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BIRD REPELLER AND DETERRENT SYSTEM

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Abstract— During Takeoffs and Landings there is a high risk which can be encountered by the pilots and the aircraft due to the birds flying around the vicinity of the airport that cannot be predicted quickly. Bird strike is a most predominant during take-off and landing of aircraft or near the airport. A tiny bird that got struck in the engine can result in a loss of a huge aircraft. These birds can cause damage by moving along the flight's path and strike the engine and other parts. The bird strike scenarios have been encountered on numerous occasions, leading to severe disasters and losses.

To overcome this issue, we have developed a bird repeller and deterrent system. This system comprises of three ultrasonic sensors, Arduino board, a relay, DC motor and a high velocity water pump. Ultrasonic sensors sense the bird's presence along flights path and if found any, it sends the signal to Arduino board. Relay connected to Arduino board receives the signal and transmits it to dc motor and water pump. Based on the direction in which sensor has positioned the bird's presence, high velocity water jet is sprayed.

Ultrasonic water jet bird repellents that are simple to install, extremely low-profile, & highly effective system are mounted on the aircraft. This technology is eco-friendly, remain safe to birds and human beings. High velocity water jet spray ensures that it hits hard on the bird and helps in repelling it away from the flights path.

Keywords— high risk, vicinity of the airport, predominant, loss of aircraft, bird repeller, Ultrasonic sensor, Arduino board

I. INTRODUCTION

Although radar has been used for large area tracking of migrating birds for many years, the requirements of small-area bird detection, at a scale suitable for airport hazard assessment and management, has been a relatively recent development. Relatively inexpensive marine radar transceivers have been developed specifically to track birds. With radar scanning rates typically of 24 rpm - once every 2.5 seconds, it is now feasible to use it for both the capture of data on significant bird activity for planning and strategic management purposes and for the real-time tactical monitoring of such activity. Installations include civil applications at New York/John F Kennedy International Airport, Chicago/O'Hare International Airport and Seattle-Tacoma. Even where it cannot be justified for permanent real-time bird activity monitoring, radar is increasingly being seen as an important component of bird hazard assessment at airports and as a means to target the airport operator's risk management effort effectively. Ideally radar coverage will extend to the whole of the International Civil Aviation Organization (ICAO) defined 13km radius bird 'safeguarding' zone and include altitudinal coverage up to 5000 ft. The very latest developments in survey are looking at the systematic detection and recording of bird strike 'Near Miss Events' - NMEs. The principle is that, if radar can detect 100% of near miss events and record the same, this data can be used to avoid further damages and precautionary measures can be taken in order to prevent any further damages in future. More than 219 people traveling by airplane have been killed worldwide as a result of bird strikes since 1988.

II. EXPERIMENTAL EQUIPMENT AND INSTRUMENTATION

COMPONENTS REQUIRED

SOFTWARE:
- Arduino IDE
- Embedded C

HARDWARE:
- Ultrasonic sensors
- Arduino
- DC motor with driver circuit
- Water pump
- Relay
- Power supply system

A. ARDUINO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without warning too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

B. ULTRASONIC SENSORS

Ultrasonic sensors "are based on the extent of the properties of sound waves with frequencies above the human audible range," often roughly around 40 kHz. Ultrasonic sensors are generally operated by generating a high-frequency pulse of sound, and then receiving and evaluating the properties of the echo pulse.

The ultrasonic sensor consists of 4 pins, they are:

- Vcc – Operating voltage of 5V
- Trigger – to transfer signals
- Eco- to receive signals
- Ground

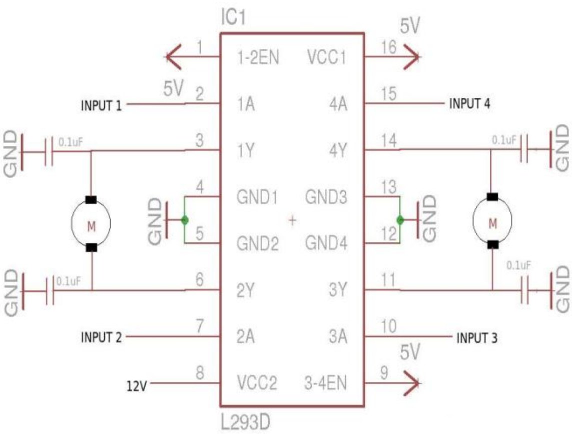
C. DC MOTOR

A DC motor is a rotary electrical machine that converts direct current electrical energy into mechanical energy. Based on the inputs of the driver circuit DC motor runs.

A DC motor is a mechanically coupled electric motor powered from direct current (DC). The stator is stationary in space by definition and so is its current. The commutator switches current in the rotor to also be stationary in space. This maintains the relative angle between the stator and rotor magnetic flux to be around 90 degrees, which generates the maximum torque. DC motors have a rotating armature winding but non-rotating armature magnetic field and a static field winding or a permanent magnet. Different connections of the armature and field winding provide different speed/torque regulation characteristics. The speed of a DC motor can be regulated by changing the voltage applied to the armature or by altering the field current. The presence of variable resistance in the armature circuit or field circuit allows speed control. Current DC motors are often controlled by power electronics systems which are called as DC drives.

D. DRIVER CIRCUIT

L293D is a quadruple H- bridge motor driver, which is used to drive the DC motors. This IC works, based on the concept of H- Bridge. H-bridge is a circuit which allows the voltage in either direction to control the motor direction.



Pin configuration of Driver Circuit

E. RELAY

A relay is similar to a switch, it is either open or closed. When the switch is open condition, no current passes through the relay, the circuit is open and the load that is connected to the relay receives no power. When a relay is closed, the circuit is completed and current passes through the relay and transmits power to the load. To open and close a relay an electromagnet is used. When the coil controlling the electromagnet is given a voltage, the electromagnet causes the contacts in the relay to connect and transfer current through the relay. The operating voltage of relay is 5V.

F. WATER PUMP

Water pump is used to spray high velocity water jet in the direction of obstacle detected by the ultrasonic sensors. It is driven by 9V battery.

III. EXPERIMENTAL METHODS

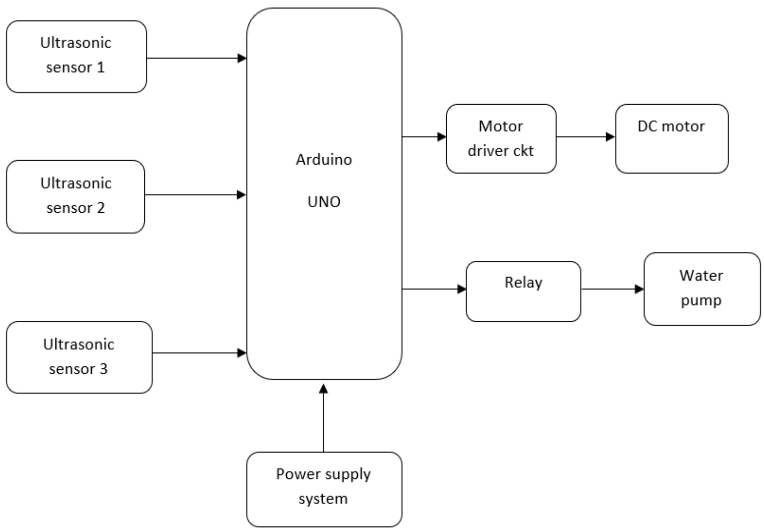
A. CONSTRUCTION OF BIRD DETERRENT SYSTEM

The experimental setup consists of 3 ultrasonic sensors. Two of the ultrasonic sensors are mounted on the wings and one ultrasonic sensor is installed in the middle of the drone. These ultrasonic sensors are further connected to the relay. Relay is a device which acts as a switch. The input of the relay is fed to the arduino board. An arduino board is pre-programmed using embedded C according to the system requirement. The power to arduino board is given through general purpose board which acts as an extension box. A 9V battery is used as a driving source for arduino and relay. A separate battery is used to drive the DC motor to which the water pump is connected.

B. WORKING

The ultrasonic sensors will scan the range specified to it and will send a signal if any object is present within that region. Upon detection, the Arduino board will raise an alarm in the form of a signal. Once the signal is raised from the Arduino, the location estimation system will estimate the position of the bird relative to the aircraft's path. A relay is used to actuate DC motor and water pump. This is done so that the high velocity water jet can be turned on to reach the location of the bird and to deflect it away.

C. BLOCK DIAGRAM



Block diagram of bird repeller system

IV. DESIGN

After undergoing rigorous analysis about the design and other important aspects that are involved in designing and developing a bird repeller and deterrent system, we decided to mimic the working principle of the entire system on a drone which would be more cost effective and work similar to how it would function on an actual aircraft. In order to give a better understanding, we have included the design of the actual representation of the system on an aircraft along with the design of our drone.

A. Implementation of the bird repeller system on F450 quadcopter

The drones are also termed as quadcopters. A quadcopter generally uses two pair of identical fixed pitched propellers i.e. two rotating in clock wise direction and the other 2 rotating in counter clockwise direction. All these 4 motors use independent variation of speed with respect to each other to achieve stability.

The power to the 4 motors is varied depending on the input provided from the pilot. If the pilot is intended to move the drone to the left side and gives the command through the RC controller, the motors situated on the right side of the quadcopter will be provided with a greater thrust when compared to the one situated on the left side. This variation in the thrust is achieved by ESCs that will vary the voltage and make the necessary adjustments to the drone.

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As mentioned earlier, in order to keep the project cost low, we have mimicked the bird repeller and deterrent system on a drone. This included the necessity to carry a minimum pay load of 500 grams. In order to carry the load of all the equipment's mentioned in the chapter 3, we had to customize the drone as per our requirement.

Components of the drone are as follows:

TABLE I
COMPONENTS LIST

Component Name	Quantity
carbon fibre Frame arms	4
Brushless motor	4
Propellers	4
Electronic speed controller(ESC)	4

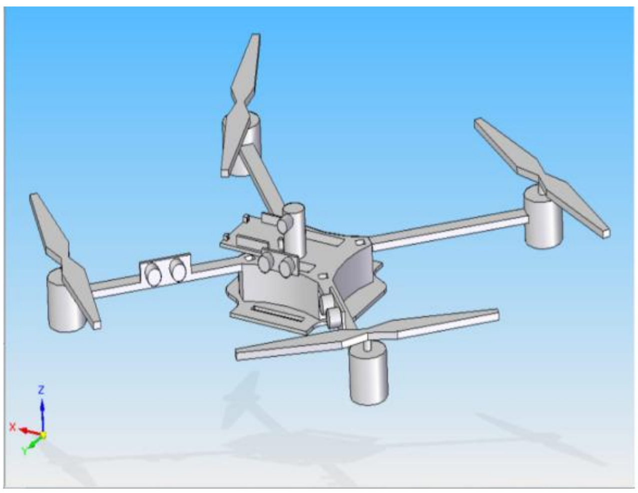
Specifications of the drone are as follows:

TABLE 2
DRONE SPECIFICATION

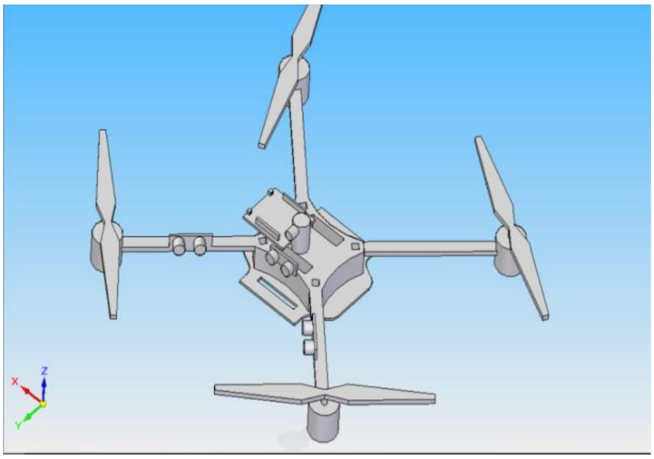
Frame	
Diagonal length	450mm
Frame weight	282 g
Takeoff weight	800 g-1600 g
ESC	
Maximum allowable voltage	17.4 V
Maximum allowable current	20 A
Signal Frequency	30 Hz-450 Hz
Weight	27 g
Motor	
Stator size	23*12 mm
KV	960 rpm/v
Weight	57 g
Propeller	
Diameter/ Thread pitch	24*12.7 cm
Weight per propeller	13 g

B. **Implementation of the bird repeller system on F450 quadcopter**

The visual representation of the drone along with the bird repeller and deterrent system can be found below.

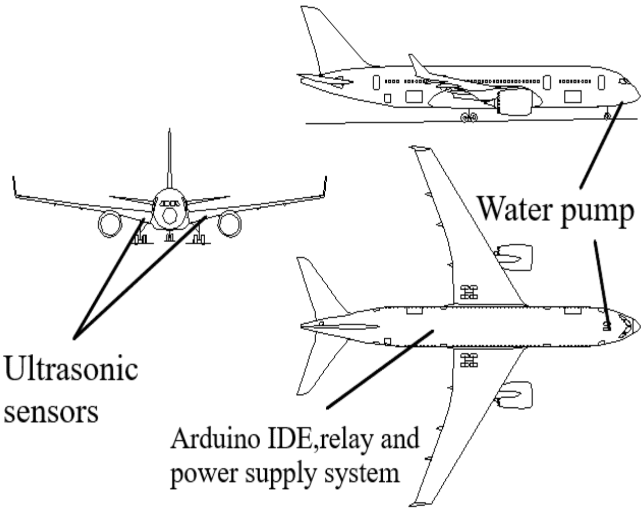


View of the assembled drone and bird repeller system



Top View of the drone and bird repeller system

C. **Representation of the bird repeller system on actual aircraft**



Location of the bird repeller system on an aircraft

V. EXPERIMENTAL RESULTS AND DISCUSSION

A. Statistical data of real world application

Bird strike is seen as a most common threat encountered by the aircrafts during take-off and landing. We are trying to assess the working condition of aircraft during the flight.
The average speed of a commercial jet during take-off and landing was estimated to be around 140 – 150 knots i.e. 250 – 270 KMPH depending on the weight of the aircraft.The average opposing wind speed was found to be around 6-10 knots i.e. 15-20 KMPH depending on the weather condition. The average speed of the birds at an altitude of 4000 – 5000 feet was found to be 25-30 KMPH. Therefore, in order to deviate the bird from the flights path, the pressure of water jet is calculated as:
Pressure = Speed of flight + wind speed + bird speed
This pressure will help the water jet to reach the bird. Since our objective is to repel the bird from flight path we are providing additional pressure of around 20KMPH. By considering all the factors the result can tabulated as follows:

TABLE 3
VELOCITY OF WATER JET REQUIRED ON ACTUAL AIRCRAFT

Flight speed	Wind speed	Bird speed	Velocity of water jet
250 KMPH	14KMPH	30 KMPH	87 m/s
255KMPH	14KMPH	30 KMPH	88.6 m/s
260KMPH	16KMPH	30KMPH	90.5 m/s
265KMPH	17KMPH	30KMPH	92.5 m/s

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B. Experimental results

The same scenario is mimicked on the drone that can fly and carry the entire setup of bird repeller and deterrent system. After undergoing numerous trials, the results was found to be as follows:

TABLE 3
VELOCITY OF WATER JET USED ON DRONE

Flight speed	Wind speed	Bird speed	Pressure of water jet
10 KMPH	2 KMPH	2 KMPH	4.4 m/s
12 KMPH	3 KMPH	2 KMPH	4.7 m/s
14 KMPH	3KMPH	2 KMPH	5.2 m/s

VI. CONCLUSIONS

This system will help in prevention of major accidents that can happen during take-off and landing of aircrafts. In order to prevent the movement of bird's in the flight path we have developed a system which can sense the movement of bird and spray high velocity water jet onto the bird and deviate it. In order to test this system, we have mimicked the same on a drone which has a similar characteristics of an aircraft. The experimental results proved that the system would work in an effective manner when implemented on an actual aircraft.

REFERENCES

[1]Bird strikes and aircraft fuselage color. BRADLEY F. BLACKWELL, USDA/APHIS/Wildlife Services' National Wildlife Research Center, Ohio Field Station, 6100 Columbus Avenue, Sandusky, OH 44870, USA

[2]RADIO WAVE SYSTEM FOR REPELLING BIRDS FROM AIRCRAFT. Thomas P. Maher Patent No.: US 7,106,216 B1 , Date of Patent:Sep 12th , 2016

[3]AIRBORNE BIRDSTRIKE PREVENTION DEVICE; Inventors: Eyal Halevy and Michael Amir Patent Number: 4,964,331, Date of Patent: Oct. 23, 1990

[4]Strategies for Prevention of bird Strike events;By Roger Nicholson, Ph.D., associate technical Fellow, aviation System Safety, and William S. Reed, Safety Pilot, boeing Flight technical and Safety.

[5] EVALUATION OF SHOOTING AND FALCONRY TO REDUCE BIRD STRIKES WITH AIRCRAFT AT JOHN F. KENNEDY INTERNATIONAL AIRPORT (1998)

[6] Modelling of Bird Strike on an Aircraft Wing Leading Edge Made from Fibre Metal Laminates – Part 1: Material Modelling. M. A. McCARTHY1,, J. R. XIAO2