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Design Infrared Radar System

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Abstract

In this paper we designed a type of close proximity infrared radar system used to detect any object close to the device by making scanning with angle 180°and distance from 10cm to 80cm. The system is based on microcontroller design. The user will hear a voice just as alarm sound and the distance of the object will be readable on the screen of small LCD. The user also can see the light given by LED appear in the direction of the object.

Keywords: Infrared Radar, Sensor, Automotive Radar, Microcontroller and Targets Detection

1. Introduction

Radar can be briefly defined as method of using radio wave to determine the location of objects in space in relation to a known point.
More precise definition of radar is that it is an electromagnetic system for detection, location and sometimes for recognition of target objects, which operates by transmitting electromagnetic signals, receiving echoes from target objects within its volume of coverge, and extracting location and other information from the echo signals [1]. IR Radar is an application of automotive radar, where this type of pulse radar is operating by sending short pulse to make scanning. Actually with small range (don’t offer more than 1.5 meter). The goal of this paper is to create a working IR Radar system to detect close proximity targets at an angle of 180 degrees, with range (10-80cm).

1.1 Features of IR radar:

1. Increases the detection range from 80cm to 4m by using sonar range finder which uses time-of-flight to measure distance.

2. Increases the angular rotation of stepper motor to 360° (full rotation) by installing brush on the shunt of the stepper motor. Comparison between Ultrasonic and IR sensors.

Ultrasonic-sensor:
- Time of flight distance measurement.
- Longer range than IR.
- affected by wind.
- affected by hardness of object.

IR-sensor
- Angle (parallax) distance measurement.
- Shorter range than SONAR.
- affected by sunlight.
- affected by color of object.

2. Method of Works:

The Sharp IR Range Finder works by the process of triangulation. A pulse of light (wavelength range of 850nm +/-70nm) is emitted and then reflected back (or not reflected at all). When the light returns it comes back at an angle that is dependent on the distance of the reflecting object. Triangulation works by detecting this reflected beam angle, by knowing the angle, distance can then be determined [2].

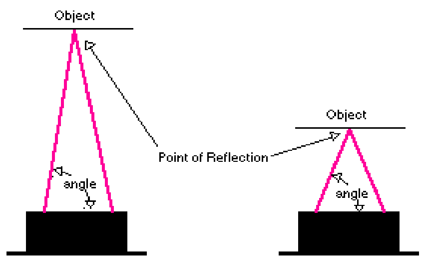

Figure1 Different Angles with Different Distances

The IR range finder receiver has a special precision lens that transmits the reflected light onto an enclosed linear CCD array based on the triangulation angle. The CCD array then determines the angle and causes the range finder to then give a corresponding analog value to be read by your microcontroller. Additional to this, the Sharp IR Range Finder circuitry applies a modulated frequency to the emitted IR beam.

Beam Width:

A major advantage we may have with the Sharp IR range sensor is beam width. Unlike sonar, it's fairly thin - meaning to detect an object your sensor must basically point directly at that object.

2.1 Principle of Operation (GP2D12 IR Sensor)

GP2D12 IR Sensor Description

The GP2D12 provides a non-linear voltage output in relation to the distance of an object from the sensor and interfaces easily using any analog to digital converter. Figure 2 shows a Sharp GP2D12. The LED on the left is an emitter, while the bigger lens on the right is a detector.

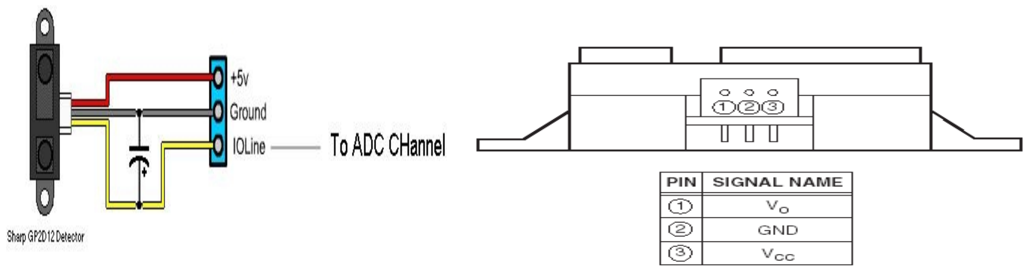

Figure 2 Pin Layouts for GP2D12 [15]

GP2D12 Infrared Ranger module has 3 terminals: Power input (Vcc), Ground (GND) and Voltage output (Vout). The output voltage depends on the following factors:

1. Distance to the nearest reflective object.
2. Object color.
3. Object surface.
4. Surrounding light.

Only the first factor is desired to affect the output voltage, it must be independent upon the other three factors, to achieve that, all sensors are positioned at carefully selected points in the vehicle to avoid direct exposure to surrounding lighting. We can make a walls covered with a plastic tape at the same height of the infrared sensors to make its color homogeneous at all points. Tape's color is selected to be light green to ensure the maximum amount of reflected ray. To read the voltage values from the GP2D12, you must wait till after the acknowledgement period which is around 32 to 52.9 ms**.**

2.2. Work instruction

When we used infrared light we should take care that the time it takes to hit an obstacle and reflect back can not be measured because infrared light travels fast. No measurement equipment is available yet. Therefore, the following theory must be used.

The infrared light is sent out from a transmitter to the object in front, by passing through a condense lens so that the light intensity is focused on a certain point. Reflection occurs once the light hits the surface of the object. Part of the reflected light will be sent back to the receiver end, in which another lens will combine these lights and determine the point of impact.

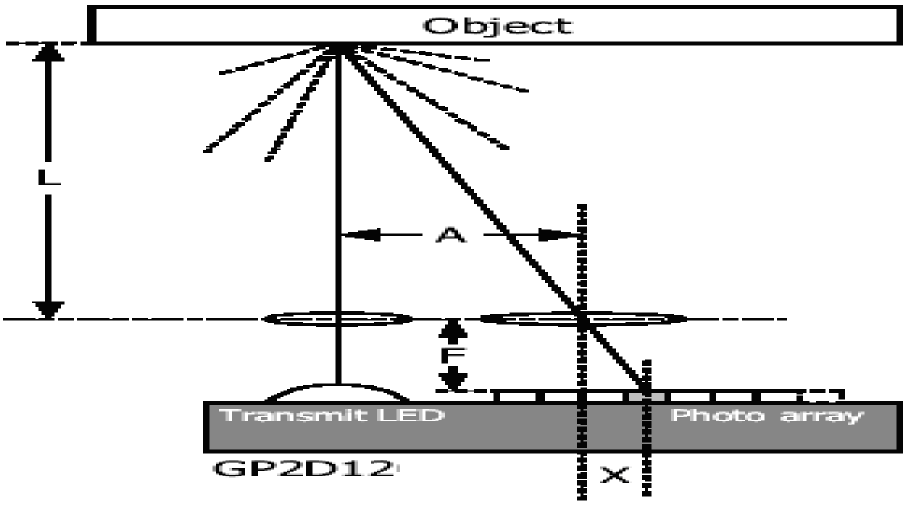

Figure3 Distance Measurement by GP2D12

The light will then be passed on to an array of photo-transistors [3]. The position in which the light falls can be used to calculate the distance (L) from the transmitter to the obstacle using the following formula:

L / A = F / X

Therefore,

L= (F x A) / X

3. PROJECT DESIGN

3.1. Processing Overview

We will discuss the operation and design of our block diagram figure 4.

Firstly switch is on, then we will get closed circuit. The stepper motor will be turned on with instruction to rotate 180 by pic (16f877A).

Stepper motor will drive the **IR SENSOR** [this sensor GP2D12 consist of emitter and detector. The emitter will send an infrared signal to detect an object. When this signal hits the object, the signal will be reflected back to the detector.

Then the detector will send analog signal with suitable voltage and angel. The voltage of this signal is suitable with the distance. **16F877A** will make its [software operation] and convert analog signal to digital by **A/D** and give a command to the led which in the direction of the object and display the distance on the **LCD** then the speaker will give alarm.

Special case:

When we deal with moving object, the software will be changed consumed with the pic variation in angel and voltage. We showed a close design to the circuit drawn using proteus program as shown in figure 5.

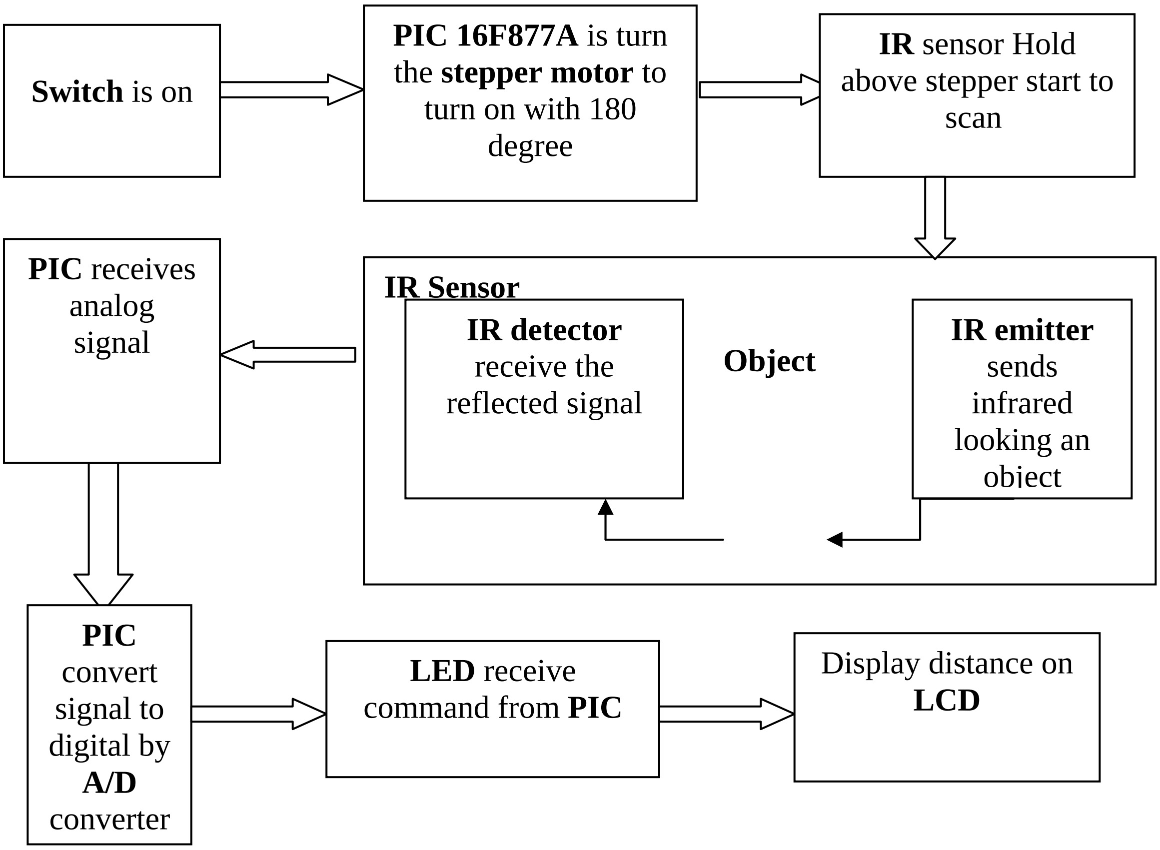

Figure 4 Block diagram of IR RADAR system.

3.2 Hard Ware Connections:

The following figure demonstrates the schematic design of our proposed system.

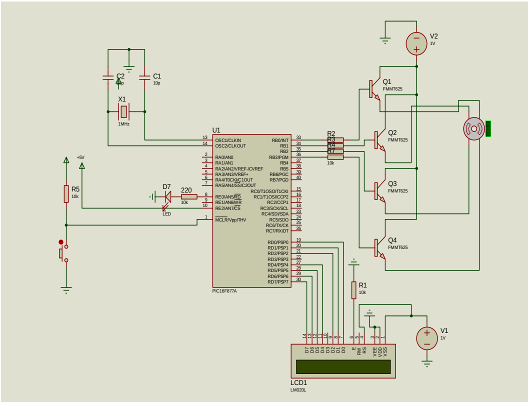

Figure 5 Circuit of the Schematics design

The following figure shows the hard ware of our designed system

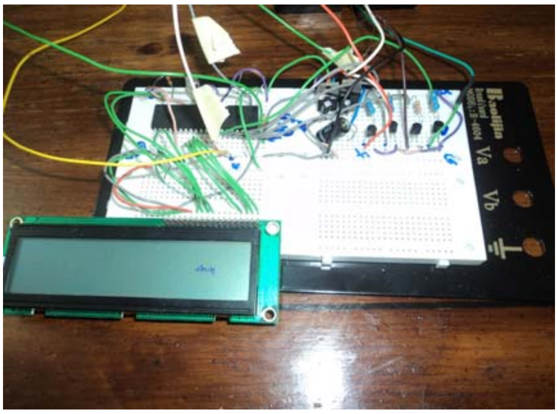

Figure 6 The hardware connection of our designed system

4. Conclusion and Future Work

There are many improvements that we can make to our system in order to create better results. First of all, we need to increase the range of the detection, not to limit our input signals as much to get accurate results. We need to adjust with the sampling rate that we used in order to be able to detect smaller velocities as well as more accurate ranges.

We could optimize the algorithm for the peak locator in the velocity analysis to give more accurate results. IR can be cheaper and smaller than Ultrasonic although sensing with light is less efficient than sensing with sound. A major problem with the Sharp IR range finder is beam width, it‘s fairly thin.

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