

EE 318 Electronic Design Lab, Project
Report, EE Department, IIT Bombay,
April 2007

Electronic Distance Measurement

Group: B-11

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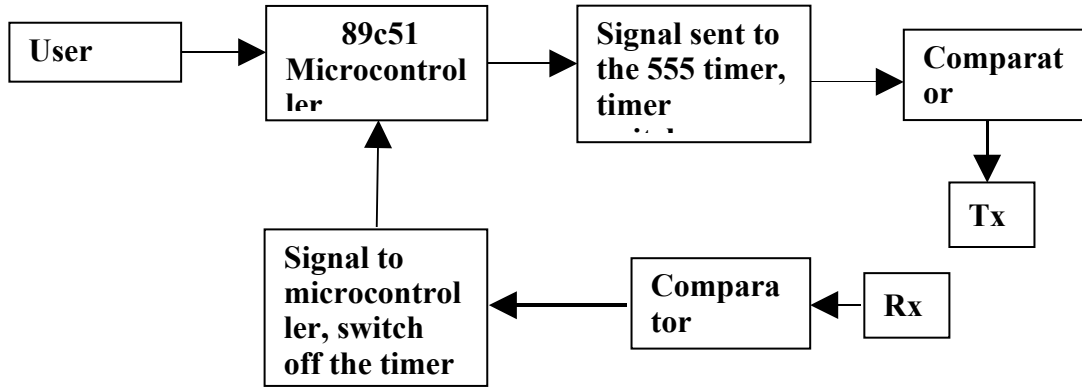
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Guide: Prof. Girish Kumar

Abstract: Electronic Distance Measurement, as the name suggests, this is an electronic device to measure distance of a stationary object kept in the specified range. The working principle is the one used in sonar using ultrasonic wave; the 40 kHz ultrasonic wave is sent which is reflected by the target object, and detected by the ultrasonic receiver. The time elapsed between the two is calculated, which on multiplying with the speed of ultrasonic wave in air (at 25-30 degree Celsius) and appropriate calculations, gives the required distance.

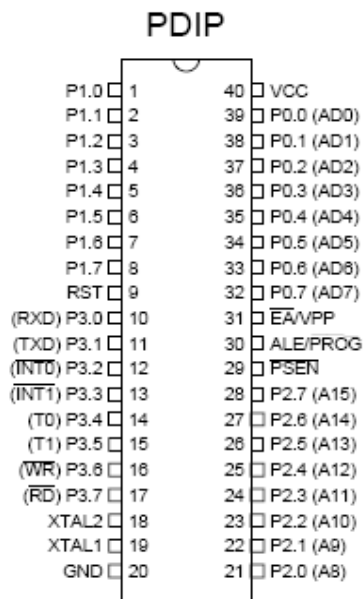
1. Design

The circuit has two parts, microcontroller digital part, and ultrasonic transmission-receiving analog part. The overall block diagram is shown below.



2. Circuit Description

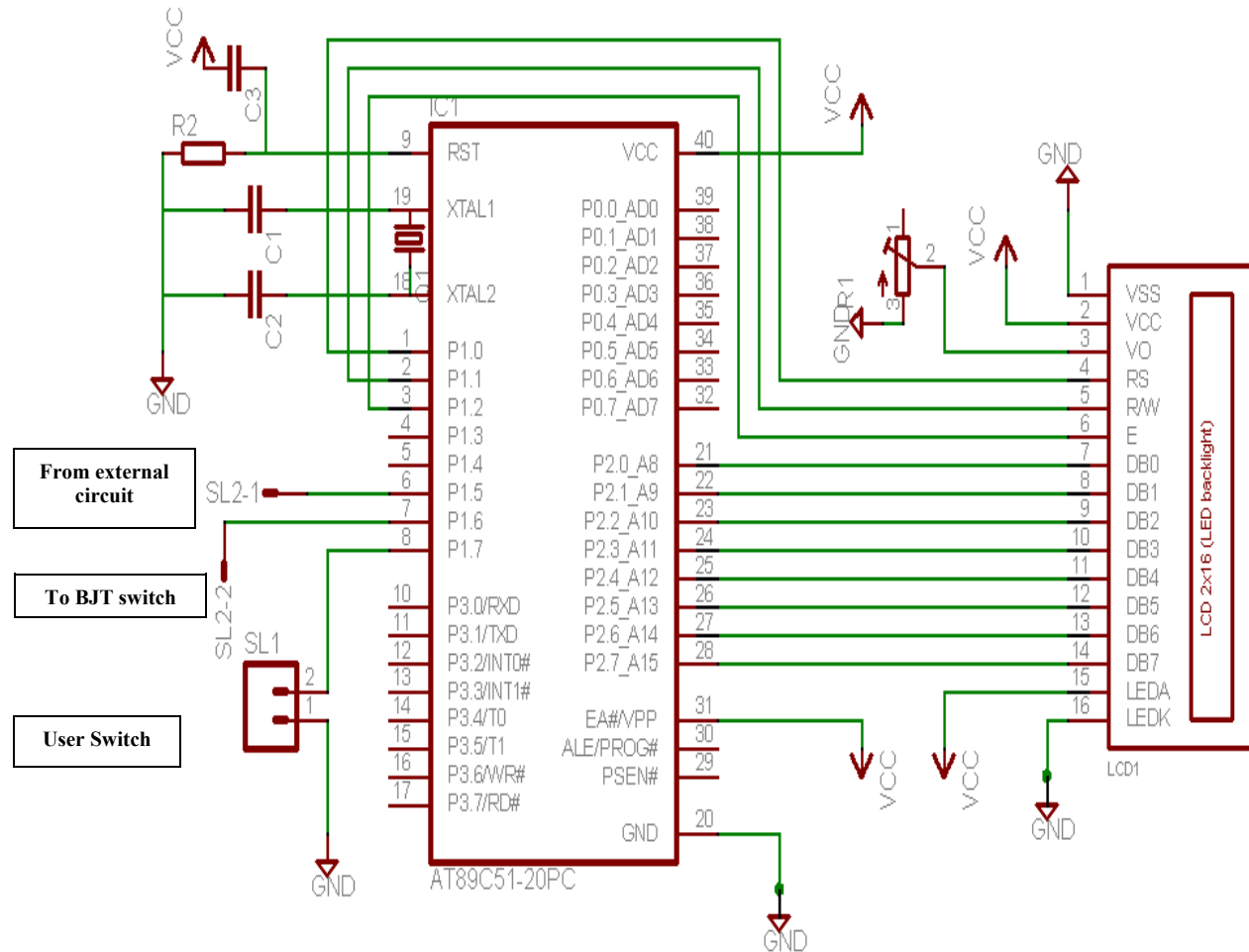
The circuit is divided into two parts, as mentioned above. The digital part consists of the user switch, microcontroller and LCD display unit. The analog part consists of ultrasonic transducers, 555 timer, LM380 comparator, LM 386 Comparator, BJT switch.



Pin diagram of microcontroller 89c51 used in the project.

2.1 Digital Part

Circuit Diagram



As shown in the circuit above, the LCD is interfaced with port 2 of 89c51, with its control lines connected to P1_0, P1_1 and P1_2. The other pins of port 1, P1_7 is connected to user switch, P1_6 is connected to BJT switch and P1_5 is connected to the output of LM386.

Working:

When the user switch is pressed, a signal is sent to the microcontroller to. On pressing the user switch, the pin value goes low momentarily, hence signaling the microcontroller, to start the process. The microcontroller, sets the internal timer T0 into mode 2 with TH0 initialized at 0x00. Then it makes pin P1_6 high, this is connected to the BJT switch, hence turning the switch on, which turns on the timer. Simultaneously, the timer T0 of the Microcontroller is triggered, and it counts the time elapse between the transmitted wave and received wave. The timer stops, as soon as it receives signal from the external circuit that the reflected wave from target has arrived. The 89c51 timer T0 count is then extracted to give the travel time information of the ultrasonic wave. This information is fetched to the formula,

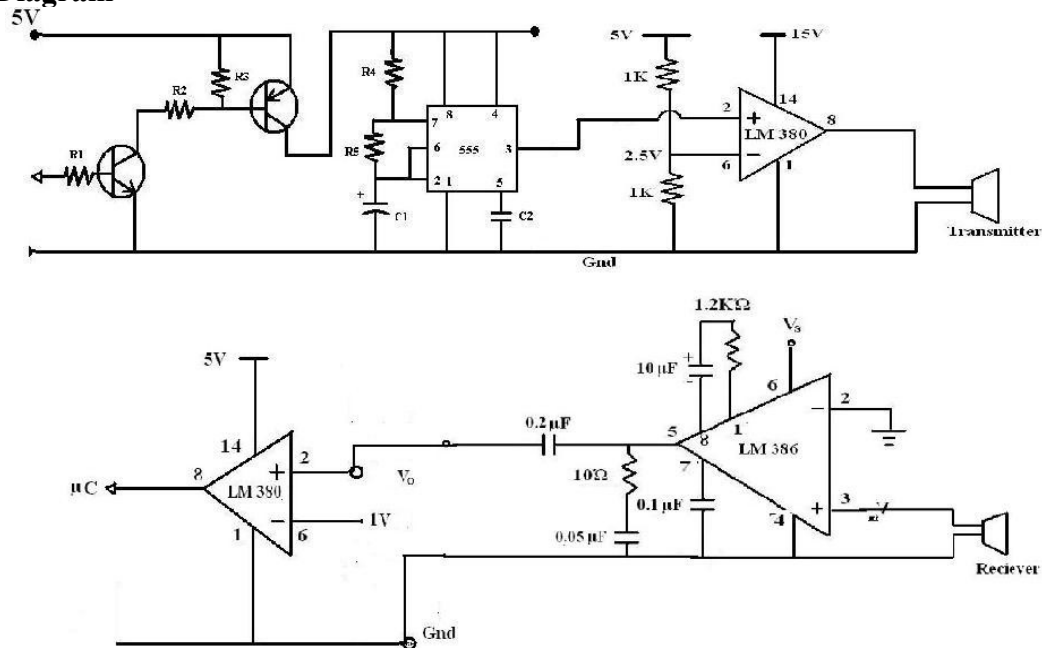
$$\text{Distance} = \text{Speed} * \text{Time taken}$$

Microcontroller calculates the distance by the above formula. This distance is twice of the required distance. Hence its reduced to half and this calculated distance is displayed on the LCD. The LCD is connected to the port 2 of the 89c51.

The LCD is refreshed after every few seconds.

2.2 Analog Part

Circuit Diagram



Working:

1. High signal from μC to the base of BJT BC547. this makes both the BJT forward biased, thus the 555 Timer starts generating the 40KHz pulse train.
2. LM 380 comparator: 5v p2p pulse train is compared with 2.5V. The V_{cc} for LM380 is 15V thus we gets a 15V p2p pulse train. Also the driving capacity of LM 380 is high (10mW) thus giving high power to the transmitter.
3. LM386 Amplifier: this amplifies the received single (50mV p2p for a distance of 1.5m) with a gain of 20 to give a output of 1mV p2p for a distance of 1.5m.
4. LM380 comparator: this compares the amplifies output from LM 386 with 1V, thus giving the high pulse if there is an object in front of the receiver at a distance less than 1.5m. This is then given to the μC , which on receiving a high signal lowers the signal to the BJT and hence the timer stops.

Status

The entire circuit is fully functional on the breadboard. The digital part is fully functional on PCB.

Analog part PCB is not

Ready yet. There is some error in result due to ICs delay which needs to be corrected. The project still draws power

from lab power supply. Need to arrange for power supply, to make the project mobile.

Sources of Error

The circuit has some limitations, and hence some sources of error.

- 1) Speed of ultrasonic sound in air: The velocity is a function of temperature, varying from 346 m/s to 349 m/s for a temperature variation between 25-30 degree Celsius. We have used an average of 348 m/s for the distance calculation.

Also the velocity is medium dependent, hence not suitable in any other medium.

- 2) ICs delay: There is some significant amount of delay caused by the various ICs used, which is causing some error in the result. This needs to be accounted for.

- 3) Object position and range: The target object must be stationary and in line with the receiver, within the specified range (range < 0.8 m). If the above criterions are not met, then the results are not correct, and too absurd.

Future Work

1. For detection of the signal using 40 Khz decoder in place of LM380 comparator, the range can be considerably increased.
2. Once fixing the transducers position, the IC delay can be calculated, and that error can be removed.
3. The use of temperature sensor, can greatly improve the performance of the circuit, making it usable over wide temperature range.
4. DC Power supply on adding can make the project mobile.