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Obstacle detection system for Micro Aerial Vehicles collision avoidance

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ABSTRACT

This experiment illustrates the working of Obstacle detection system for Micro Aerial Vehicles collision avoidance by interfacing the camera mounted on Micro Aerial Vehicle with the Arduino Uno and L293D motor controller. Micro aerial vehicle is a kind of a miniature Unmanned Aerial Vehicle that is been employed for multiple operations. It has been proposed to develop aObstacle detection system for Micro Aerial Vehicles collision avoidance for micro-aerial vehicles. The camera mounted on the Micro-Aerial Vehicle can detect the type of obstacle encountered with high accuracy, and the Microprocessor on the L293d motor controller receives the signal and plans the path appropriately, preventing collisions.

Keywords: MAV - Micro Aerial Vehicle, FOV - Field of View, CAS - collision avoidance system.

1.INTRODUCTION

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Over the last decade, advancements in modern technology have increased the usage of Unmanned Aerial Vehicles and Micro Aerial Vehicles for numerous tasks and services, minimizing human effort. Even though there are several obstacle detection and collision avoidance systems available for Micro Aerial Vehicles, each has its own set of restrictions. The Obstacle detection system for Micro Aerial Vehicles collision avoidance has been designed to detect the type of obstacle and give precise inputs to the flight control system.

Micro Aerial Vehicles are smaller and more complex versions of Unmanned Aerial Vehicles. Modern MAV can be as small as 5 centimeters which is effortful to control in both indoor and remote operations. Unmanned aerial vehicles are restricted on various operations due to their size and weight, however the Micro-Aerial vehicle can be employed for many tasks. Micro-Aerial vehicles are smaller and lighter, allowing them to operate at low altitudes and in tiny places. Micro-Aerial vehicles have a higher power efficiency, resulting in greater endurance. The Micro-Aerial Vehicles can perform multiple operations such as surveying, mapping, datacollection, rescue operations,etc.To avoid multiple collisions, a Micro-Aerial Vehicle's obstacle detection and collision avoidance system (CAS) is necessary. Collisions can occur in both autonomous and human-piloted flight. By installing such a system on the Micro-Aerial vehicle, the unexpected emergence of various obstacles, such as birds in open spaces or fixed objects, can be avoided.

Previous studies have used ultrasonic and sonar sensors to study obstacle detection and collision avoidance systems, but these sensors have been shown to be inadequate in determining the type of barrier encountered to provide more precision. The Micro-Aerial Vehicles vision-based obstacle detection and collision avoidance technology assists the flight control system in detecting the obstacle and thus navigating the vehicle in a free path. The camera which has capability of providing accurate data has been installed on the Micro-Aerial Vehicle and connected to the system. The camera with the help of vision-based techniques and the various components provide inputs continuously to the flight control system allowing them to adjust their controls to travel in the free path available. The L293D motor driver helps the Vision based obstacle detection and collision avoidance system to communicate with Micro-Aerial vehicle by adjusting the speed and directions of Dc motors based upon the required travel path.

EXPERIMENTAL APPROACH

2.1 COMPONENTS USED

2.1.1 ARDUINO UNO

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The Arduino UNO used in lidar based obstacle detection and collision avoidance system is a single-board microcontroller, which has operating voltage of 5 volts and the input voltage from 7 to 20 Volts.The microcontroller has 14 Digital //O Pins in total with 6 Analog input pins. The DC power Jack and the USB port can be used to supply power to the microcontroller. The Microcontroller has 2KB of SRAM and 1KB of EEPROM.

2.1.2 L293D, DC MOTOR WITH ARDUINO

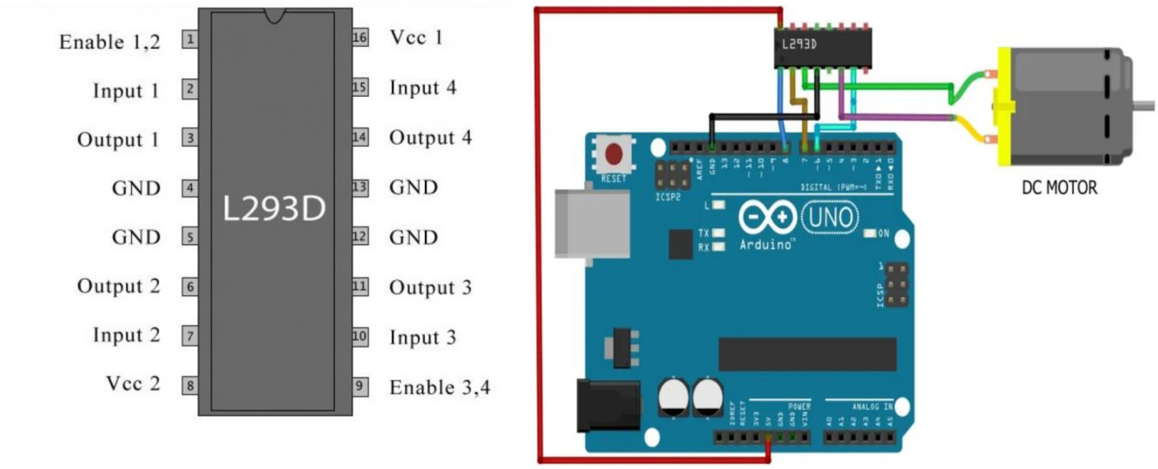

Fig.2 L293D, Arduino Connections.

L293D has 16 pins, of which each 8 on either side are for controlling one DC motor. Vcc and GND pins are for the power supply to the L293D. Input pins receive input from Arduino which defines the direction of rotation of the motor. Output pins carry the current input to the motor. ‘Enable’ pin receives the motor speed data from the Arduino. The connections are as shown in Fig.2.

2.1.3 CAMERA

The camera installed on Micro-Aerial Vehicle can detect multiple objects by providing their accuracy and their type, this helps the flight control system to take the travel path decisions by moving MAV in free path.

2.1.4 DC MOTOR

The Dc motor installed on the Micro-Aerial vehicle receives signal from the Arduino and the camera s to adjust its speed based upon the operations of the flight after

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getting input from the Arduino. The motor speed must be adjusted in order of their respective application or to continue in a fixed flight path.

2.2 INTERFACING COMPONENTS WITH MICRO-AERIAL VEHICLE

The Arduino uno is connected to various components which completely madethe Obstacle detection system for Micro Aerial Vehicles collision avoidance. The L293D is installed and connected to control the motor speed. The camera is installed to identify the obstacle and its type and to provide accurate information to the flight controller to adjust its flight plan by identifying the type of obstacle detected from the far distance. The DC motors are connected to Micro-Aerial Vehicle.

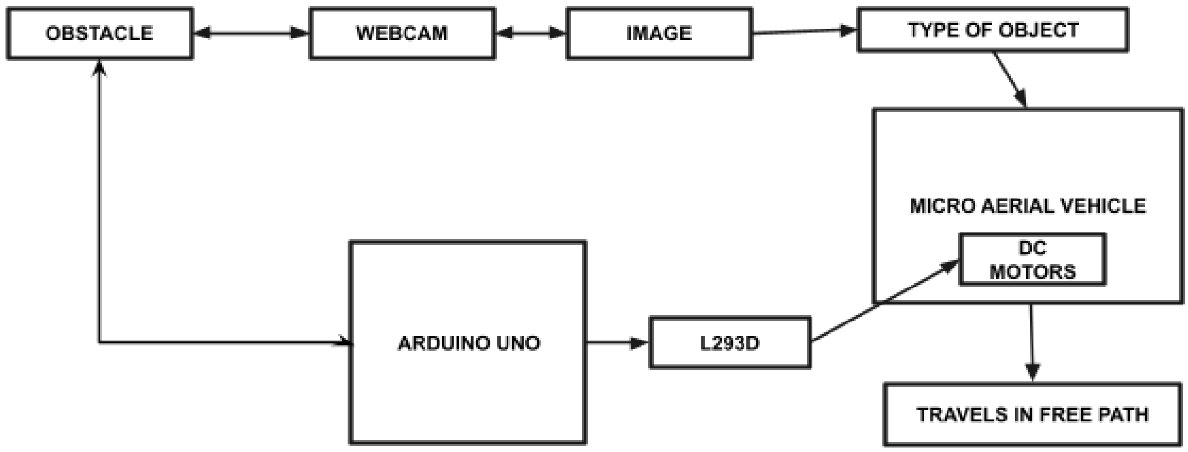

Fig.1 Block diagram of the components

2.3 WORKING PROCEDURE

The camera provides the data about the type of obstacle detected and those inputs are being used to take accurate action. The system avoids obstacle after receiving inputs from the different components fitted to the system and give signals to the flight controller to continue safe flight. The block diagram of working procedure has been shown in Fig.2 where camera is been used as primary component in detecting the obstacle, therefore provide inputs continuously to the flight control system to adjust its navigation. The camera detects the type of obstacles with the help of other installed components such as the Arduino Uno, L293d Motor driver, DC Motors,etc.The path has been planned by the system in order to avoid collisions by making it to scan and travel in free path available.

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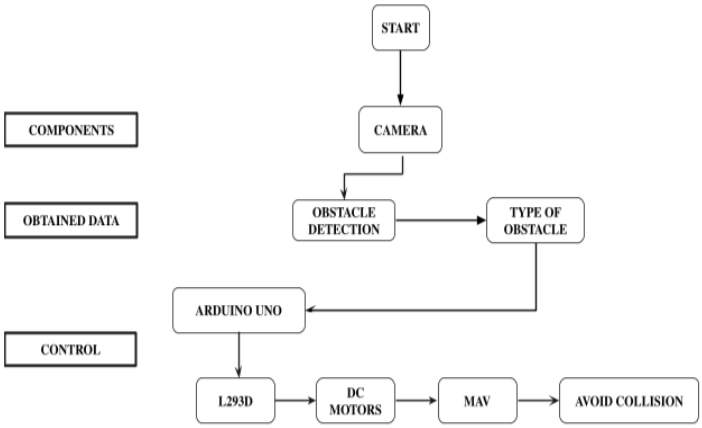

Fig.2 BLOCK DIAGRAM OF WORKING PROCEDURE

In the first image, the Micro-Aerial Vehicle (MAV) detects a single obstacle, whereas in the second image, the Micro-Aerial Vehicle detects multiple obstacles and assigns a path accordingly as shown in Fig.3.

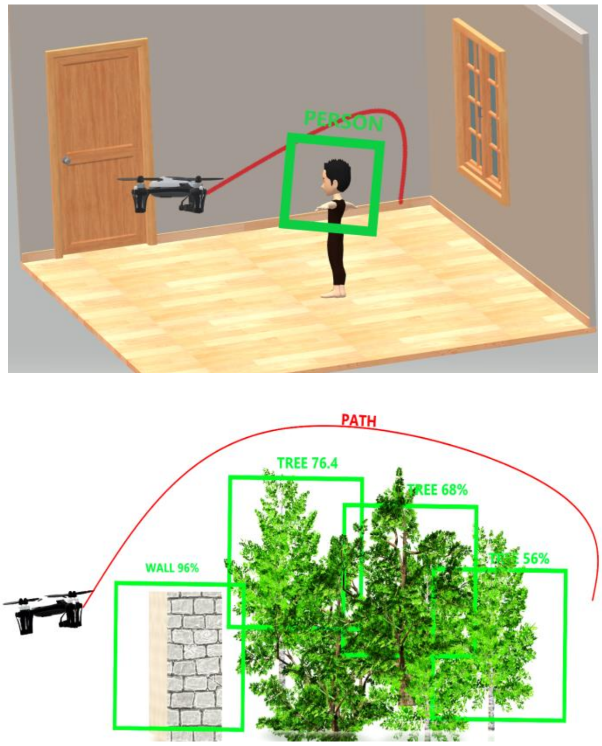

Fig.3 MAV DETECTING VARIOUS OBSTACLES AND ASSIGNING PATH

2.4 TESTING

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The Components connected to the Micro-Aerial Vehicle are being tested to provide accurate information to the flight controlled. The inputs from various sensors and the components have been received and sent to flight controller. The DC Motors receives input from L293D motor controller to adjust their speed as per the required flight plan. The Fig.4 shows the Micro-Aerial vehicle connected to multiple systems is ready for testing and detection of multiple objects are being done using the connected camera to the Micro-Aerial Vehicle. The testing has been done in closed environment in order to provide more accurate information.

Fig.4 Testing Micro-Aerial Vehicle with connected components

Vision based Techniques are being used to detect the type of obstacle and their accuracy. The camera connected to Micro-Aerial Vehicle has been used to detect the type of the object and their accuracy to provide additional information in order to avoid collision. The camera fitted on Micro-Aerial Vehicle can detect various objects and been tested in closed environment. The camera has detected cellphone with 67.46% accuracy from a noted distance shown in Fig.5

Fig.5 Testing of Vision based obstacle detection with accuracy

RESULTS AND DISCUSSION

The study has been conducted for three continuous times in different environments. Results were obtained accurately after getting inputs from the Obstacle detection system for Micro

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Aerial Vehicles collision avoidance, Micro-Aerial vehicle can travel in required path avoiding the obstacle by eliminating the collision by getting the type of obstacle detected.

The camera mounted on Micro-Aerial vehicles with all connected systems has provided various results. The Fig.6 shows the system detecting the person in open environment with 69.74% accuracy therefore signal is passed to the flight controller to make suitable changes for Navigation.

Fig.6 Vision based results detecting person open environment near distance

The Fig.6 shows the system detecting the person in an open environment with 61.69% accuracy therefore a signal is passed to the flight controller to make suitable changes for Navigation.

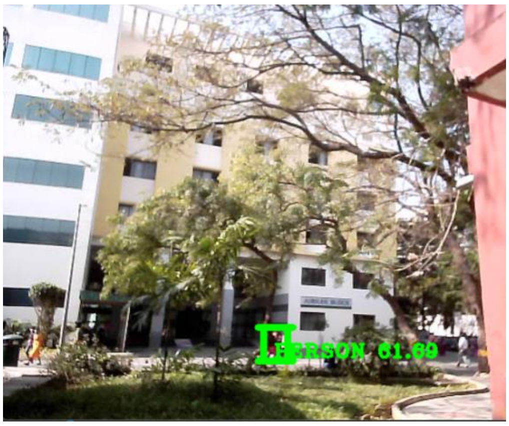

Fig.7 Vision based results detecting person open environment far distance

The Fig.8 shows the system detecting multiple cars in the car parking accurately with their accuracy and the signal is passed to the flight controller to make suitable changes for Navigation.

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Fig.8 Vision based results detecting multiple cars in car parking with accuracy

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