When learning how to fly a drone, the controls will become second nature once you know how they operate and interact together to form a complete flying experience. When you first start out, push the sticks very gently so the drone performs slight movements. As you get more comfortable, you can make sharper movements.

Figure 8. Drone flying in air

There are four main drone controls:

Roll:

Done by pushing the right stick to the left or right. Literally rolls the drone, which maneuvers the drone left or right.

Pitch:

Done by pushing the right stick forwards or backward. Tilts the drone, which maneuvers the drone forwards or backward.

Yaw:

Done by pushing the left stick to the left or to the right. Rotates the drone left or right. Points the front of the copter in different directions and helps with changing directions while flying.

Throttle:

To increase, push the left stick forwards. To decrease, pull the left stick backward. This adjusts the altitude, or height, of the drone.

Rodent and bird repelling system

The use of audible sound to deter pests is an old strategy; the ancient Chinese used several mechanically operated sensory-repellent devices to deter rodent infestations in agricultural crops and buildings. Ultrasound, which is defined by sound frequencies beyond the upper limit of human hearing, has been used as pest control only over the past few decades, however.

Figure 9. Repelling system

III. Proposed System Architecture

System Overview

As we are aiming to produce enough food and remain sustainable, we are supposed to be ready to face all the agricultural challenges too. Upcoming generation prefers technology-based agriculture for their farms. Hence, we introduce drone technology into the agriculture. Drone -Technology initiates modern farming Culture. An agricultural drone is called as an unmanned aerial vehicle used in agriculture operations, mostly in yield optimization. Drones can help farmers to optimize the use of inputs (seed, fertilizers, water), to react more quickly to threats (weeds, pests, fungi), to save time crop scouting (validate treatment/actions taken. Here we build a micro drone with an obstacle detection feature using LIDAR. This drone helps you understand drone flying as well as how obstacle sensing can be done using drones. Also, its small size and lower cost makes it less risky to fly it in dense forest of tricky places.

Hardware Architecture

The mini drone consists of 4 drone motors with propellers with Arduino Pro Mini F3 EVO controller and a lidar sensor and buzzer. The lidar sensor uses IR for detecting any obstacles in front of it. If any obstacle is detected the lidar signal are decoded by controller to operate a buzzer and led for indication of obstacle proximity alert. The user is constantly alerted with about the proximity by modifying the led and buzzer frequency as per proximity so drone can be controlled accordingly to avoid collision. The small drone uses 4 motors to lift off and control the flight. The RC controller commands are interpreted and used by flight controller through the rf receiver to achieve desired flight movement. The drone makes use of a Arduino Pro mini to sense the proximity using LIDAR and the operate the led and buzzer accordingly. Thus, we get a lightweight micro drone that can take off from anywhere, fly indoors or in forests or gardens and sense obstacles using LIDAR proximity sensing.

IV. Results

The scientific procedures undertaken on LiDAR Based micro drone with three different subjects and herby the outcome test results are to be demonstrated / discussed to get better understanding of the interferences made on the experiment.

Table 1 Testing Results

SUBJECT NO	DISTANCE	LED	BUZZER
1	200 CM	LOW	LOW
2	100 CM	LOW	LOW
3	50 CM	HIGH	HIGH / DELAY 2S
4	25 CM	HIGH	HIGH / DELAY 1S
5	5 CM	HIGH	HIGH / DELAY 0.3S

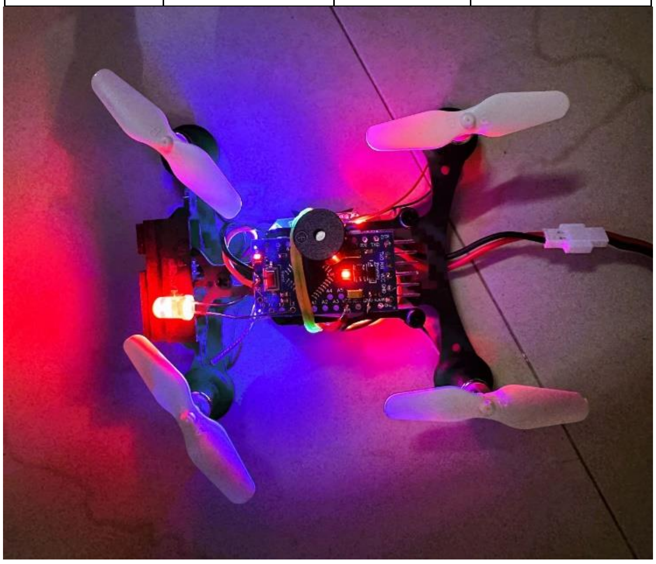

Figure 10 Micro Drone

Testing

The results are taken once the subject is connected with the PC, here the detection system is integrated with LiDAR module and its threshold level are shown in Table 6 Evaluation is done for three times on a periodical interval for 1 min on each subject.

Table 2. Threshold level

COMPONENT NAME	THRESHOLD LEVEL
LiDAR	Vout < 50cm
LED	Low
Buzzer	Low

Applications

They are used for a wide range of applications like aerial photography, surveillance, and agriculture. Drones have a wide range of applications in various fields. They can be used for aerial photography, surveillance and agriculture purposes. Drones can be used for various purposes like monitoring the environment, search and rescue operations and disaster relief efforts. Drones can also be used to take photos or videos from an aerial perspective which is not possible with other equipment. A drone is a flying robot that can be remotely controlled or self-controlled. Drones are used for many tasks such as surveillance, military applications, and even for recreational purposes. Drones are used in the following industries:

Application in Agriculture

Farmers can use drones to monitor their crops and identify any potential damage or diseases. They can also use them to apply pesticides and fertilizers on the crops from the air.

Conclusion and Future Scope

In the context of supervision for farmers. One of the approaches based on drone technology is using a LiDAR based drone to enable farmers to get rid of the birds and rodents from the agricultural field in his absence. These drones will help them to take care of the production of crops. Furthermore, this LiDAR based drone also act as collision detection system to avoid collisions.

In future work, we will propose a design of a LiDAR based micro drone with multiple frequencies and to add a micro camera in order to capture the image in front of it and process the image using image processing and identify the related bird / rodent and play the respective frequency in order to get rid of them.

Our challenges are to make the drone fly with the weight of the camera and ultrasonic frequency generator in order to fly the drone we require an more powerful drone motors and better design and more powerful batteries with those components we may achieve our goal.

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