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# Dynamic Target Tracking & Object Avoiding Using an Arduino Based Quadcopter

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**ABSTRACT:** This paper demonstrates a solution to real time obstacle avoidance for a quadcopter in an indoor environment. Proposed solution uses ultrasonic sensors and flight controllers to detect and avoid Obstacles. By implementing the chosen strategy, the quadcopter is supposed to avoid obstacles successfully and maintain altitude. Results show that the strategy is feasible and opens possibilities of Autonomous navigation and 3D mapping.

**KEYWORDS:** obstacle avoiding, quadcopter, arduino, ultrasonic sensors

## I. INTRODUCTION

With the enormously increasing interest in the application of UAVs, obstacle avoidance, undoubtedly, has become a crucial pre-function in the operation of unmanned aerial vehicles. Therefore, implementing the concept of obstacle avoiding by using commercially available ultrasonic sensors would give the quadcopter a sense of its surroundings making it easier and multiple times safer to operate in close proximity. Thus, to verify the performance, empirical data will be collected from experimental trials conducted according to the proposed procedures.

This project is aimed at discussing and proving the concept of obstacle avoiding using an arduino based quadcopter. The choice of using a quadcopter was made after considering its high maneuverability as it can take off, cruise, hover and land in narrow areas. This also made it easy to run our trials indoors to limit certain variables. Thus, the project can be divided into four;

1. Take off
2. Task performance
3. Obstacle's detection and avoiding
4. Safe landing

Various studies on the study of obstacles avoiding use of camera and computer-based vision. However, sometimes camera Nat does not distinguish between obstacles, thus by using ultrasonic sensors we are providing additional assistance to the UAV to be fully aware of its surroundings and the existence of obstacles. Now again also due to the increase in UAV operations in communities our project fills in the research gap by emphasizing safety and keeping it as our utmost priority. Furthermore, our procedure can be made available on shelf commercially at the same time used as a study for proof of concept. It can also be integrated into an already existing quadcopter granting it obstacle avoiding capabilities.

Our aim to improve UAV safety by implementing systems that enable them to be aware of their surroundings. We also aim at making the process available on shelf as it can be integrated on ready-made quadcopters. The other objective is to make the quadcopter safe for indoor operations in academic demonstrations to allow further proof of concept.

## II. RELATED WORK

Various studies on the study of obstacles avoiding use of camera and computer-based vision. However, sometimes camera Nat does not distinguish between obstacles, thus by using ultrasonic sensors we are providing additional assistance to the UAV to be fully aware of its surroundings and the existence of obstacles. Now again also due to the increase in UAV operations in communities our project fills in the research gap by emphasizing safety and keeping it as

our utmost priority. Furthermore, our procedure can be made available on shelf commercially at the same time used as a study for proof of concept. It can also be integrated into an already existing quadcopter granting it obstacle avoiding capabilities.

Past researchers have dived into the applications of obstacle avoidance using ultrasonic sensors but then it was not very efficient because the sensors lacked accuracy and procurement was not easy. Thus, the idea was never fully implemented on actual UAVs. Although navigation of an autonomous UAV in an outdoor environment is possible using GPS data for positioning, indoors these systems are not operational. Other approaches for indoor application use camera systems for obstacle detection, collision avoidance and positioning. These systems lack different drawbacks like dependency on external camera systems and heavy computation requirements. Further leading approaches use 3D-camera systems like the Kinect camera from Microsoft or laser scanners. However, any optical sensor is sensitive to light and a diaphanous environment. Therefore smoke, steam and every gas which absorbs light will cause optical sensor systems to fail. In contrast, ultrasonic sensors are not affected in such a harsh way, what will be shown in this paper.

Nils Gageik, Thilo Müller, Sergio Montenegro of University of Würzburg, Aerospace Information Technology(Germany) have done research on obstacle detection and collision avoidance of an autonomous quadcopter using low-cost ultrasonic sensors.

Muhammad Fazlur Rahman and Rianto Adhy Sasongko, Journal of Physics also proposed object avoidance using ultrasonic sensors on a quadcopter integrated with several modes to check if the UAV would avoid the obstacles

Anis, Hanafi, et al. "Automatic Quadcopter Control Avoiding Obstacle Using Camera with Integrated Ultrasonic Sensor." Journal of Physics: Conference Series. Vol. 1011. No. 1. IOP Publishing, 2018 demonstrated an object avoiding system which included image processing from camera-based vision.

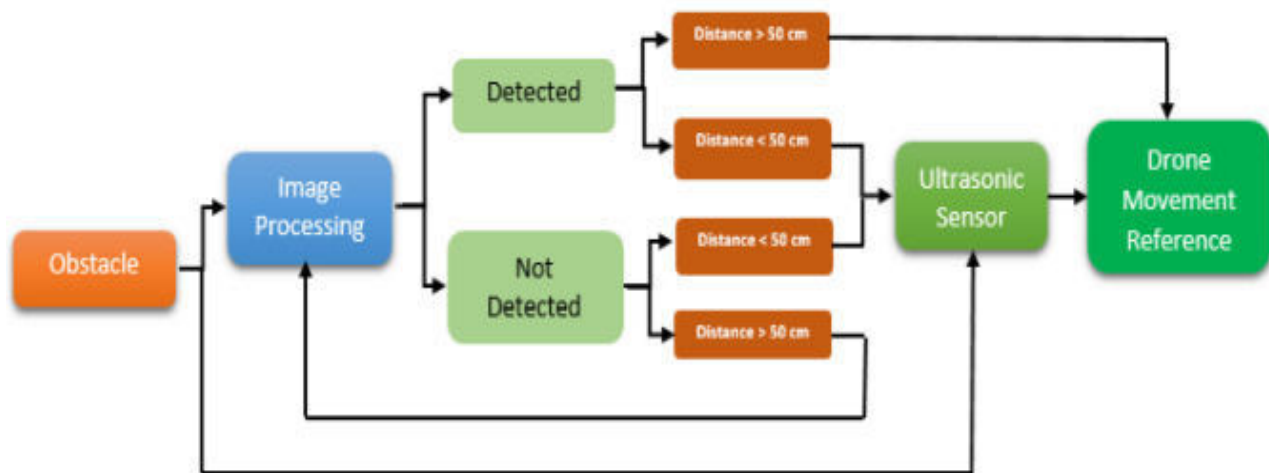


Figure 1- Distance Calculation

However for our case we are going to bypass the image processing and avoid any sonic wave reflecting objects in the path of the quadcopter.

S. Suherman, R. A. Putra and M. Pinem, "Ultrasonic Sensor Assessment for Obstacle Avoidance in Quadcopter-based Drone System," 2020 3rd International Conference on Mechanical, Electronics, Computer, and Industrial Technology (MECnIT), Medan, Indonesia, 2020, pp. 50-53, doi: 10.1109/MECnIT48290.2020.9166607. This paper provided an insight on the performance of ultrasonic sensors given a fuzzy based algorithm which determined the drone's decision to surroundings.

The quadcopter was designed in Fusion 360 and the components designed were: motors, propeller, landing gear and arm support, upper and lower base designs. The static structural analysis was also done in Fusion 360. It was done by taking the assumption that a load which is greater than that of available load is used to determine the safety factor. The material considered in the analysis were aluminum and carbon fiber Static structural analysis of the mid grid was done assuming all other components are rigid and the forces were applied to the main base. The result showed that over time the base board sags due to continuous action of the assumed load – hardware in real case.

### III. METHODOLOGY

The mission is to fly through way points and avoid obstacles successfully along the path. Thus we set up predefined distance with respect to the capabilities of the ultrasonic sensors which can be used to execute the avoidance process

Clear distance – distance at which quadcopter can fly safely

Safe distance – minimum distance at which sensors can detect obstacles

Clear to avoid distance – distance at which quadcopter cannot move any further.

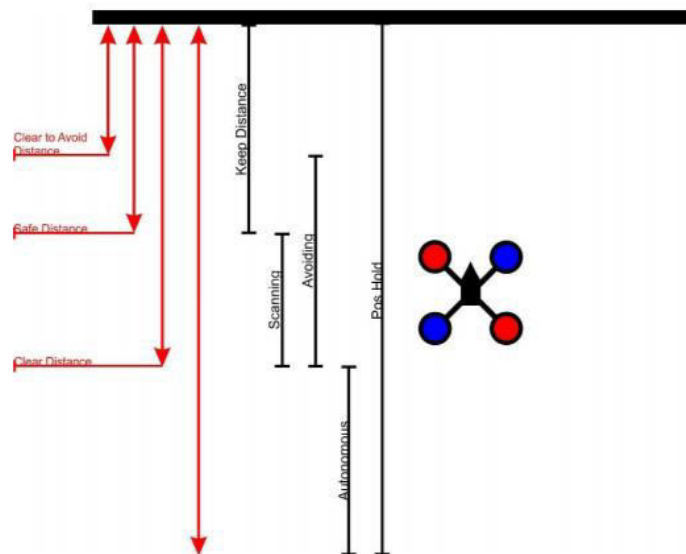


Figure 2 – Distance Configuration

However the functionality is to make sure that no collision occurs. In order to achieve the objective, this project will address the following problems

1. How to sense and extract useful Intel
2. How to decide that a collision is imminent
3. How obstacle avoidance is performed
4. How to maneuver, start and stop the avoidance process.

### IV. EXPERIMENTAL RESULTS

The quadcopter used ultrasonic as a sensor to measure distance and the data will be used to trigger the avoidance mode. During flight, the measurement experiences noise which will disturb the flight mode. Therefore, a filter should be applied to reduce those noises. To verify the performance of the proposed obstacle avoiding capabilities, several experiments were conducted indoors. The set up consists of frame and flight controller -arduino – which computes target detection safe maneuver, selected owing to its low cost.

Some experiments were also carried out while the quadcopter was hovering at a constant altitude not more than 2m. 75% of the trials were a success with the highest yield within 200cm. Thus we concluded that the greater the distance the less accurate the detection. Below is the sensor assessment to the maximum and minimum distances between which the system is effective.

The emitter drum emits ultrasound when we trigger the module using the trigPin by sending a 10 microsecond's high pulse.

As soon as the ultrasound is emitted through the emitter the module makes the echoPin high. Emitted ultrasound travels forward till it gets reflected by the object and then travels backward. The reflected ultrasound is detected by the receiver.

When the reflected ultrasound is received by the receiver, echoPin is made low. Now we have the time taken by the ultrasound to reach the object and again reach the source which is also equal to the duration for which the echoPin was high. This time is stored in the microcontroller. Therefore travel time of ultrasound between just sources to object is half the time take to travel source-object-source we know that:

$$\text{Distance} = \text{Speed} \times \text{Total Time}$$

However the time taken to travel the whole distance is half the total time:

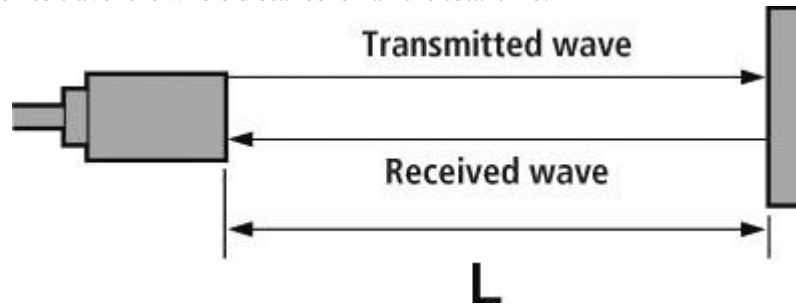


Figure 3- Time travel

$$\text{Distance} = (\text{Time}/2) \times \text{Speed}$$

$$\text{Distance} = (\text{Time}/2) \times 29.1$$

### 3.3.3 Evaluation

A variety of difficulties were faced during the experimental stages with the main one being the Ground Effect and Downwash.

#### Ground Effect

The Near Ground Effect gave a positive reaction to the rotors however at the expense of accuracy of the ultrasonic sensors. Away From Ground Effect is the opposite if there are no hard surfaces for the downwash to react against. Therefore the Ground Effect is an important thing to be considered while designing our system. It should be intelligent enough to process nonlinear inputs

#### Applications

- Programmed drones could be used in synchronization to lift and transport heavy materials.
- By feeding mathematical models of objects, we could merge gesture control to control the quadcopter.
- Drones flying in programmed formations can lift objects and place them in desired orientation on inclined planes.
- Drones are being increasingly employed in firefighting and rescue operations.
- Quadcopters equipped with wireless speakers are being developed which could be used to relay messages.
- Aerial imagery is another field where quadcopters find applications

## V. CONCLUSION

This project extends the use of different sensors and controllers designed to enable a quadcopter to avoid a moving target in a dynamic environment. Using the above mentioned systems the drone will be able to successfully track stationary targets, with and without obstacles in its path, as well as dynamic targets moving in the environment.

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