Microcontroller Based Electronic Circuitry to Record Speed of Moving Objects

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Conventional speed measurement techniques use Radar or Laser based devices, which are usually more expensive compared to an IR sensor system. The aim of the paper is to design the Microcontroller based electronic circuit which generates the time pulses and thus calculates the speed of the moving object using IR sensors. The work involves two IR sensors that are placed at a distance 'D' on the same axis that 'see' the moving object, and calculate the speed of the object which will be useful in choosing the material for a particular application.

Keywords: *IR Sensor, Microcontroller, Moving Object, Speed*

INTRODUCTION

The objects moving with high velocity have the high pressure waves which can damage the aircraft after striking. By calculating the velocity of an object the material of aircraft structure can be made more reliable and effective so that it can absorb these pressure waves. Different measurement systems are used and in every system the triggering time is calculated when object passes through the system. The distance is fixed and time is determined so from these two variables, velocity can be calculated.

Speed of the moving objects can be measured with Microcontroller based electronic circuitry device methods. One of the advantages of these methods is the ability to determine the object speed without any contact. The fundamental of this method is to measure the time spent by the object between two sensors. The block diagram of the system is shown in Figure 1

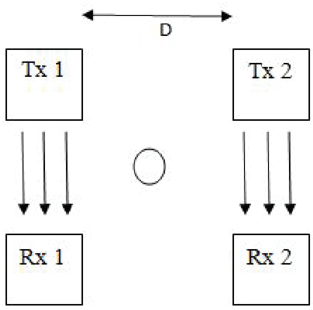

Figure 1. Block Diagram of Sensor & Object

System consist of two sensors. Each sensor is formed by a IR-Transmitter Receiver pair which are optically connected. First sensor includes Tx1 transmitter and Rx1 receiver. The second sensor includes Tx2 transmitter and Rx2 receiver. The distance between the two sensors is indicated by D.

The linear moving object (bullet) comes to the first sensor's scope area and while passing, it cuts the rays of this sensor. Then it comes to the second sensor's scope area and cuts the rays of the second sensor. Measuring the object's passing time between sensor and using the following equation,

V = D/t ----------------------------(1)

where 't' is the passing time of the object, the speed of the object can be determined.

Design OBJECTIVE

The traditional method for the speed measuring uses a fixed time controller. When an object travels to a distance under the fixed time, speed can be obtained by simple calculations.

To measure the speed of a moving object it is very cost effective which uses radar or laser based devices. This circuit is used for measuring the moving objects' speed. Originally developed to measure the velocity of bullets are usually optical gate based devices. Microcontroller based electronic circuitry to record speed of moving objects must be located such that the flight of the object passes in a relatively narrow region above the sensors. Because they employ optical sensing, the accuracy, repeatability and reliability of such devices is heavily dependant on ambient lighting conditions such as provided by the specific type of indoor lighting used in the vicinity of the microcontroller based electronic circuitry to record speed of moving objects or the variable lighting conditions typical outdoors. Where fluorescent lighting is the source of ambient lighting, a dedicated and specialized light source must be used with the chronograph. When used outdoors a diffuser must generally be employed with the chronograph. Like radar based systems, this circuit provides data for a single point in the objects' flight.

Present Conventional Method

The present conventional circuitry is Laser beam which is converted into Pulses by Intensity Modulated Scheme to overcome the problem of setting the threshold value which varies with the intensity of light variation in the day while testing. The velocity is calculated with this concept. Proper setup using this design will calculate the velocity with more accuracy but the cost of the circuit increases.

Proposed Method

The proposed method is microcontroller based electronic circuitry to record speed of moving objects using IR sensors. Speed of the moving object of high velocities with good accuracy can be calculated with cost effective IR circuit.

Hardware & Software

Hardware Setup for speed calculation is shown in block diagram (figure 2). It consists of an IR sensor, a microcontroller and a display apart from mechanical setup used for object motion.

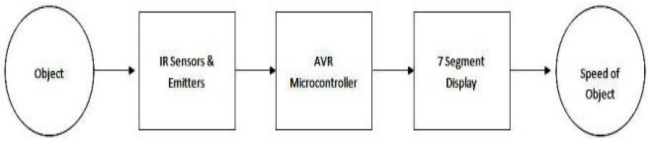

Figure 2. Block Diagram for speed calculation

Microcontroller based electronic circuitry

The heart of the circuit is the ATMega328P microcontroller shown in figure 3. Specification of microcontroller are as AVR Central Processing Unit, 1.8V ~ 5.5 V Operating voltage from 0 to 20 MHz ,32 KB of on-chip Flash program memory with ISP (In-System Programming) and 2Kb RAM, 23 I/O, 32 X 8 general purpose working registers, TTL logic levels.

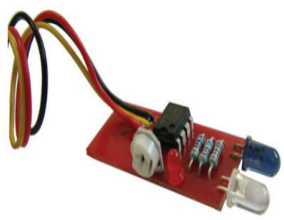

Figure 4. IR sensor

74LS48:

The 74LS48 is a BCD to 7-Segment Decoder consisting of input buffers, seven NAND gates, and seven AND-OR-INVERT gates. Seven NAND gates and one driver are connected in pairs to make BCD data and its complement available to the seven decoding AND-OR-

INVERT gates. The remaining NAND gate and three input buffers provide lamp test, blanking input/ripple blanking input for the LS48. The circuit accepts 4-bit binary-coded-decimal (BCD) and, depending on the state of the auxiliary inputs, decodes this data to drive other components.

IR Sensor:

IR Sensors (shown in figure 4)work by using a specific light sensor to detect a select light wavelength in the Infra-Red (IR) spectrum. By using an LED which produces light at the same wavelength as what the sensor is looking for, you can look at the intensity of the received light. When an object is close to the sensor, the light from the LED bounces off the object and into the light sensor.

Software:

Keil compiler is software used where the machine language code is written and compiled as shown in figure 5. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code

SIMULATION model & EXPERMENTAL RESULTS

The programmable timings of the pulses i.e. ON-time, OFF-time and initial delay are set by using reset switch or user friendly interface written in microcontroller. These timings are sent to controller. When the controller receives a valid data, the signal is sent to acknowledge the successful reception of the data. Each time a new data is written to the controller the timings are updated and remains till the new timings are entered. After the timings are fixed, the controller waits for the triggering signal from sensor unit. When the object is sensed by the unit, it pushes the sensor switch. This sends an interrupt to the microcontroller. Once the controller senses the interrupt, it disables the sensor switch to prevent wrong triggering. After this controller waits for time period equals to the initial delay and switch ON the sensor-1. The sensor-1 remains ON for the time duration equal to exposure time set and then is switched OFF. The controller than waits for time period equals to TOFF1 and then switched ON the sensor-2 for ON-time. The sensor-2 remains ON for the time duration equal to exposure time set and then is switched OFF. The controller than waits for time period equals to TOFF2 and controller waits for next object(bullet) to be fired for next recording of images.

The hardest part about the setting this thing up is getting something to hold the sensors where they need to be. There's a 12V and a ground for each sensor, and the two terminals that go to the transistor switches and form the sensor's output signal. Once the sensors are connected, decide how far apart the sensors must be placed in meters/feet. Now the sensors are aligned and distance is measured as accurately as possible.

Microcontroller calculates the bullet speed and shows the measured value on the display. After every shooting, system is prepared for new shooting by pressing the 'reset' button. The simulation model of the circuit is shown in figure 6.

RESULTS

Microcontroller based electronic circuit to record speed of the moving object has been designed and used for speed measurement as shown in figure 7. The effect of the distance between sensors and the length of the scope area to the error occurred have been examined and the extreme points have been found.

The experimental setup is used to calculate the speed of the bullet. No of trails are been made to find accuracy of the device. Table 1 shows the speed measurement of the bullet under test. The accuracy of the device is found to be good.

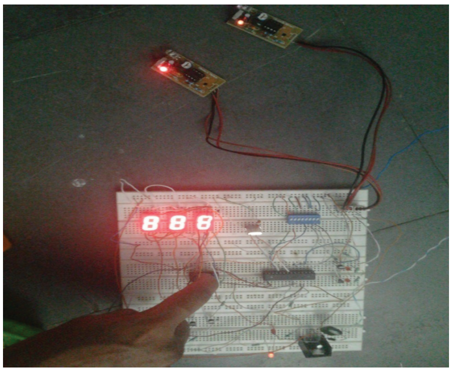

Figure 7: Experimental Setup

SHOOTING	SPEED (m/s)
1	189
2	192
3	192
4	190
5	191
6	190
7	192
8	190
9	188
10	188

Table 1: Object shooting Speed Measurement

Conclusion

The microcontroller based electronic circuitry to record speed of moving object in "Design and analysis of mounting structure for an avionic package" is designed and tested. The output from this circuit is being measured with an accuracy of 190.75m/s.

Acknowledgement

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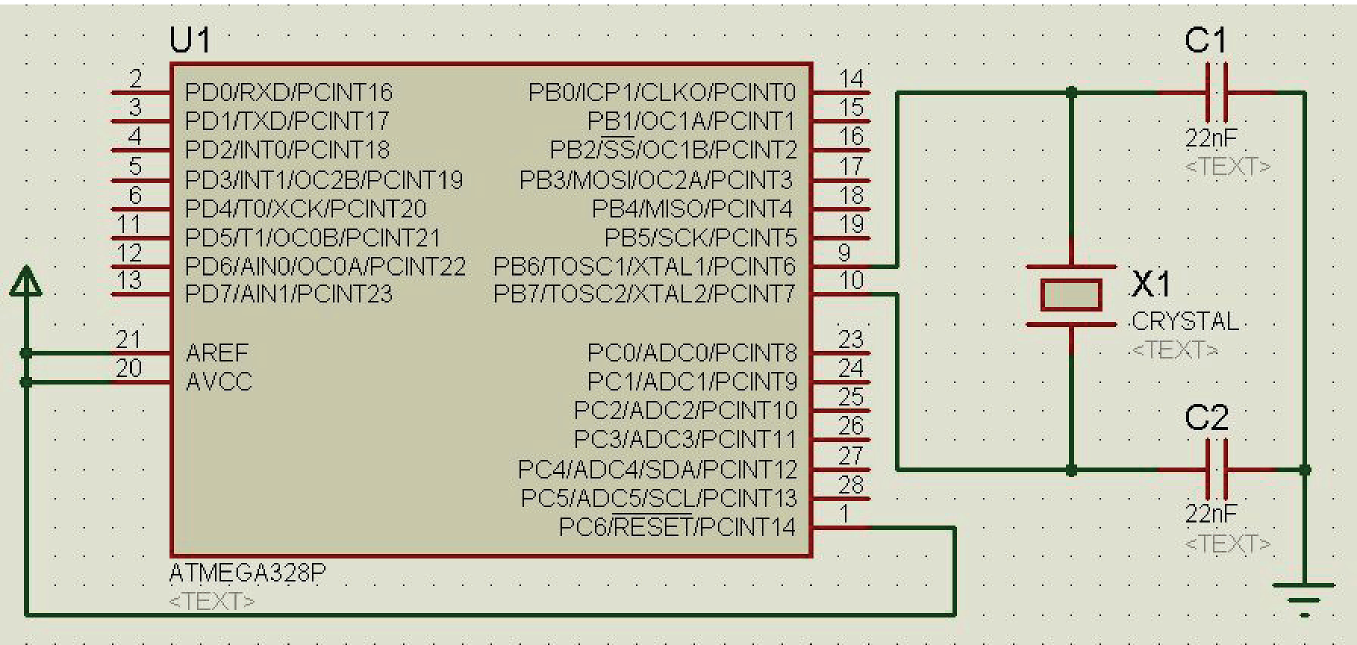

Figure 3. Schematic of ATMega328p

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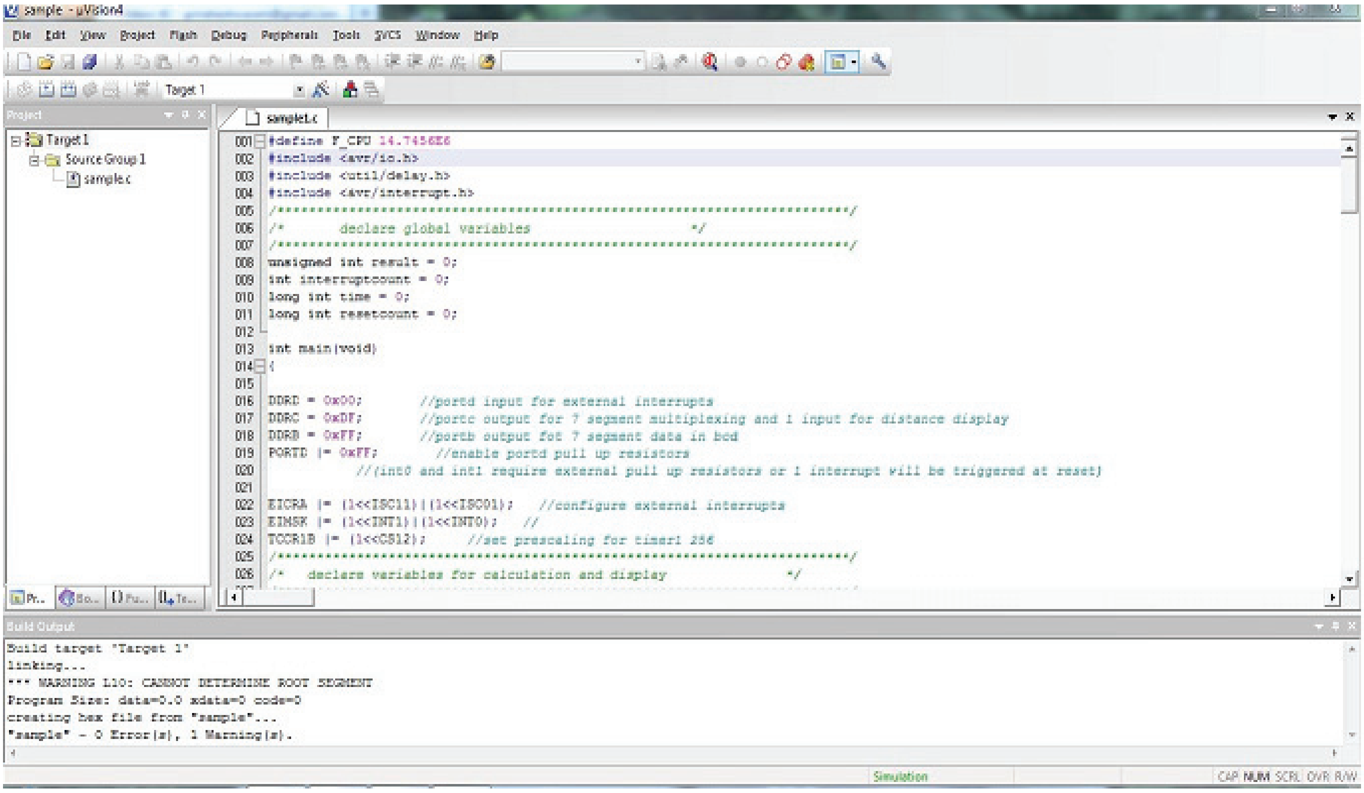

Figure 5: KEIL software

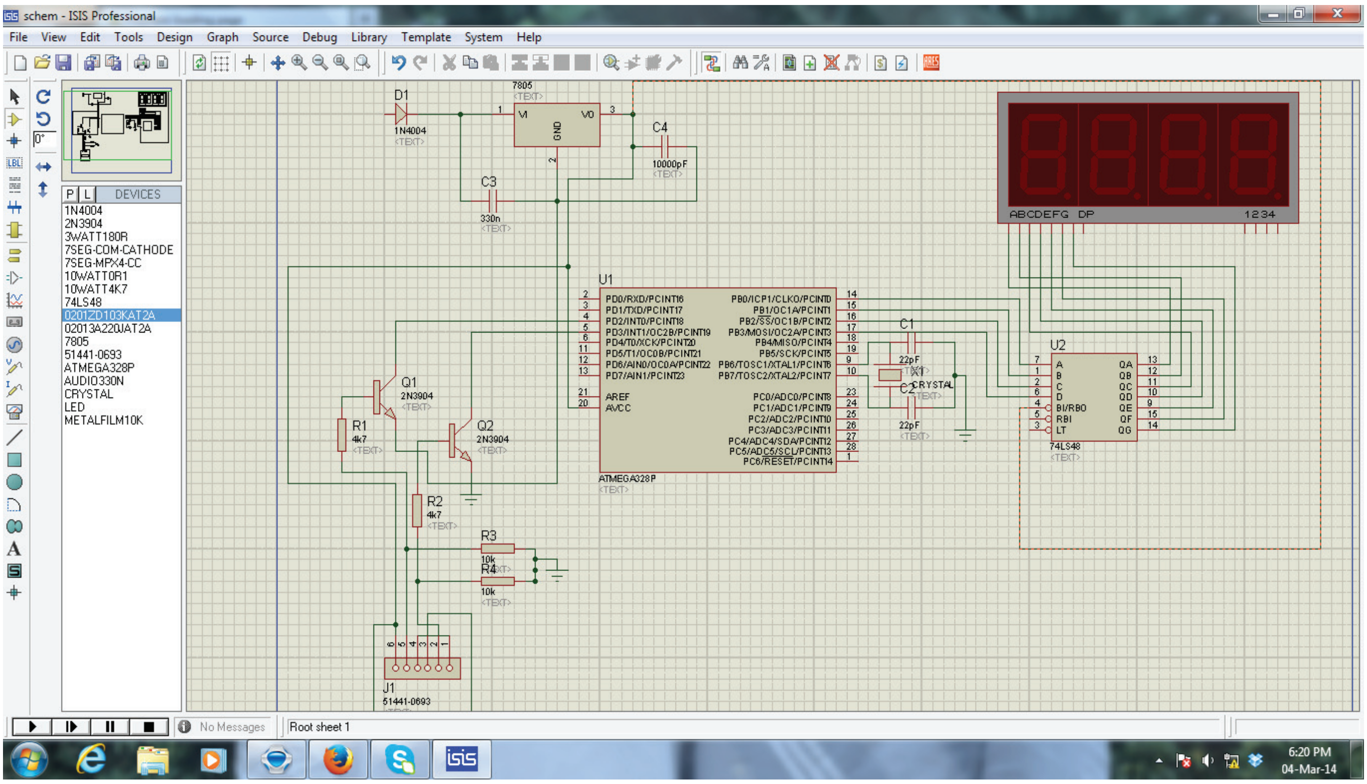

Figure 6: Schematic diagram