“OBSTICAL DETECTION & COLLISION AVOIDANCE FOR RAILWAYS”

Project Exhibition -1

Submitted in partial fulfillment for the award of the degree of

Bachelor of Technology

In

ELECTRONICS AND COMMUNICATION ENGENEERING

Submitted to

VIT BHOPAL UNIVERSITY (M.P.)

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CANDIDATE'S DECLARATION

We hereby declare that the Dissertation entitled “obstacle detection & collision avoidance for railways" is our own work conducted under the supervision of Prof Mayank Gupta, Designation, Name of Department at VIT University, Bhopal.

We further declare that to the best of my knowledge this report does not contain any part of work that has been submitted for the award of any degree either in this university or in other university / Deemed University without proper citation.

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CERTIFICATE

This is to certify that the work embodied in this Project Exhibition -1 report entitled **“obstacle detection and collision avoidance for railways”** has been satisfactorily completed by Khushi rathore(18BEC10037), Muskan Sahu (18BEC10053), Shivani Sahu (18BEC10074), Varsha Sudarshan (18BEC10089) ,Utkarsh Gupta (18BEC1088) in the School of Electrical & Electronics Engineering of Electronics and Communication Engineering at VIT University, Bhopal. This work is a bonafide piece of work, carried out under my/our guidance in the School of of Electrical & Electronics Engineering for the partial fulfilment of the degree of Bachelor of Technology.

Dr. Mayank Gupta

Assistant Professor,SEEE

Forwarded by

Dr. Ribu Mathew
Program Chair

Approved by

Dr. Ribu Mathew
Program Chair

Acknowledgement

We have taken efforts in this project. However, it would not have been possible without the kind support and help of individuals and institution. We would like to extend my sincere thanks to all of them.

We are highly indebted to Prof.Mayank Gupta for his guidance and constant supervision as well as for providing necessary information regarding the project & also for his support in completing the project. We would like to express my gratitude towards our parents & member of VIT Bhopal University for their kind co-operation and encouragement which help us in completion of this project.

We would like to express our special gratitude and thanks to institution persons for giving us such attention and time. Our thanks and appreciations also go to our colleague in developing the project and people who have willingly helped us out with their abilities.

Executive Summary

Now a days, we saw number of accidents occurred in railways. The accidents were mainly occurred due to obstacles in the way . When the train met with an accident maximum people lose their lives. Most of the accidents were occurred with negligence of humans and without proper communication from Train Traffic Control Station (TTCS).To prevent this problem we identified a sensors which will identify the obstacle in the way. The purpose of the project is to develop and design a low-cost system with high integrity and reliability for enhancing to prevent the train's collision in adverse weather situations, such as a foggy or rainy and identify the obstacles in the way. In this we used IR sensors, arduino boardmicrocontroller, buzzer,power circuit. In this paper we alert the driver to avoid the obstacles with the help of buzzer.

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CHAPTER 1: INTRODUCTION

This thesis presents the design and implementation of an obstacle detection and avoidance system for use in railway system . The research described in this thesis was carried out as part of a larger project aimed at demonstrating obstacle detection and avoidance for an trains .Specific contributions of the thesis include an assessment of the different obstacle detection sensors and obstacle avoidance algorithms used in autonomous vehicle research, and development of a new obstacle avoidance system for the trains, including a unique obstacle avoidance algorithm. Simulation and testing results show the effectiveness of the approach.

1.1 Objective

- To detect the cracks present on the railway tracks.
- To detect the obstacles entry on to the railway tracks.

CHAPTER 2: LITERATURE SURVEY

An object can be detected with an infrared system consisting of an infrared transmitter and a receiver. More in detail an **IR transmitter**, also known as IR LED, sends an infrared signal with a certain frequency compatible with an **IR receiver** which has the task to detect it. There are different kind of IR sensors for different type of application. IR technology is used, for example, in proximity sensors to detect a near object, in contrast sensors to find a path or in counting sensors to count objects.

Principle of operation

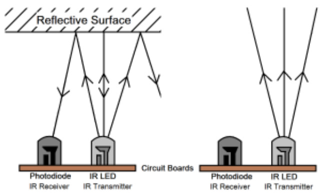


Figure9.1 IR sensor principle of operation with/without object.

The IR transmitter sends an infrared signal that, in case of a reflecting surface (e.g. white color), bounces off in some directions including that of the IR receiver that captures the signal detecting the object.

When the surface is absorbent (e.g. black color) the IR signal isn't reflected and the object cannot be detected by the sensor. This result would occur even if the object is absent.

IR transmitter and IR receiver

The IR transmitter is a particular LED that emits radiation in the frequency range of infrared, invisible to the naked eye. An infrared LED just works as a simple LED with a voltage of 3V DC and a current consumption of about 20mA. The IR receiver, such as a photodiode or a phototransistor, is capable of detect infrared radiation emitted from the IR transmitter. Aesthetically it is similar to a LED but the external capsule can be wrapped by a dark color film.

IR Sensor FC-51

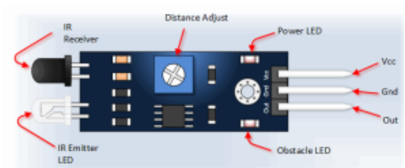


Figure 9.2: Pin map of the FC-51 sensor.

The sensor used in our demo is model **FC-51**. It is a cheap sensor easily available on the internet for less than 2$ but unfortunately we didn't find the datasheet. In any case we will explain the operation of the related electronic circuit and subsequently implement some demo to test its functioning.

CHAPTER 3: WORK MODULE

Work plan

S.NO	Particulars	Duration	Outcome
1	Module1(Train Collision Avoidance by Using Sensors)	--- 10-15 days	Acknowledged about the research paper on the topic.
2	Module2(Planning)	--- 1 week	--- Gathering components and acknowledging about them
3	Module3(Design)	--- 10 days	--- Studying and adding new things
4	Module4(Implementation)	--- 1 week	--- Assembling components and testing

CHAPTER 4: Problem Formulation and Methodology:

Problem Identification

The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and of course, the lack of proper maintenance of rails which have resulted in the formation of cracks in the rails and other similar problems caused by antisocial elements which jeopardize the security of operation of rail transport. In the past, this problem has lead to a number of derailments resulting in a heavy loss of life and property. Obstacles in rails have been identified to be the main cause of derailments in the past, yet there have been no cheap automated solutions available for testing purposes.

PROPOSED SYSTEM: This system involves the design of obstacle detection system for finding obstacles in the way. This system uses controller for interfacing the robotic vehicle and obstacle detection sensor. The sensing device senses the voltage variations from the IR sensor and then it gives the signal to the microcontroller. The IR sensor checks if there is any obstacle and microcontroller will start the buzzer and the buzzer starts running.

CHAPTER 5: METHODOLOGY

5.1 Working

At Normal Condition:

The IR transmitter sensor is transmitting the infrared rays. These infrared rays are received by the IR receiver sensor. The Transistors are used as an amplifier section. At normal condition Transistor is OFF condition. At that time relay is OFF, so that the vehicle running continuously.

At Crack Condition:

At crack detection conditions the IR transmitter and IR receiver, the resistance across the Transmitter and receiver is high due to the non-conductivity of the IR waves. When the track is in continuous without any obstacles then output of IR LED and Photodiode will be high. As soon as the obstacle detected by the system the sensor reflection will be equal to zero and the system will be stopped automatically. When a crack is detected by IR sensor the microcontroller will start the buzzer.

EMBEDDED SYSTEM

In the day-to-day life we come across a wide variety of consumer electronic products. We are habituated to use them easily and flawlessly to our advantage. Common examples are TV Remote Controllers, Mobile Phones, FAX machines, Xerox machines etc. However, we seldom ponder over the technology behind each of them. Each of these devices does have one or more programmable devices waiting to interact with the environment as effectively as possible. These are a class of “embedded systems” and they provide service in real time i.e. we need not have to wait too long for the action.

Embedded systems contain processing cores that are typically either microcontrollers or digital signal processors (DSP). The key characteristic, however, is being dedicated to handle a particular task. They may require very powerful processors and extensive communication, for example air traffic control systems may usefully be viewed as embedded, even though they involve mainframe computers and dedicated regional and national networks between airports and radar sites (each of the radar probably includes one or more embedded systems of its own).

Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Physically, embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.In general, "embedded system" is not a strictly definable term, as most systems have some elements with embedded systems such as the operating systems and microprocessors that power them, but they allow different applications to be loaded and peripherals to be connected. Moreover, even systems that do not expose programmability as a primary feature generally need to support software updates. On a continuum from "general purpose" to "embedded", large application systems will have subcomponents at most points even if the system as a whole is "designed to perform one or a few dedicated functions", and is thus appropriate to call "embedded".

Embedded systems are computers which are part of special-purpose devices. Due to the limited duties this systems can be highly optimized to the particular needs. Traditionally most of these systems are used for control and process measurement, as a side-effect of higher integration of integrated circuits more complex applications can be solved by embedded systems. To be able to solve these problems embedded systems are commonly equipped with various kinds of peripherals.

Nowadays embedded systems can be found in devices from digital watches to traffic-control systems. The broad range of applications with totally different requirements leads to various implementation approaches. The range of hardware used in embedded systems reaches from FPGAs to full blown desktop CPUs which are accompanied by special purpose ICs such as DSPs. On the software side, depending on the needs, everything, from logic fully implemented in hardware, to systems with own operating system and different applications running on it, can be found.

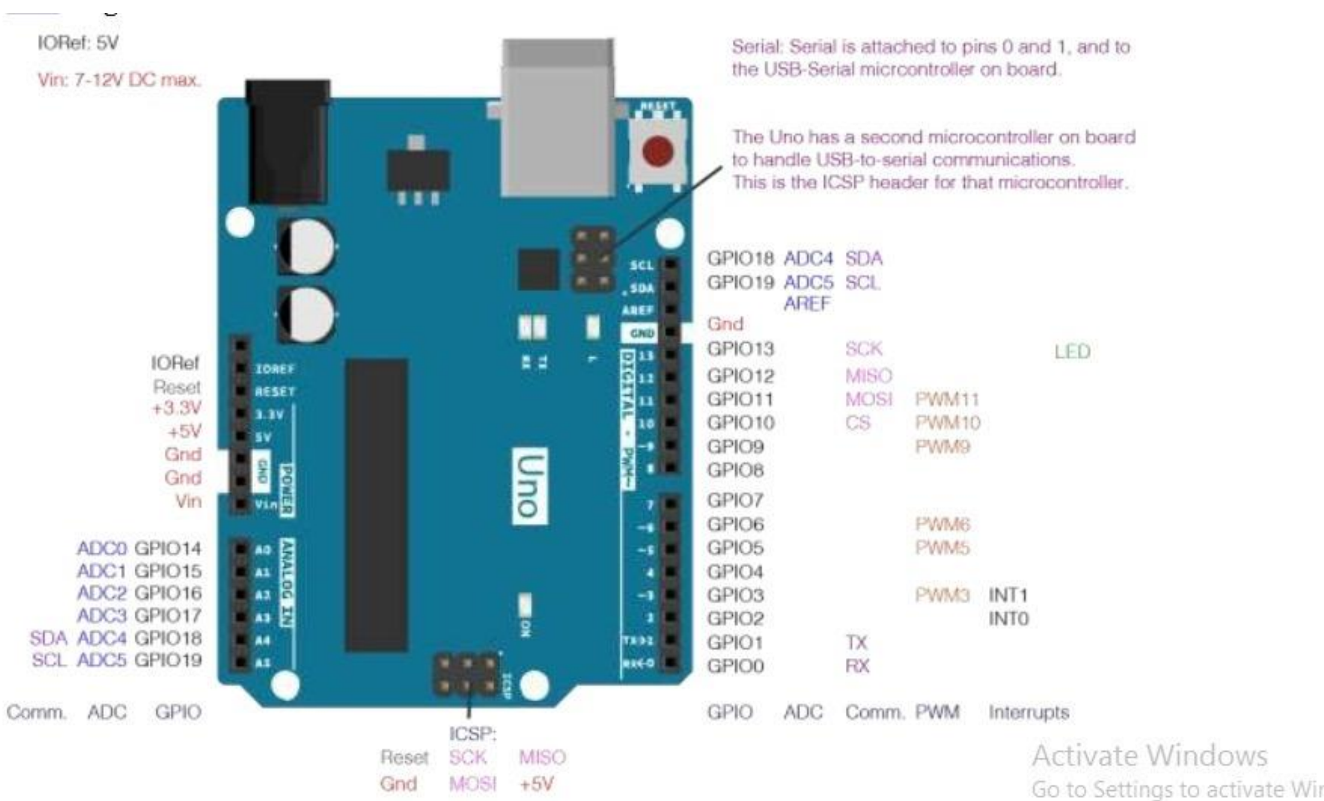
5.2HARDWARE COMPONENT DESCRIPTION:

5.2.1Microcontroller ATMEGA 328

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs,16MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with power circuit to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial convertor.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil(0.16"), not an even multiple of the 100 mil spacing of the other pins.



Features:

1.Microcontroller-ATmega328

2.Operating Voltage-5V

3.Input Voltage (recommended) -7-12V

4.Input Voltage (limits)-6-20V

5.Digital I/O Pins-14 (of which 6 provide PWM output)

6.Analog Input Pins-6

7.DC Current per I/O Pin-40 mA

8.DC Current for 3.3V Pin-50 mA

9.Flash Memory -32 KB (ATmega328) of which 0.5 KB used by bootloader

10.SRAM -2 KB (ATmega328)

11.EEPROM -1 KB (ATmega328)

12.Clock Speed -16 MHz

Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

Power Supply Circuit;

The whole electronic system is depend on the power supply for providing the required power for their operational circuit. For the microcontroller keyboard, +5V are required and for operating buzzer +12V is required. The power supply supplied the regulated output of +5V & non-regulated output of the +12V DC supply.

IR SENSOR:

An Infrared (IR) sensor is used to detect obstacles in front of the robot or to differentiate between colors depending on the configuration of the sensor. The picture shown is a very simple black box model of the IR Sensor. The sensor emits IR light and gives a signal when it detects the reflected light. An IR sensor consists of an emitter, detector and associated circuitry. The circuit required to make an IR sensor consists of two parts; the emitter circuit and the receiver circuit. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, its resistance and correspondingly, its output voltage, change in proportion to the magnitude of the IR light received. This is the underlying principle of working of the IR sensor.

TSOP OBSTACLE SENSOR:

The TSOP-OBSD–Single is a general purpose proximity sensor. Here we use it for collision detection. The module consist of a IR emitter and TSOP receiver pair. The high precision TSO receiver always detects a signal of fixed frequency. Due to this, errors due to false detection of ambient light are significantly reduced. The module consists of 555 IC, working in a stable multi-vibrator configuration. The output of TSOP is high whenever it receives a fixed frequency and low otherwise. The on-board LED indicator helps user to check status of the sensor without using any additional hardware. The power consumption of this module is low. It gives a digital output and false detection due ambient light is low.

Simple IR Sensor has a disadvantage that it gives false detection when used in presence of sunlight. We can make more complex IR sensor which is able to differentiate between IR light from its own source and sunlight or any other light from surrounding light sources. Here I am going to introduce TSOP based IR Sensor.

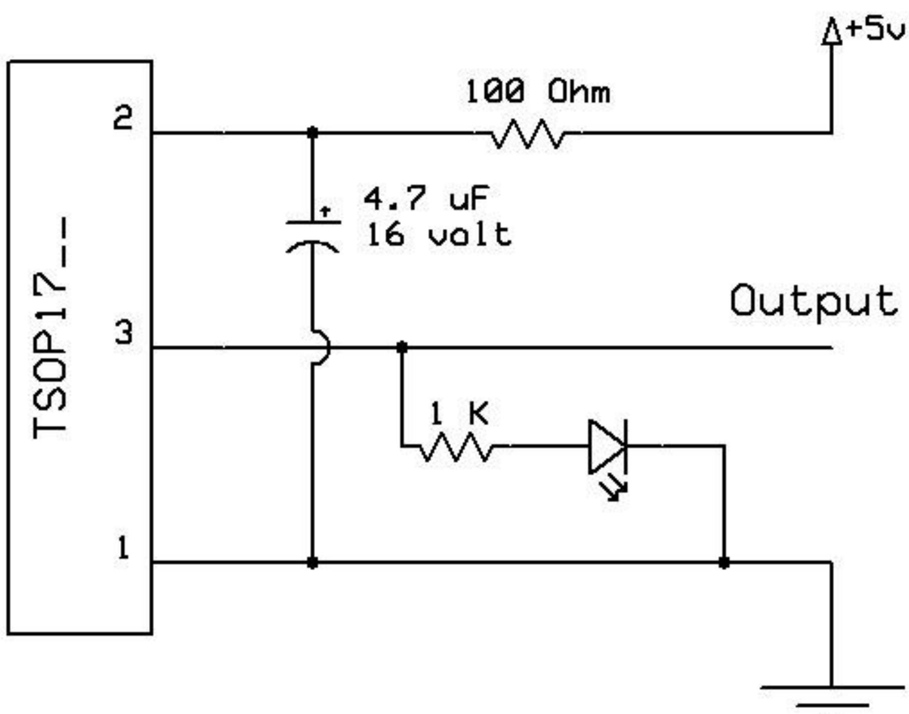
Basic Idea:-

In simple IR sensor (link) an IR LED is used to transmit a continuous beam of IR light and a Photo Diode is used to detect reflected light from any surface (surface can be of any obstacle or floor when we are using this sensor in line follower robot). In TSOP based IR Sensor a modulated IR light at selected frequency is transmitted and a receiver is made that would only detect light of the same frequency, filtering out light of other frequencies.

TSOP is a miniaturized receiver for infrared remote control systems. It consists of a PIN diode and a pre-amplifier in a single package. Output of TSOP is active low. As shown in figure ambient light is filtered out by the epoxy package and then the outputof PIN diode is amplified and pass through a band pass filter.TheoutputofTSOPcandirectlybeconnectedbyanyI/Opinofmicrocontroller.There are various TSOP available in market cantered to different frequency.

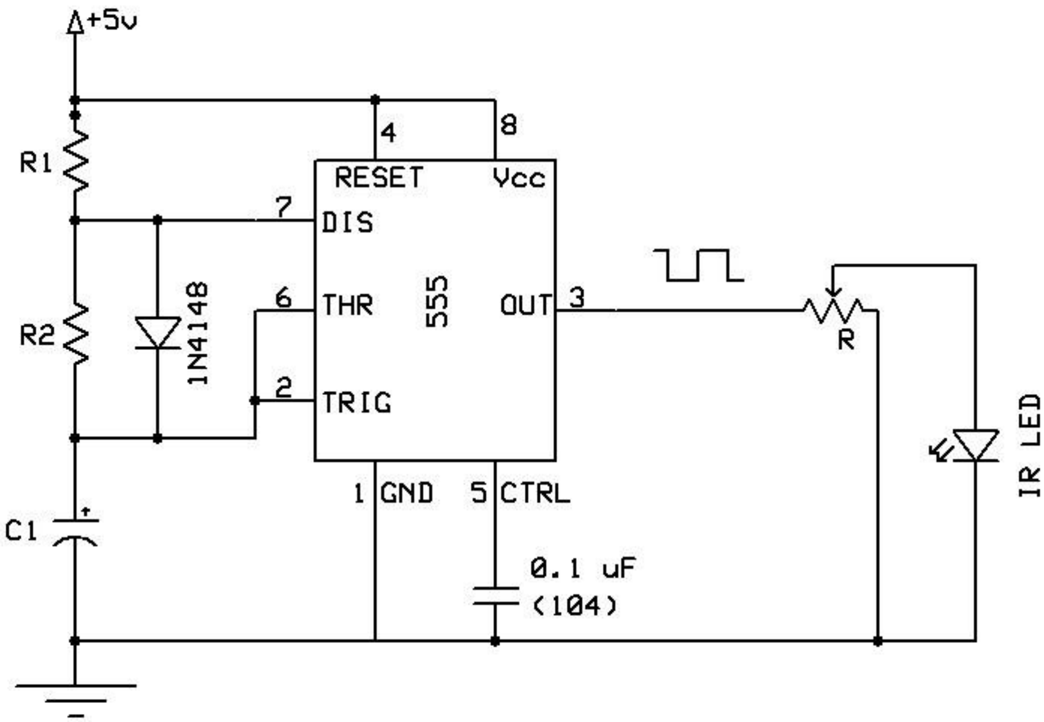
Circuit of Rx :-

In the above circuit 100 Ω resistance and 4.7µF is connected to suppress power supply disturbances. An LED is connected at the output pin of TSOP to indicate the logic level.



Circuit of Tx:-

Totransmitlightof36KHzfrequencywecangeneratethatfrequencybyusinganymicrocontroller,oscillatororby555timeric.Herewehaveusing555timerinastablemodetogenerateasquarewavesignaltodriveanIR-ledatafrequencyof36khz.



List of Components/Software/Tools used

COMPONENTS

ARDUINO UNO ATMEGA328

IR SENSOR

POWER CIRCUIT

BUZZER

WIRES

Software Used: Arduino IDE,Proteus

Programming Language- C/C++ based arduino coding

Tools – Shoulder,Glue

CHAPTER 6: RESULT AND DISCUSSION

In this paper, we have presented the IR sensor based crack detection of railway system. The obstacle can be detected easily & it does not give the false output. Arduino UNO ATMEGA328 base obstacle detection system automatically detects obstacle without any human interface. This method having many advantages on traditional detection techniques. Themain advantages of this system like less cost, low power consumption, on time data operation and minimum analysis time. The simple idea can be implemented in large scale in order to have long run to facilitate better safety and provide effective testing infrastructure for achieving better results in the future.

Application

It used in railway departments to reduce the accidents.

This can be used in car avoidance.

CHAPTER 7: CONCLUSION & FUTURE SCOPE

Conclusion

In this paper we have designed a cost effective, low-power embedded system, which facilitate better safety standards for rail tracks for preventing railway accidents due to cracks and obstacles on railway tracks. The Prototype of testing vehicle can efficiently detect cracks and obstacles on railway tracks. The result shows that this new innovative technology will increase the reliability of safety systems in railway transport. By implementing these features in real time application, we can avoid accidents up to approximately 70%.

Future Scope

Although work can be done in order to provide a better speed to the automated vehicle robot. Also enhancement can be done to get better accuracy about the location of the place where the fault had occurred. Also the robot can be made large so that by using its weight track shiftiness i.e. stress and strain parameters of the track can be determined so as to make this system more effective. A zigbee module can also be incorporated for low cost short distance scrutinizing mechanism in order to provide good connectivity at a low input cost.

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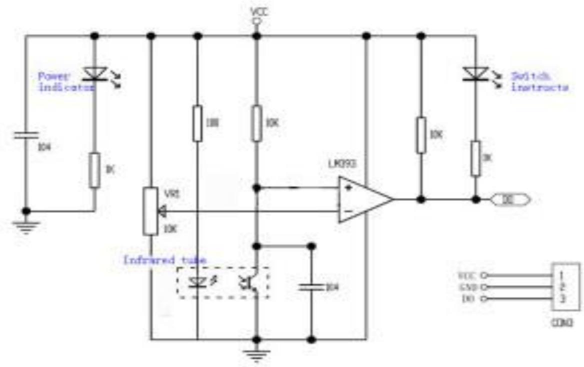
Appendix I

Pinout and schematic



This is the schematic of the IR sensor FC-51.

The package has three connection pins:

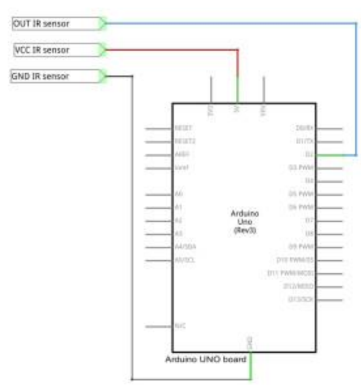
1. **Vcc** to the power supply 3-5V DC;
2. **Gnd** to the ground reference;
3. **Out** for the digital output signal of the sensor.

This sensor detects objects at a distance in range between 2~30cm. With the potentiometer you can calibrate the sensitivity according to the application and environmental conditions (e.g. brightness). The IC **LM393** is an open-collector voltage comparator which provides an output if there is a pull-up R between the output of the IC (DO) and the power supply Vcc (R=10KΩ). The output DO is:

- high if the object is not detected;
- low if the object is detected.

Proposed Demos explained :-

Test IR sensor FC-51 with serial terminal (Demo 01)



Demo 1 schematic.

In the first demo, through the connection between the Arduino serial port and the PC, we will read about the detection of the object.

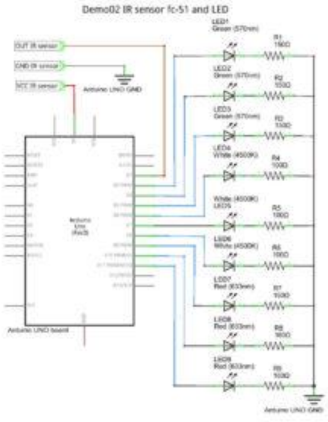
Lets take a look to steps required by this demo:

1. We connect the OUT pin of the sensor to digital pin 2 of Arduino called **IR**.
2. The **setup()** function is performed only once before the main loop. We insert here the initialization code which enables serial port Arduino and sets the digital pin 2 as input.
3. **loop()** is the main function and is cyclically repeated until you turn off the Arduino board. We convert in C language the operation of the electronic circuit analyzed before. We save in the variable **detection** the value taken from the pin IR with the specific function **digitalRead**, if the value is low there is an object otherwise there isn't.

Lets take a look to our code:

```
#define IR 2

int detection = HIGH;    // no obstacle

void setup() {

  Serial.begin(9600);

  pinMode(IR, INPUT);

}

void loop() {

  detection = digitalRead(IR);

  if(detection == LOW){

    Serial.print("There is an obstacle!\n");

  }

  else{

    Serial.print("No obstacle!\n");

  }

  delay(500);    // in ms

}
```

IR sensor FC-51 and LED (Demo 02)



Demo 2 schematic

In this demo we associate an input to each operation state of IR sensor. The required components are:

- **IR sensor FC-51**;
- **3 x Green LEDs**;
- **3 x R=150Ω**;
- **3 x White LEDs**;
- **3 x R=100Ω**;
- **3 x Red LEDs**;
- **3 x R=160Ω**.

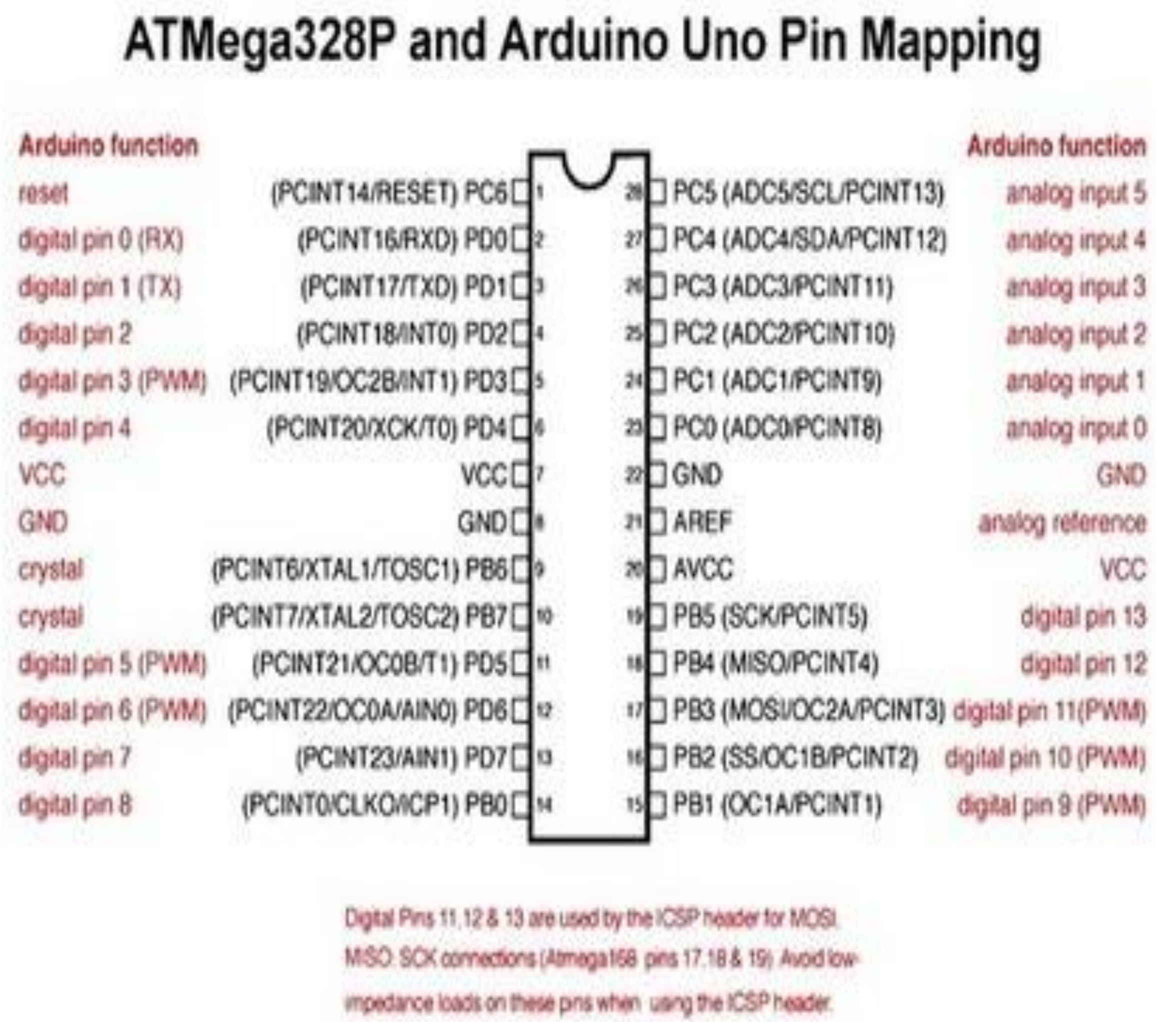
Remember that the I/O pins can absorb/disburse up to 40mA max, total maximum 200mA (see **ATmega328P** datasheet at page 313).

Lets take a look to steps required by this demo:

1. We connect the OUT pin of the sensor to digital pin 2 of the Arduino. We define the digital pins of LEDs as an array of pins, from 3 to 11 called **LedPIN**.
2. The **setup()** function is executed only once before the main loop. In addition to the initialization already seen, we call the 9 LED as output using a for loop.
3. The **loop()** function is the main function and is cyclically repeated until you turn off the Arduino board. We save in the variable **detection** the value taken from pin **IR** with the specific function **digitalRead()**. This value can be low, if there is an object, or high if there is no object. We do this loop every millisecond. Lets take a look to our code:

```
#define IR 2    // digital pin input for ir sensor

int detection = HIGH;    // no obstacle

inti = 0;

// array digital pin for: green led(3,4,5) - white led (6,7,8)- red led (9,10,11)

intLedPIN[] = {3, 4, 5, 6, 7, 8, 9, 10, 11};


void setup() {

  pinMode(IR, INPUT);

  for(i = 0; i&lt; 9; i++){

    pinMode(LedPIN[i], OUTPUT);

  }

}

void loop() {

  detection = digitalRead(IR);

  if(detection == LOW){

    BlinkLED();

  }

  else{

    LedOFF();
```

Appendix II


ATMega328P and Arduino Uno Pin Mapping
Arduino function
reset
digital pin 0 (RX)
digital pin 1 (TX)
digital pin 2
digital pin 3 (PWM)
digital pin 4
VCC
GND
crystal
crystal
digital pin 5 (PWM)
digital pin 6 (PWM)
digital pin 7
digital pin 8
(PCINT14/RESET) PC6
(PCINT16/RXD) PD0
(PCINT17/TXD) PD1
(PCINT18/INT0) PD2
(PCINT19/OC2B/INT1) PD3
(PCINT20/XCK/T0) PD4
VCC
GND
(PCINT6/XTAL1/TOSC1) PB6
(PCINT7/XTAL2/TOSC2) PB7
(PCINT21/OC0B/T1) PD5
(PCINT22/OC0A/AIN0) PD6
(PCINT23/AIN1) PD7
(PCINT0/CLKO/ICP1) PB0
PC5 (ADC5/SCL/PCINT13)
PC4 (ADC4/SDA/PCINT12)
PC3 (ADC3/PCINT11)
PC2 (ADC2/PCINT10)
PC1 (ADC1/PCINT9)
PC0 (ADC0/PCINT8)
GND
AREF
AVCC
PB5 (SCK/PCINT5)
PB4 (MISO/PCINT4)
PB3 (MOSI/OC2A/PCINT3)
PB2 (SS/OC1B/PCINT2)
PB1 (OC1A/PCINT1)
Arduino function
analog input 5
analog input 4
analog input 3
analog input 2
analog input 1
analog input 0
GND
analog reference
VCC
digital pin 13
digital pin 12
digital pin 11(PWM)
digital pin 10 (PWM)
digital pin 9 (PWM)
Digital Pins 11,12 & 13 are used by the ICSP header for MOSI,
MISO, SCK connections (Atmega168 pins 17,18 & 19). Avoid low-
impedance loads on these pins when using the ICSP header.