International Journal of Electrical and Electronic Engineering & Telecommunications

ISSN 2319 – 2518 www.ijeetc.com
Vol. 5, No. 1, January 2016

Research Paper

APPLICATION OF ULTRASONIC SENSORS FOR THE DEVELOPMENT OF ANTI-COLLISION DEVICE

Piyush Kumar Maiti[1]* and Surekha Bhusnur[2]

*Corresponding Author: Piyush Kumar Maiti, ✉ maitipiyush@yahoo.com

Thousands of cars and other vehicles pile up on the road every year adding to the traffic. Cars, buses and trucks roll over the main roads and highways while also the cars crawl their way through the narrow roads within the city. Traffic means possibleaccidents. In this paper a programmable anti-collision device is built using a simple concept of radar to control the occurrences of road mishaps. The programming environment used here is Embedded C, with a microcontroller.

Keywords: Microcontroller, Embedded systems, Ultrasonic sensors, Embedded C, Anti collision

INTRODUCTION

Safety on the roads is a paramount necessity. An estimated 1.24 million deaths occurred worldwide in the year 2010 due to road accidents. The report according to the World Health Organization says it is slightly down from 1.26 million deaths in the year 2000. The figure shows that a significant amount of progress is still necessary to pull down the death tolls caused by road accidents. However, if certain devices are designed and incorporated in the vehicles these mishaps can be controlled to much extent. Although certain rules such as the speed restrictions have helped in curbing the problem but still safe driving alone would not eradicate the problem totally. A lot of cases have been reported where the drivers either dozed off or were out of senses while driving. It is therefore imperative to consider the advantages of an early warning system or an override system incorporated into the brakingmechanism. A simple yet an effective prototype using principle of radar system,a quality assured device has been implemented. The idea of integrating a radar system however dates back to the 1970's.

With the use of a simple microcontroller Atmega 8051 based embedded systems, the device measures the safe distance between the object and the vehicle. By setting a

[1] B.E. Student Electrical & Electronics Engineering, Bhilai Institute of Technology, Durg, Chhattisgarh 491001, India.

[2] Professor, Electrical & Electronics Engineering, Bhilai Institute of Technology, Durg, Chhattisgarh 491001, India.

parameter such as the safe distance the device will sound off an alarm gradually over riding the manual drive of a vehicle to act accordingly. The microcontroller constantly compares the distance of the objects using set parameters. The basic principle used in this device is the property of the ultrasonic waves. The ultrasonic sound waves have a frequency range from 20 kHz to 40 kHz generated by an AstableMultivibrator, 50% duty cycle. The waves generated are amplified and transmitted through a Transducer.

WHY ULTRASONIC?

Ultrasonic energy also known as the acoustic energy, in the form of waves has a frequency above the human hearing range. This works on the principles similar to radar. Due to its low cost and high functionality ultrasonic sensors are used in this model. This sensor turns ultrasound into electrical signals to be used in the microcontroller as an input.

EMBEDDED SYSTEM

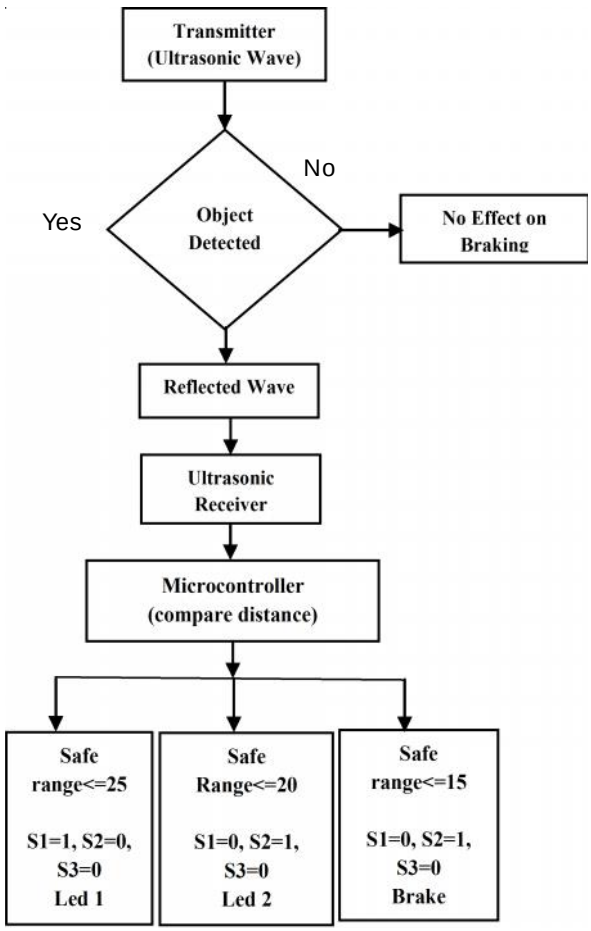
Embedded Systems plays a key role in developing this system. The microcontroller is the brain of the whole system that makes all the calculations with accuracy. In an Embedded Systems a coded integrated chip placed on board has all the information that determines how to progress.

According to the requirements and demands of an application reprogramming of the controller can be done to yield desired outcome.

PROPOSED SYSTEM

The transmitter is used to send the signals. A HC-SR04 has been used in this prototype. The sensor sends a short pulse of 10 us to the trigger input to start the ranging and then the module sends out an 8 cycle burst of ultrasound at 40 kHz. If any object is detected the receiver gets back the echoed signals and sends it to the microcontroller to calculate the distance. The received echoed signal calculates the Range.

Figure 1: Block Diagram



Range = [high level time * (340 m/s)]/2

The pre-set Safe Range for the model has been set in three levels which the calculated Range constantly compares with.

The three levels of Safe Range being set at:

1. 15 cm
2. 20 cm
3. 25 cm

The microcontroller accordingly sends signals to the braking circuit. The braking circuit works according to the above specified ranges. At 25 cm an LED will blink indicating an approaching object. However if the driver fails to react to this indication the second range of 20 cm beeps the buzzer along with the LED.Upon reaching the 15 cm limit the braking circuit beeps the buzzer as well as overdrive to apply brakes through a motor drive. The motors used in the model are stepper motor.

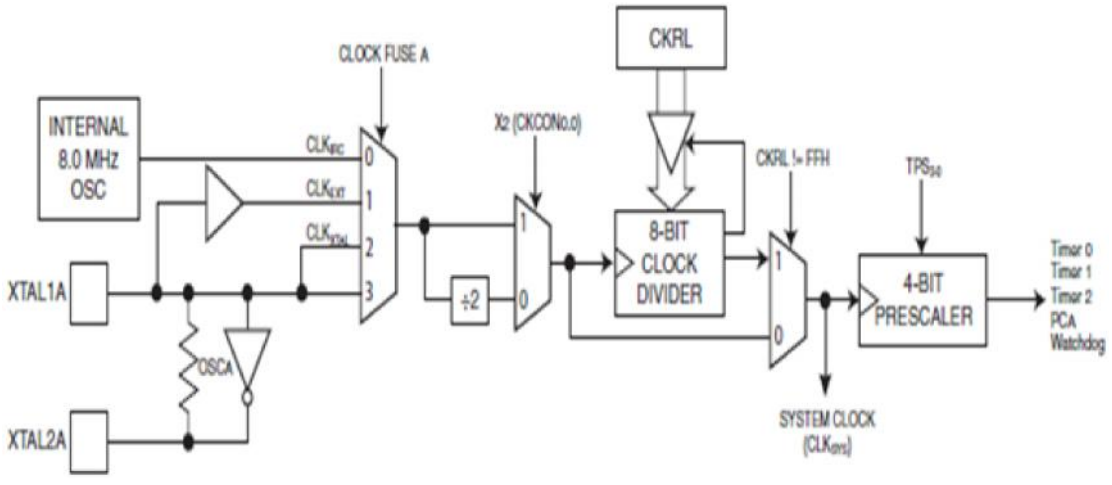
SYSTEMS COMPONENTS

The 8051 Microcontroller

With the microcontroller have been specified Atmel 8051 Microcontroller, the heart of the whole process. Few specifications according to the data sheet provided along with the microcontroller has been given below for clarifications for the selection of this controller.

- Single Clock Cycle per Byte Fetch
- 12 Clock per Machine Cycle Compatibility Mode
- Up to 20 MIPS Throughput at 20 MHz Clock Frequency
- Fully Static Operation: 0 Hz to 20 MHz
- On-chip 2-cycle Hardware Multiplier
- 16 x 16 Multiply–Accumulate Unit
- 256 x 8 Internal RAM
- On-chip 2 KB Expanded RAM (ERAM)
- Software Selectable Size (0, 256, 512, 768, 1024, 1792, 2048 Bytes)
- 4-level Interrupt Priority
- Non volatile Program and Data Memory
- 64 KB of In-System Programmable (ISP) Flash Program Memory
- 4 KB of EEPROM (AT89LP51ED2/ID2 Only)
- 512-byte User Signature Array
- Endurance: 10,000 Write/Erase Cycles

Figure 2: AT89LP51|D2 Clock Subsystem Diagram



- 2 KB Boot ROM Contains Low Level Flash Programming Routines and a Default Serial Bootloader.

System Clock

The system Clock is an essential component for the proper operation of the microcontroller. It times the algorithm inside the brain or the controller.

The AT89LP51RD2/ED2 has a single system clock that is generated directly from one of three selectable clock sources: on-chip crystal oscillator A in high or low power operation, external clock source on XTAL1A, and the internal 8 MHz RC oscillator. A diagram of the clock subsystem is shown in Figure 2. The clock source is selected by the Clock Source A. In addition to this system clock, the AT89LP51ID2 device adds a second system clock source that is selectable from on chip low frequency crystal oscillator B in, external clock source on XTAL1B, and the internal 8 MHz RC oscillator. The choice of clock source also affects the start-up time after a Power on Reset (POR), Brown Out Detection (BOD) or Power-down event. The AT89LP51RD2/ED2/ID2 includes a X1/X2 feature for compatibility with AT89C51RD2/ED2/ID2. This feature determines if the oscillator source is divided by two or not to generate the system clock. The 8-bit system clock divider may be used to prescale the system clock to reduce the operating frequency. In addition a 4-bit prescaler is available to change the clocks of the peripherals.

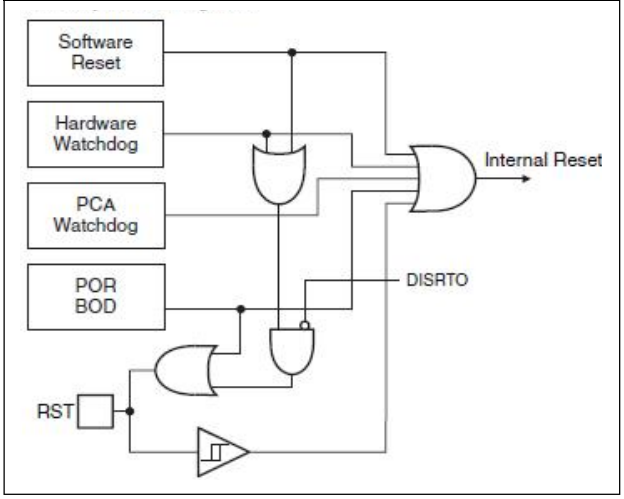
MULTIPROCESSOR COMMUNICATION

The following paragraph describes how to use the serial interrupt for multiprocessor communications. The ports can be programmed such that when the stop bit is received, the serial port interrupt is activated only if RB8 = 1 at the controller pin. This feature is enabled by setting bit SM2 in SCON. When the master processor must transmit a block of data to one of several slaves, it first sends out an address byte that identifies the target slave. An address byte differs from a data byte in that the 9th bit is “1” in an address byte and “0” in a data byte. With SM2 = 1, no slave is interrupted by a data byte. An address byte, however, interrupts all slaves. Each slave can examine the received byte and see if it is being addressed. The addressed slave clears its SM2 bit and prepares to receive the data bytes that follow. The slaves that are not addressed set their SM2 bits and ignore the data bytes. The SM2 bit can be used to check the validity of the stop bit in Mode 1. In a Mode 1 reception, if SM2 = 1, the receive interrupt is not activated unless a valid stop bit is received.

RESET

The reset button has a major significance and has been installed in the system to use

Figure 3: The Reset Circuit



accordingly for re-buffering when switching on the module or simply to kill the ongoing process and start afresh.

VOLTAGE REGULATOR IC-7805

- Output Current up to 1.5 A
- Internal Thermal-Overload Protection
- High Power-Dissipation Capability
- Internal Short-Circuit Current Limiting
- Output Transistor Safe-Area Compensation

The application of this IC is on-card regulation for elimination of noise and distribution problems. Each of these regulators delivers up to 1.5 A of output current. They are also used as fixed-voltage regulators, and can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload.

ULTRASONIC RANGING MODULE HC-SR04

HC-SR04 has a resolution of 0.3 cm and the range of distance is from 2 cm to 500 cm. It operates from a 5V DC supply and the standby current is less than 2 mA. The module transmits an ultrasonic signal, picks up its echo, measures the time elapsed between the two events and outputs a waveform the high time of which is modulated by the measured time which is proportional to the distance.

Trigger: The trigger signal for starting the transmission is given to this pin. The trigger signal must be a pulse with 10 µs high time. When the module receives a valid trigger signal it issues 8 pulses of 40 KHz ultrasonic sound from the transmitter.

The echo of this sound is picked by the receiver.

Echo: At this pin, the module outputs a waveform with high time proportional to the distance.

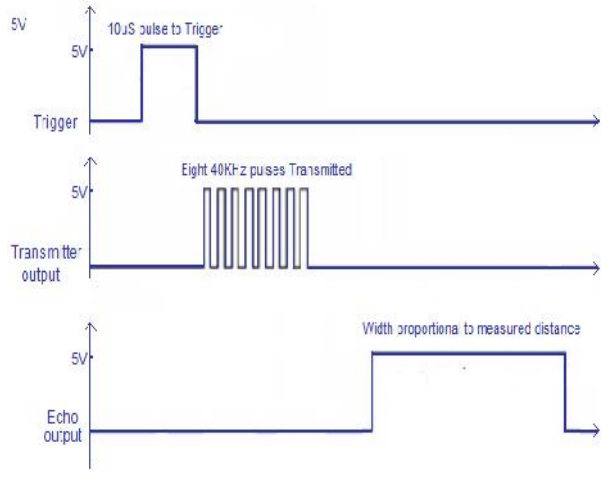
HC-SRO4 TIMING DIAGRAM

The Timing diagram is shown below. Only it is needed to supply a short 10 µs pulse to the trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The range through the time interval between sending trigger signal and receiving echo signal is calculated.

Range = [high level time * (340 m/s)]/2

A use over 60 ms measurement cycle is prescribed, in order to prevent trigger signal to the echo signal.

Figure 4: HC-SR04 Timing Diagram



MOTOR DRIVER

Featuring Unitrode L293 and L293D Products from Texas Instruments

- Wide Supply-Voltage Range: 4.5 V to 36 V
- Separate Input-Logic Supply
- Internal ESD Protection
- Thermal Shutdown
- High-Noise-Immunity Inputs
- Functionally Similar to SGS L293 and SGS L293D
- Output Current 1 A Per Channel (600 mA for L293D)
- Peak Output Current 2 A Per Channel (1.2 A for L293D)
- Output Clamp Diodes for Inductive Loads.

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs. When the enable input is low, these drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

On the L293, external high-speed output clamp diodes should be used for inductive transient suppression. A VCC1 terminal, separate from VCC2, is provided for the logic

Figure 5: Bipolar Stepping Motor Control

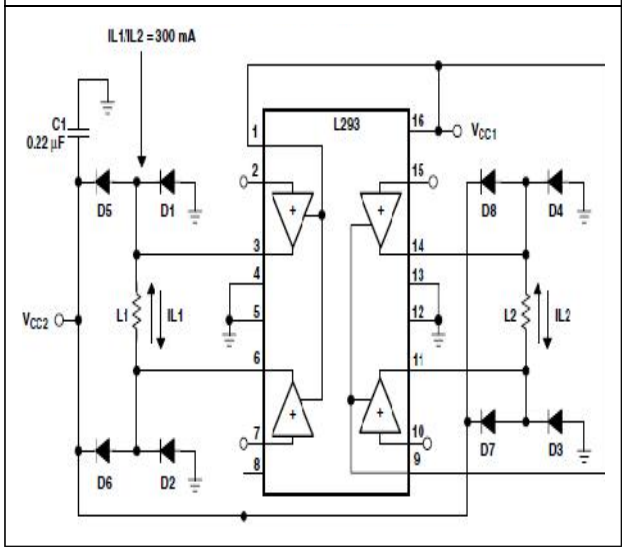
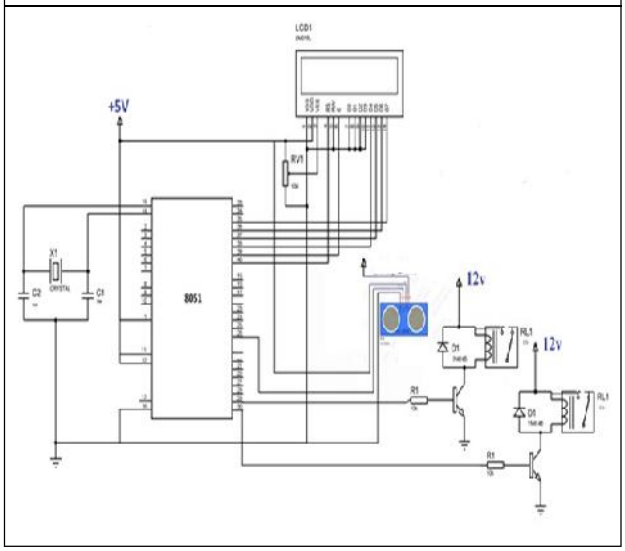


Figure 6: Circuit Diagram



inputs to minimize device power dissipation. The L293 and L293D are characterized for operation from 0°C to 70 °C.

RESULTS AND FUTURE SCOPE

The module was successfully developed in real time application. The ultrasonic sensor was able to measure the data up to 2 cms. The results are accurate with a minor tolerance value.

If Distance less than 25 cm (S<25)

Led 1 blinks

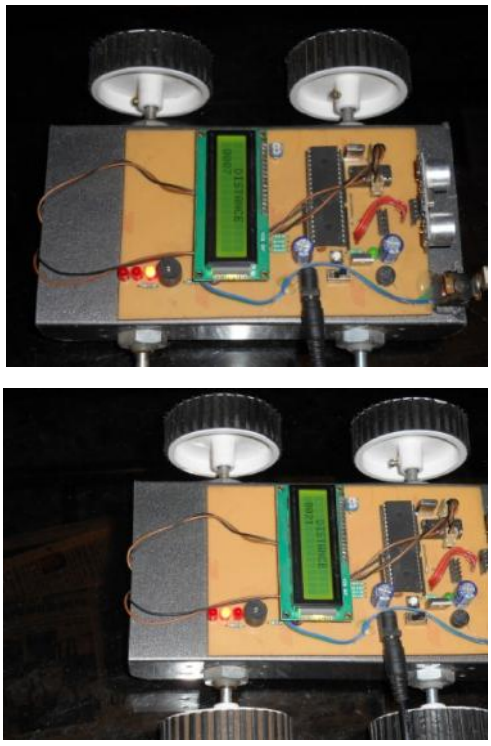
If Distance less than 20 cm (S<20)

Led 2 blinks

If Distance less than 15 cm (S<15)

Led 3 blinks and The Vehicle Stops

Figure 7: The Model (with Distances Displayed)



Further optimization can make the system more accurate. The design can also be extended with a GPS system integrated along with the sensors so that the locations of each vehicles surrounding can be analysed and the system can work more accurately, accordingly controlling the speed of the vehicle and analyzing the time to brake or de-accelerate the vehicle.

Gathering the information from other vehicles demands a suitable communication system in whichZigbee may be used.

- It provides 360 degree protection of vehicle.

CONCLUSION

In this project an effective vehicle anti-collision system, using ultrasonic range finder, braking circuit and microcontroller was presented. With modification applied the concept can be extended to any kind of vehicle.

According to reports, in the last four years, around 15% of rail accidents took place in India.it can be installed in trains after further modification. “The braking distance of passenger trains is about 1 km, while for freight trains it is about 1.4 kms.” This will be especially helpful in preventing accidents that occur due to the lack of information on the location of the other train.

- The design can be used in auto parking system to protect the vehicles from minor accident in parking places.

REFERENCES

1. Alessio Carullo and Marco Parvis (2001), “An Ultrasonic Sensor for Distance Measurement in Automotive Applications”, in *IEEE Sensors Journal*, Vol. 1, No. 2.

2. Benliang Li, Houjun Wang Bin Yan and Chijun Zhang (2006), "The Research of Applying Wireless Sensor Network to Intelligent Transportation System Based on IEEE 802.15.4", 6th International Conference on ITS Telecommunication Proceeding, pp. 939-942.
3. JelenaKaitovic, Robert Langwieser and Markus Rupp (2013), "A Smart Collision Recovery Receiver for RFIDs", in *EURASIP Journal on Embedded Systems, a Springer Open Journal*.
4. Johann Borenstein and YoramKoren (1998), "Obstacle Avoidance with Ultrasonic Sensors", in *IEEE Journal of Robotics and Automation*, Vol. 4, No. 2.
5. Mimoza Durresi, Arjan Durresi and Leonard Barolli (2005), "Sensor Inter-Vehicle Communication for Safer Highways", in Proceedings of the 19th International Conference on Advanced Information Networking and Applications, AINA.
6. Morioka T Sota and Nakagawa M (2000), "Anti-Car Collision System Using DGSP and 5.8 GHz Inter-Vehicle Communication at an Off-Sight Intersection", Technical Report of IEICE ITS 2000-4, p. 193.
7. www.atmel.com/products/microcontrollers/8051 Architecture/default.aspx