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RESEARCH ARTICLE

REAL TIME OBSTACLE DETECTION ALGORITHM USING ATMEGA-328 PROCESSOR

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ABSTRACT

This paper demonstrates the real time obstacle detection using ultrasonic sensor onarduinouno board in micro aerial vehicle (MAV). Ultrasonic sensor (HC-SR04) is used to measure the distance of an object (Prashanth *et al*., 2013). An algorithm is developed for obstacle detection, which is embedded on an Arduinouno that acts as control board. Four ultrasonic sensors are placed in all the directions. The four green LEDs and four red LEDs are interfaced to arduino board through jumper wires. Obstacle is considered with different colors and the ultrasonic sensor was fixed at a point. Measurements are marked upto 4 m as the range of ultrasonic is 400 cm. It is connected to the laptop containing arduino IDE software. Obstacle distance is considered with two colors it shows how a color is varying with different distance when obstacle present. Green LED indicates when obstacle is detected from an ultrasonic sensor for larger distance between 30-40 cm. Red LED for lesser range upto 20 cm when sensor detects the obstacle and the corresponding sensor will be activated and blinks the LED. It is concluded that the algorithm implemented is useful in obstacle detection for mini aircraft applications (Jeffery, 2005).

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INTRODUCTION

The Arduinouno is an open source microcontroller board based on the ATmega 328. It has 14 digital input/output pins and 6 analog input. It contains everything needed to support the microcontroller, and it is simply connected to a computer with USB cable to get started. The Arduinouno can be programmed with the Arduino Integrated Development Environment (IDE). Ultrasonic sensors are widely used for distance measurement purposes. They offer low cost and a precision of less then 2 cm to 4 m. However, the most popular method used in these measurements is based on the Time of Flight (ToF) measurements (Stephen Griffiths *et al*., 2015). MAV is a class of miniature UAV that has a size restriction and it is autonomous. It can be as small as 15 centimeters.

Hardware and software

Ultrasonic sensor (HC-SRO4)

Figure 1 shows ultrasonic ranging module HC – SR04, which provides 2 cm – 4 cm non contact measurement function, ranging accuracy can reach to 3 mm. The modules includes ultrasonic transmitters, receiver and control circuit.

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The basic principle of work is (1) Using IO trigger for atleast 10 us high signal. (2) The module automaticallysends eight 40 kHz and detects whether there is a pulse signal back.(3) If the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time*velocity of sound (340M/S) / 2

Arduino Uno Microcontroller

The Arduinouno is a microcontroller board based on the ATmega 328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and reset button. It is connected to a computer with USB cable for powering with a AC to DC adapter or battery to get started. The power source is selected automatically. The board is operated on an external supply of 6 to 20 volts. If supplied voltage is less than 7 V, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12 V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The arduino board is shown in figure 2

Figure 1. ultrasonic module HCSR04

Specifications of HCSR04

Working voltage	DC 5 V
Working current	15 ma
Working frequency	40 kHz
Max range	4 m
Min range	2 cm
Measuring angle	15 degree
Trigger input signal	10 us TTL pulse
Echo output signal	Input TTL level signal and range in proportion

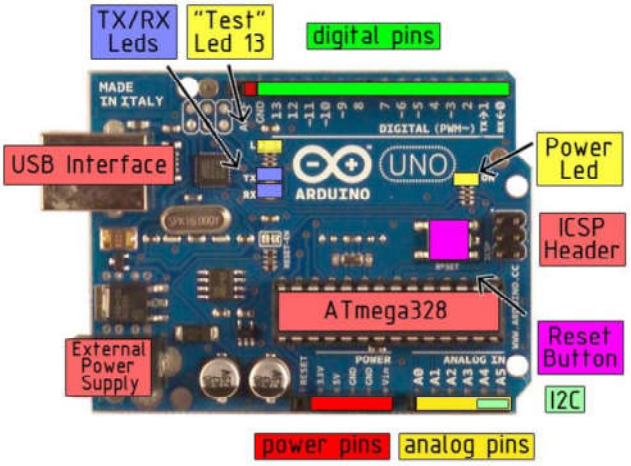

Figure 2. The arduinouno board

Light Emitting Diode (LED)

LED has two different legs, also called leads. The longer lead is the anode and the shorter is the cathode. Anode to the positive supply, i.e to one of the digital pin of Arduino board, and the cathode to the ground pin. Arduino supplies 5 V and an LED operates at a maximum of around 3 V, as shown in figure 3.

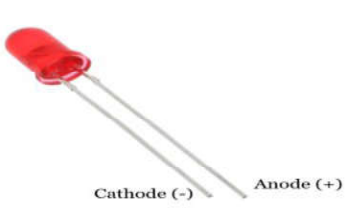

Figure 3. LED cathode and anode

Battery

In which device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smartphone, electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. This is connected as external power supply to Arduino board.

Buzzer

A buzzer or beeper is an audio signaling device which is mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.Apiezo electric type of buzzer is shown n figure 4.

Figure 4. Piezoelectric buzzer

Arduino IDE tool

Arduino
IDE is an open source project to which ATmega chips connect it. In the software the code is written and uploaded to any ATmega chip and then the code is executed on the chip. Many 3D printer electronics and Arduino compatible use ATmega chip. Sketch is the window in which the program is to be written which is shown in figure 5.

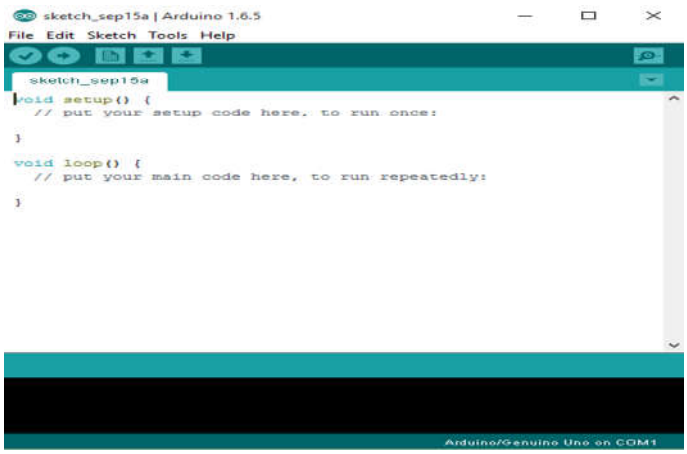

Figure 5. Arduino sketch window version 1.8.5

Implementation

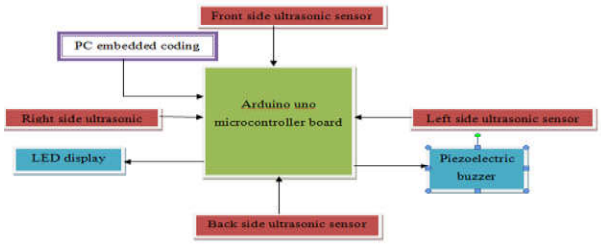

Figure 6: Block diagram of real time obstacle detection by ultrasonic sensor

The block diagram of implementation is shown in figure 6. In the diagram external peripheral sensor (HC-SR04) is used. Four ultrasonic sensors are implanted in all the four directionsnamely right, left, front, back. All four sensors are interfaced to the arduinouno microcontroller board (Stephen Griffiths, 2006). Ultrasonic sensor consists of two modules transmitter and receiver, which are connected to the Arduino Uno board.

The ultrasonic sensors are connected to the arduino board by interfacing trig and echo pins to the digital pins of Arduino. The data from Arduino is transmitted and received by TX and RX pins. The ultrasonic sensor consists of Vcc which is also powered by 5V. The ultrasonic sensor sends a trig pulse into the air to detect the obstacle and the reflected pulse is received at the echo pin from the receiver module. The obtained echo pulse is connected to the arduino digital pin, Here the calculation of distance is obtained on the serial monitor of the arduino IDE. In implementation, eight LEDs are interfaced to arduino board. Four are used green LEDs and four red LEDs are used. These pair of LEDs are placed at respective sensors in all directions. Buzzer is interfaced to the arduino board. The sensor measures the distance, if any of the sensors detects the obstacle and distance is less than 40 cm then the green LED blinks in respective side of the sensor (Choon-Young Lee *et al*., 2007). If any sensor detects the obstacle for distance less than 20cm then the red LED blinks in respective side of the sensor. If any two sensors detect the obstacles by showing the distance less than 40 cm then respective sides of two sensors blinks green LEDs (Shridevi *et al*., 2017). Simultaneously if any two sensors detect the obstacles by showing the distance less than 20 cm then respective sides of two sensors blinks red LEDs and has an option to notice that in any of the other two directions excluding the obstacle distance. When any of the sensors detects the obstacle by showing the distance less than 20 cm then buzzer also starts to beep to notice in danger position.

Flow diagram of implementation

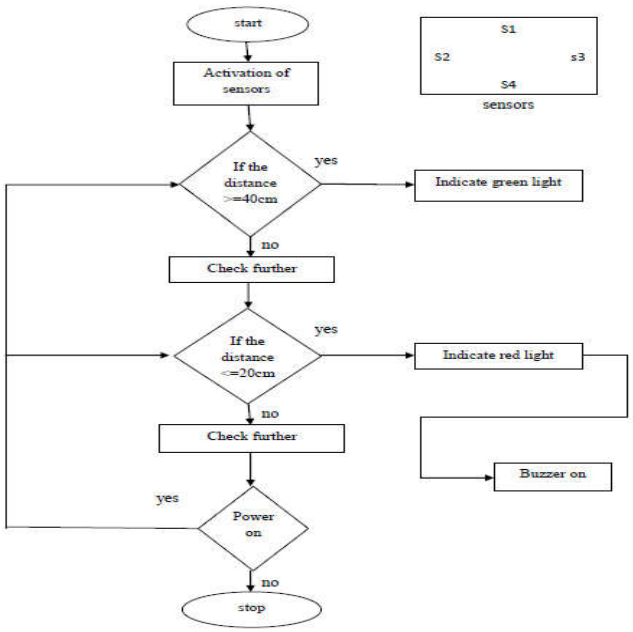

Figure 7. Algorithm /flowchart for obstacle detection

The flow chart shown in figure 7 explains the path followed to detect the obstacles (Shridevi, 2017). In the initial step the distance from all the sensors are obtained by Arduino board. The distance of the obstacle is measured from activation of sensors by sending the pulse signal from transmitter module. All the sensor distances are considered, if any of the sensor is showing distance less than 40 cm is considered. If any sensor detects the obstacle by showing the distance less than 40 cm then green LED blinks. If any sensor detects the obstacle by showing the distance less than 20cm then red LED blinks and buzzer is switched on (Shridevi *et al*., 2017). The respective left/right/front/back side ultrasonic sensors are operated same operation.

RESULTS AND DISCUSSION

Results are obtained from implementation shown in the figure 8. From figure it is seen that four ultrasonic sensorsare placed in all the directions. Each ultrasonic sensors of trigger pin and echo pin is interfaced to the arduinoboard.

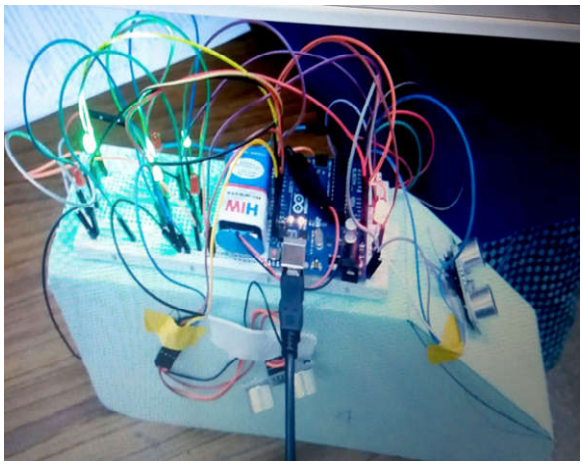

Figure 8. Hardware implementation of real time obstacle detection

The four green LED and four red LED are interfaced to arduino board through jumper wires. Obstacle is considered. Measurements are marked upto 4 m as the range of ultrasonic is 400 cm connected to the laptop containing arduino IDE software. Figure 8 shows obstacle distance considered with two colors which shows how a color is varying with different distances when obstacle is present. Green LED indicated when obstacle is detected from an ultrasonic sensor for larger distance between 30-40 cm. Red LEDblinks for lesser range upto 20 cm when sensor detects the obstacle. The obstacle is moved for each particular distance and the corresponding sensors are activated switching on respective LEDs (Marthias Nieuwenbuisen, 2013).

Conclusion

Algorithm implemented in the present work is useful in obstacle detection for mini aircraft applications and is also used in automobiles industry (Shridevi *et al*., 2017). It is also concluded that an algorithm isimplementedwith color identification for different ranges for obstacle detection.

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