

Sensor System Implementation for Unmanned Aerial Vehicles

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Abstract

Now a days, to monitor any parameter of a system, sensors are widely used because of the fact that it does not affect the parameters. In this paper, we are analysing the obstacle detection and collision avoidance by using the ultrasonic sensor and also the dropping and lifting of an object by using micro gripper for an UAV's. In the field of research related to unmanned aerial vehicle, its design, production, application and maintenance, sensor implementation comes very handy. Talking about key devices-ultrasonic sensors is most significant. The Unmanned Aerial vehicle (UAV) is an emerging technology being used for a various range of applications³.

Keywords: Micro Controllers, Micro Gripper, UAV's, Ultrasonic Sensor

1. Introduction

The Quad copter based Unmanned Aerial Vehicles (UAV'S) generally called as; "DRONES" is normally an aircraft without human pilot onboard. They are remotely controlled from the base station with all the specific controls required for its flight. UAV's are now wide variety of applications in the real world due to their high level of performance and reliability at a broader extent in various fields of science and technology¹. The most important operation to be concentrated on the flight of an UAV is all about the obstacle detection as the integration of many actuators and sensors according to their task forms the basic requirement of it. Obstacle detection is basic necessity for any autonomous UAV. Obstacle detection can be carried out by variety types of sensors as per

requirement and convenience from the available ones. The most common ones which could be used as such are infrared sensor, ultrasonic sensor, laser range finder and so on². Among them ultrasonic sensors suits much better than the others because of its features like high capability and it's of low cost. The ultrasonic object detection system consists of the HCSR04 distance measuring sensor.

Also, here the quad copter UAV can also be made to play a role as a payload carrier by using a micro gripper where in which is not present in others UAV doesn't facilitate this kind of feature. The micro gripper attached to the UAV would be able to pick up and drop payload equivalent to it. The payload may include an object which could be dropped down safely during floods and higher equivalents could pick up a human being drowning in water. This would make the application more useful

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where there is no human access much. Thus it is ideal for transporting lifesaving drugs in times of crisis, or tight spots.

Thus, Unmanned Aerial Vehicle (UAV) is a rising technology which is being used in a wide range of applications namely remote sensing, real time monitoring, and search and rescue since it is a pilotless airplane controlled by remote control³. Hence it is suitable for UAV's to operate in catastrophic areas for monitoring, observing, and gathering information for its applications.



Figure 1. UAV model.

2. System Overview

The UAV is designed in specific way that it could detect objects from the environment and avoid collision based on the distance measuring information given by the ultrasonic sensor. The UAV system facilitates to obstacle avoidance by using ultrasonic sensors and pick up and dropping of the objects by using micro grippers. The ultrasonic sensor used here is made to sense any obstacle in the path of the UAV's flight. This system uses four ultrasonic sensors in all the four directions (namely left, right, front and back) thus it makes sure that it could work in such a way that obstacle detection could work from any direction. These sensors are interfaced to an ARDUINO board. The input signal is received from sensor circuit and ARDUINO is operated according to the received sensor's signal. The main scenario to opt ultrasonic sensor as an obstacle detection device is that it could determine the information regarding the range of the object and this data is much useful to control the UAV for the avoidance from the same. In this research HCSR04 ultrasonic sensor is made use. The process of analog to digital converter is done by the ARDUINO with a software and this data is used to control the require outputs. The basic block diagram that makes these processes is shown in Figure 2.

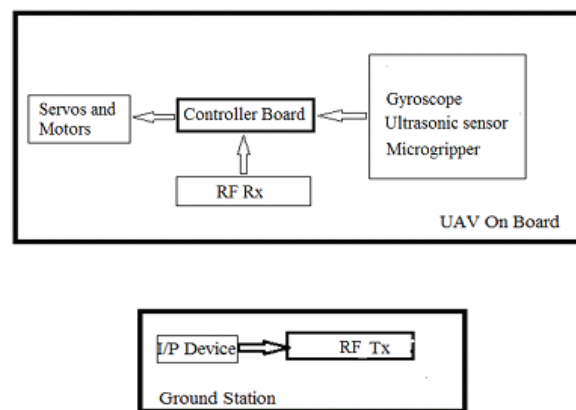


Figure 2. Basic Block Diagram.

3. Dropping and Lifting of an Object

Micro gripper is a device which is used to grasp and manipulate micro scale objects safely. The need of micro-grippers generally is essential when there occurs a situation where human beings can't extend their help to pick up or drop any materials without any damage. A wide range of micro grippers in reach are mechanical gripping, gripping by vacuum, angular gripping and many as such.

The application of micro gripper in our project deals with the grasping and releasing of the objects from an UAV's such that the materials needed to be grasped from the ground surface can be acquired easily and vice versa things needed could be placed on the ground from an higher altitude without any damage. The block diagram given below gives us a clear idea about the working:

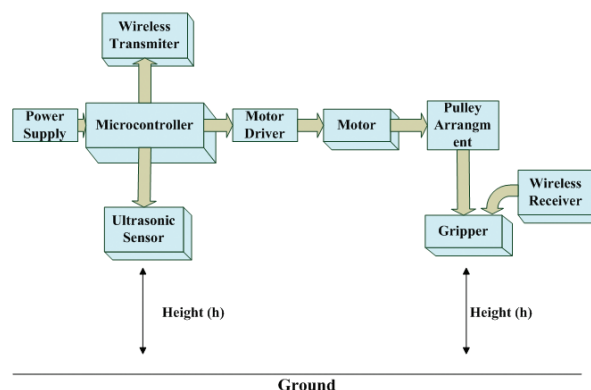


Figure 3. Block Diagram of Dropping and Lifting of an object application.

The micro gripper interfaced to the UAV with a rope pulley works in such a way that when the power supply is given to it is in ON state which activates the wireless module, makes the data transmission from the wireless module to the gripper to be activated for the activity to be taken place. Now it gives a signal to quadruple high current drivers to control a bipolar stepping motor and micro gripper. This process makes the dropping and lifting of the object from an altitude. When the voltage changes from low to high, the gripper is made to be open and pick the object and while the signal is high to low, the gripper closes its arms. This makes the total operation of the micro- gripper to grasp and release an object on the ground from a specific height. Here we make use of a wireless RF434 module which makes it operate from a range of 100metres. The transmitter and the receiver make the data transmission possible between the gripper and the base station from where it going to be operated.



Figure 4. Micro gripper.

4. Obstacle Detection and Avoidance System's Circuit Operation using HCSR04

This HC-SR04 is one of the most renowned ultrasonic sensors which are used to determine the distance from an object. The main features which makes it at the top is that it's most reliability, available at low price and has high accuracy. External noises or sunlight could not affect the operation of an ultrasonic sensor. HC-SR04 ranges its measurement function between 2 and 400 cm at a range accuracy of around 3mm. This module consists of a transmitter, receiver and a control circuit.

In our research, we make use of an Arduino UNO R3 microcontroller board as a reason being it could make the controlling part easy over the system. Moreover, we used HCSR04 ultrasonic sensor as mentioned above with its reliable features.



Figure 5. HCSR04 Ultrasonic Sensor..

- Vcc-5v.
- Trig-Input of sensor (trigger).
- Echo-Output of sensor (Echo).
- GND-Ground.

The operation of the project is pretty simple and systematic at all the levels. The sensor LED'S would illuminate as when the system approaches an object. When distance denotes to be more between the objects and the system it is in safe zone such that the green LED illuminates and yellow if the distance is slightly average and red if the object is much close and indicates a danger.

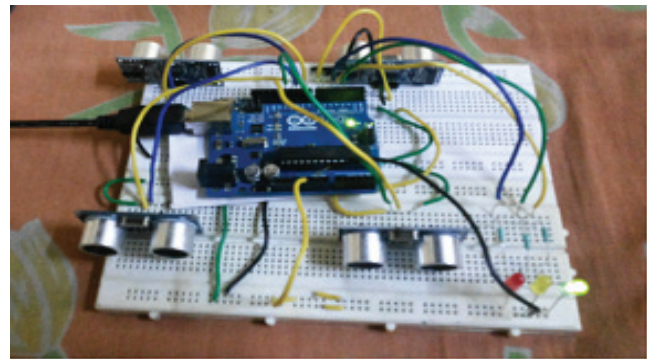


Figure 6. Experimental Circuit Connection.

As shown in the Figure 7, four ultrasonic sensors are used in order to detect obstacles in all four directions. Each ultrasonic sensor covers a span of 15° in each direction thereby detecting the obstacle.

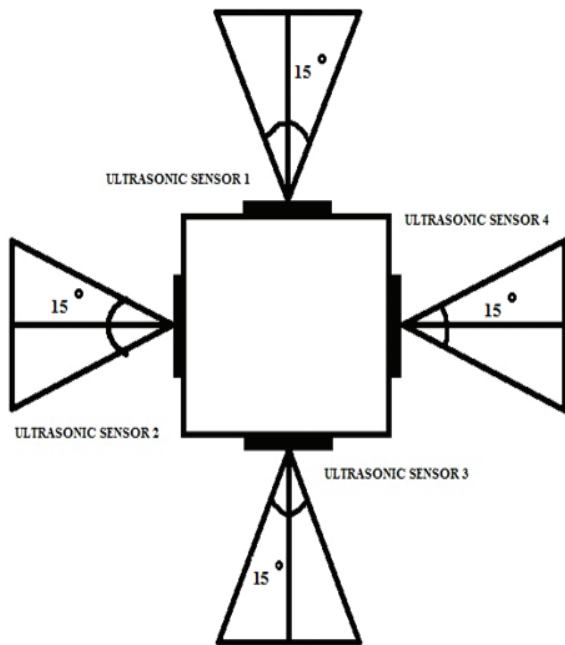


Figure 7. Ultrasonic sensor projection angle.

The tipping angle of ultrasonic sensor is found to be approximately 27.5° as shown in Figure 8. This enables the system to detect an obstacle within 0° and 27.5° tipping angle.

5. Block Diagram and Detection Statements

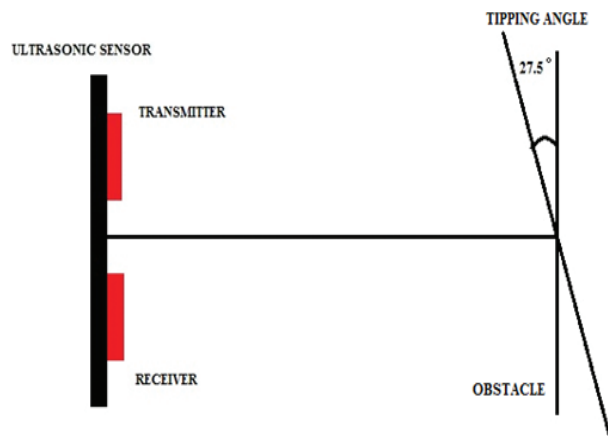


Figure 8. Tipping angle.

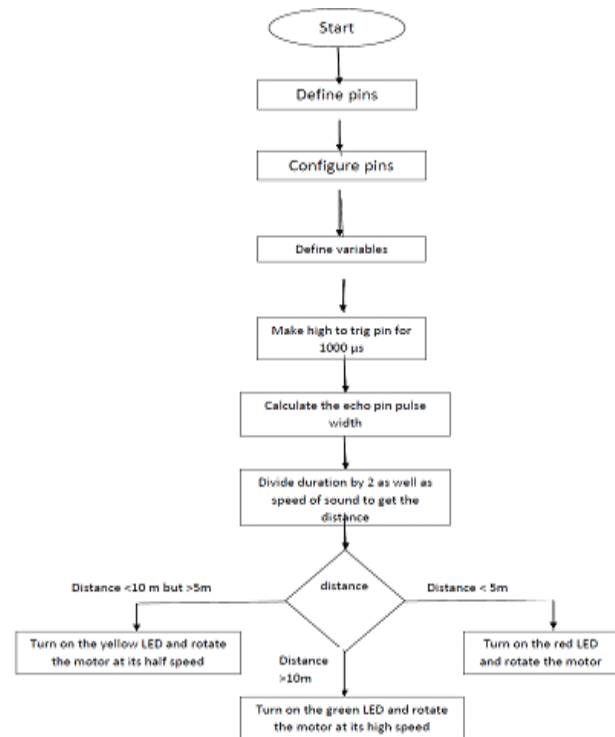


Figure 9. Block diagram of obstacle detection and collision avoidance.

- The block diagram states the step by step procedure that actually takes place in the hardware of the total apparatus from which the exact outline of the collision detection and avoidance could be easily understand.
- In the first phase the pins required for the operation has to define along which the configuration of the pins has to be done. Simultaneously the variables have to be defined to be used like echo, trigger, ground and Vcc.
- Further to proceed, the trigger pin has to be made high as such to 1000 microsecond. Then the echo pin pulse should be calculated. The duration has to be divided by 2 as well the speed of sound to get the distance.
- Now the distance factor is divided in our program into three variation using three colors of LED's namely red, yellow and green as per their order of risk.
- When the distance is less than 5cm between the objects and our system (UAV) then the red LED illuminates and the motor speed is reduced by one-fourth actual flight speed.

- Now when the distance is more than 5cm and less than 10cm then the yellow light glows and the motor speed reduced to half.
- In a last notation, when the distance is more than 10cm, the green light is illuminated and the more speed is maintained at its high.

6. Conclusion and Discussion

Thus the sensor system implementation for an UAV's is made successfully and is designed in specific way that it could detect objects from the environment and avoid collision based on the distance measuring information given by the ultrasonic sensor. The UAV system facilitates obstacle avoidance by using ultrasonic sensors and pick up and dropping of the objects by using micro grippers. But, still there is a drawback of the system like measuring range of an ultrasonic sensor and also the angle problem of sensors to the obstacle surface. So, the effectiveness of sensors at the end of the arms and the higher angle between each sensor should be increased as a whole distribution which would lead to further investigation¹.

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8. References

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