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Design of all Color Line Follower Sensor with Auto Calibration Ability

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ABSTRACT

The proposed system focusses on designing a Line Follower Sensor for various robotic based applications. Unlike the traditional line follower sensor which uses IR pair as transmitter and photodiodes as receiver and works well only for white line over black surface or vice versa, this paper discusses the designing of sensor array using RGB LED as transmitter and Phototransistor as receiver. This sensor can be used for any colored surface and line as it can switch automatically between Red, Green and Blue color LED depending on surface and line colors making it an all color line follower. Thus, it can be used in places where the robot has to follow a line drawn over changing colored background. The sensor along with the controller is used to form an algorithm that can detect the change in surface color and make a decision to switch to a specific colored LED depending on the color on which it has to navigate. Furthermore, the system is designed for self-adjustment of the threshold value used for the motor control of the robot eliminating the need for manual threshold calculation. The ATMEGA328 controller is used for processing the analog sensor signals and for controlling the motor movement via H-Bridge motor driver. The main purpose of this project is to design a cost effective and robust sensor that it is capable of sensing the change in its background color as well as line color and switching to a LED color that would differentiate between the surface and the line, self - threshold value adjustment to send motor control signals which in turn would provide proper path to the robot and follow the line and control the locomotion of the robot.

Keywords : LED, colors making, ATMEGA328 controller, H-Bridge motor driver.

I. INTRODUCTION

A line follower algorithm plays a vital role in turning an robotic system into an autonomous robot with self-driving capacity. Navigation of the robotic system can be easily designed using a line follower . Depending on the current position of the robot on the line and the surface, the next movement of the

motor is decided. This decision making is done by the controller which takes inputs from the sensor and after processing the data, sends the signals to the motor to follow the desired path. There are various ways in which sensors can be designed. The main function of the sensor is to detect the line over the surface and generate the control signals to drive the motor to follow the path. This can be done by transmitting a light source onto the surface using LED When this light falls on the colored surface below it, certain amount of light will get absorbed depending on the color of the surface as well as the transmitted light. Rest of the light gets reflected back. This reflected light is captured by the receiver element which is a photo detecting device. So,the sensor array consists of transmitter and receiver pairs.

IR LED's used as transmitter and photodiodes as receiver. In this project we used a 5 RGB LED and Photo Transistor pairs to detect the line over the surface irrespective of the color of the line as well as the surface. Use of photo transistor will help in reduction of ambient light interference thus providing accurate sensor readings the use of RGB LED to emit either red, green or blue light at a time depending on the color of the surface and the line. The color of the LED would switch automatically according to the change in either the line color or the surface color. It ends up selecting the LED which would give maximum difference values between the line and the surface. This will help the robot to differentiate between the line and the surface easily. Also, it calculates the threshold value of all the receiver elements. This threshold value is used to generate the motor control signals which will drive the robot over the line.The line follower sensor is made up of transmitter and receiver components.

The transmitter used in the proposed system is 5mm LED – RGB Water Clear Common Cathode It is capable of transmitting three different colors -red, green and blue. Each RGB LED has transmitting wavelength in between 460nm to 625nm. Every time the LED emits a specific color on the colored surface, a particular wavelength is transmitted onto the surface. This light will reflect back from the colored surface. Different colors reflect different amount of light depending on their reflection properties This reflected light is captured by the receiver component. Phototransistor involved in this project is L14F1]. It receives the light energy which is reflected back from the colored surface. A photo current value proportional to the wavelength of the reflected light as absorbed by the photo transistor is generated at the output of the transistor. The voltage levels at the output of the photo transistor does not vary with the ambient light. This provides accurate sensor readings to the controller. As its rise and fall time is also very less, it can sense the change in the light energy very quick with minimum delay i.e. it can change output states in micro seconds. Maximum current generated by L14F1 under dark conditions or color is 1000nA and it can generate 500uA in maximum light condition.

II. LITERATURE SURVEY

Title: "Light-emitting diodes."
Author: Bergh, Arpad A., and Paul Jeremy Dean
Light-emitting diodes (LEDs) are devices designed to efficiently convert electrical energy into electromagnetic radiation, most of which is visible to the human eye. Some of the disciplines involved in the understanding and utilization of LEDs are reviewed, with emphasis on the III-V semiconducting compounds and GaP LEDs in particular. Salient features of photometry, the physics of electrical injection and luminescence, and the design of LEDs are discussed in detail, followed by a survey of prominent applications for the various LEDs.
"**Title :** Implementation of autonomous line follower robot."

Author: Hasan, Kazi Mahmud, and Abdullah Al Mamun.

The line follower is an autonomous robot that detects and follows a line. The path may be visible like a black line on a white surface or may be reverse of that or it can be invisible like a magnetic field. A close loop control system is used in the robot. The robot must sense a line and maneuvers accordingly to stay on course while correcting the wrong moves using feedback mechanism thus forming a simple but yet effective closed loop System [1]. The robot is designed to follow very tight curves as the data from the sensors are continuous in nature. This robot is simple but effective having straightforward design to perform line following task.

Title: "Design and implementation of advanced auto calibrating line following sensor for coloured surfaces with a white line."

Author: Patil, Samruddhi, Ameya Wagh, Mitali Sawant, Saurav Panda, and Aditya Bhopale

Light emitting diodes, phototransistor and an onboard microcontroller Arduino Mega 2560 which communicates with any navigation control system using serial communication. Moving average filters are implemented per channel to remove the fluctuations in the readings due to vibration of the sensor during locomotion. It then gives the error feedback or the offset of the white line from the centre, to the system that is corrected using Proportional-Integral-Derivative algorithm. It also takes care of non scaled readings of the line sensors due to ambient light by having separate threshold values for individual sensors making each sensor independent. The main aim of this paper is to highlight the use and need of a line following sensor capable of differentiating any background colours with white line and at different light conditions. Performance metrics were measured and compared to show trade off between cost and performance.

III. PROBLEM IDENTIFICATION

- There is a problem in industries to carry the tools from one place to another place.
- There is a problem in domestic working like floor cleaning etc.
- There is problem of guidance to provide path in shopping malls, museums etc.
- There is a problem in hotels to supply the food from one place to another place.
- The number of patients died because of few numbers of trained medical staff .Shortage of nurses is 'killing thousands a year': Patients in overstretched hospitals developing fatal complications which could have been cured .A lot of hospitals have stopped recruiting nurses and medical personnel since 2005 and 2006. From the past two years there is an increasing trend of recruiting more doctors than the nurses. If sufficient number of nurses based on the patient numbers visiting a hospital can be recruited then the number of deaths can be estimated decreases by 10 % .

IV. OBJECTIVES

- The main objective of this robot is carrying the tools.
- This robot plays a very important role in industrial automation, military applications and consumer applications.
- These robots works without any supervision i.e they work like automatic guided vehicles.
- It has features like obstacle avoidance.
- It should be capable of taking various degrees of turns.
- The robot must be reliable.
- Scalability is the primary concern in the design.
- The colour of the line must not be a factor as it is darker than the surroundings.

V. METHODOLOGY

1. DESCRIPTION OF BLOCK DAIGRAM

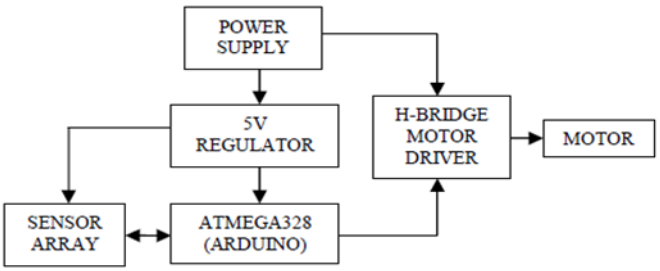


Figure 1

i. Power Supply and regulator module

- Operating voltage: 4.5V to 5.0 V
- Supply current: 150 Ma
- Output format: 8 Analog and Digital voltages.
- Optimal sensing distance: 3 mm.
- Maximum recommended sensing distance: 6 mm
- Potentiometer to adjust the sensitivity of the individual sensors.
- Uses 5 sensors for best resolution
- Comes with easy to use digital outputs that can be connected directly to microcontrollers
- The system is powered using a 12V battery. This 12V is applied to the H- Bridge driver circuit to supply the required voltage and current to the motor. Also, this 12V is stepped down to 5V using a voltage regulator IC. 5V is further given to the sensor board as well as the ATMEGA328 micro-controller.

ii. Color Sensor

1) Intensity to Frequency.
2) Programmable Color and Full-scale Output
3) Communicates Directly with a Microcontroller.
4) Single-supply Operation(2.7V to 5.5V).
5) Power down Feature.
6) Nonlinearity Error Typically 0.2% at 50kHz.
7) Stable 200/ C temperature coefficient.
8) Low-profile Lead(pb) Free and RoHS.
9) Complaint Surface-mount Package.
10) High-Resolution Conversion of Light

Figure 2

Line follower sensor is made up of transmitter and receiver components.(Ref fig 5.2).The transmitter used in the proposed system is 5mm LED RGB Water Clear Common Cathode . It is capable of transmitting three different colors -red, green and blue. Each RGB LED has transmitting wavelength in between 460nm to 625nm. Every time the LED emits a specific color on the colored surface, a particular wavelength is transmitted onto the surface. This light will reflect back from the colored surface. Different colors reflect different amount of light depending on their reflection properties . This reflected light is captured by the receiver component. Here, Phototransistor L14F1 is used . It receives the light energy which is reflected back from the colored surface. A photo current value proportional to the wavelength of the reflected light as absorbed by the photo transistor is generated at the output of the transistor. It has a very narrow viewing angle of 8 degree that gives us a very narrow reception range. The advantage of Photo transistor over normal photo diodes or LDRs is that it can avoid the ambient light interference to a very great extent. The voltage levels at the output of the photo transistor does not vary with the ambient light.

This provides accurate sensor readings to the controller. As its rise and fall time is also very less, it can sense the change in the light energy very quick with minimum delay i.e. it can change output states in micro seconds. Maximum current generated by L14F1 under dark conditions or color is 1000nA and it can generate 500uA in maximum light condition. Refer Figure 2 for the Spectral Response of the Photo transistor .

iii. Microcontroller(Arduino Uno)

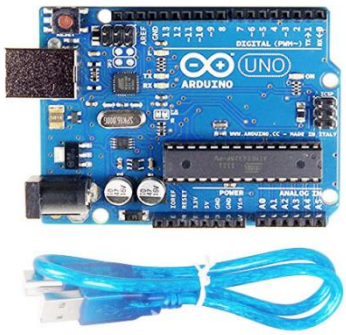


Figure 3

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 Ma
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

The Arduino Uno is a microcontroller board based on the ATmega328. Arduino is an open-source, prototyping platform and its simplicity makes it ideal for hobbyists to use as well as professionals. The Arduino Uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

ATMEGA328 is a 8-bit RISC microcontroller that works like the brain of the Robot . It has 6 channels of 10-bit resolution (Ref fig 5.3).ADC channels which can map 0-5 V analog input value to respective 10-bit digital value (0 to 1024 in decimal). It has 32kb of flash memory to store a flash program. Programming of the microcontroller is done by using Arduino IDE.

VI. Pin Discription of Microcontroller

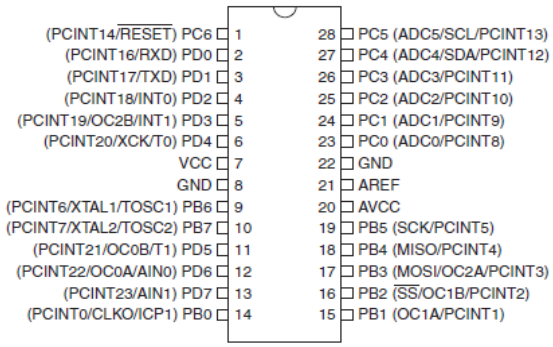


Figure 4

- **VCC** is a digital voltage supply.
- **AVCC** is a supply voltage pin for analog to digital converter.
- **GND** denotes Ground and it has a 0V.
- **Port B** consists of the pins from **PB0** to **PB7.** Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes

active, even if the clock is not running. Depending on the clock selection fuse settings, PB6 can be used as input to the inverting oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting oscillator amplifier. If the internal calibrated RC oscillator is used as chip clock source, PB7..6 is used as TOSC2..1 input for the asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

- **Port C** consists of the pins from **PC0** to **PC7.** Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5..0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The port C pins are tri-stated when a reset condition becomes active, even if the clock is not running
- **PC6/RESET:** If the RSTDISBL fuse is programmed, PC6 is used as an input pin. If the RSTDISBL fuse is unprogrammed, PC6 is used as a reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running
- **Port D** is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port D pins that are externally pulled low will source current if the pull-up resistors are activated. The port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.
- **AVCC** is the supply voltage pin for the A/D converter, PC3:0, and ADC7:6. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that PC6..4 use digital supply voltage, VCC.
- **AREF** is the analog reference pin for the A/D converter.

Memory Description

1. **Flash Memory** has 32KB capacity. It has an address of 15 bits. It is a Programmable Read Only Memory (ROM). It is non volatile memory.
2. **SRAM** stands for Static Random Access Memory. It is a volatile memory i.e. data will be removed after removing the power supply.
3. **EEPROM** stands for Electrically Erasable Programmable Read Only Memory. It has a long term data.

The Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2- wire serial interface, SPI serial port,6-channel 10-bit A/D converter (8-channelsin TQFP and QFN/MLF packages),programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz.

VII.Voltage Regulator

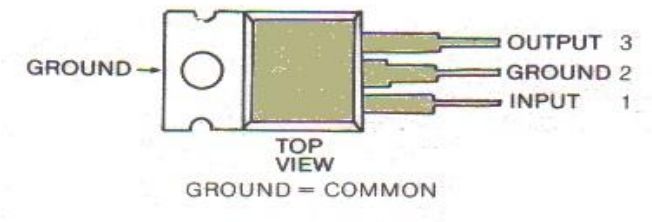


Figure 5

Features:

- **5V** Positive **Voltage Regulator**.
- Minimum Input **Voltage** is 7V.
- Maximum Input **Voltage** is 25V.
- Operating current(I_Q) is 5mA.
- Internal Thermal Overload and Short circuit current limiting protection is available.
- Junction Temperature maximum 125 degree Celsius.
- Available in TO-220 and KTE package.

The brightness of the LED changes linearly with voltage change that's why to provide constant light regulated voltage source is preferable. In this case +5V voltage regulator is used.

Constant voltage level. It converts a positive voltage (7-29V) to +5 volts. Heat sink p rovided in the center to release heat generated due to drop across the IC. Input volt age of about 5 to 18 V is given Ground is 0 V and regulated output of +5V. It may use an electromechanical mechanism, or passive or active electronic components.Depending on the design, it may be used to regulate one or more AC or DC voltage is. There are two types of regulator:

- Positive Voltage Series (78xx)
- Negative Voltage Series (79xx)

78xx: 78' indicate the positive series and "xx indicates the voltage rating Suppos e 7805 produce the maximum 5V. "05" indicates the regulator output s 5V.

79xx: 78' indicate the negative series and "xx' indicates the voltage rating Suppos e 7905 produces the mximum 5V. 05' indicates the regulator output is -5V.

Motor Driver

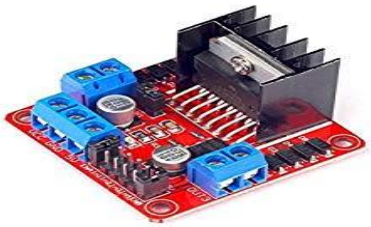


Figure 6

Features

- High operating voltage, which can be up to 40 volts.
- Large output current, the instantaneous peak current can be up to 3A.
- With 25W rated power.
- Two built in H-bridge, high voltage, large current, full bridge driver, which can be used to drive DC motors, stepper motors, relay coils and other inductive loads..
- Using standard logic level signal to control.
- Able to drive a two-phase stepper motor or four-phase stepper motor, and two-phase DC motors.
- Adopt a high-capacity filter capacitor and a freewheeling diode that protects devices in the circuit from being damaged by the reverse current of an inductive load, enhancing reliability
- The module can utilize the built-in stabilivolt tube 78M05 to obtain 5v from the power supply. But to protect the chip of the 78M05 from damage, when the drive voltage is greater than 12v, an external 5v logic supply should be used.
- Drive voltage: 5-35V; logic voltage: 5V
- PCB size: 4.2 x 4.2 cm

We must use a driver IC for controlling the motors. The microcontroller sends a signal to the driver that acts as a switch. If the signal received by the driver is high, it will rotate the motor or else it won't do so. Note that the microcontroller only sends a signal to a switch which gives the voltage required by the motor to rotate.one of good driver for motor control, we chose L298 as it has current capacity 2A per channel 45V compared to 0.6A 36V of a L293D. L293D's package is not suitable for attaching a good heat sink; practically you can't use it above 16V without cooling it. On the other hand, L298 works happily at 16V without a heat sink, although it is always better to use one.

L298N consists of four independent power amplifiers. Two of them form H-bridge A while other two form H-bridge B(ref fig 5.4). **One H bridge** is used to switch the polarity in controlling direction of DC motor. **Pair of H Bridge** is used to control a bi-polar stepper motor.

- Amp A1 and A2 => H Bridge A
- Amp B1 and B2 => H Bridge B

Basically L298N is used to drive inductive or magnetic loads, so there can come voltage spikes in output. To avoid that voltage spikes there should be some internal parasitic or Flywheel diodes. But it lacks them. We use externally these flywheel diodes. They can be 1N5819 schottky diodes or 1N4001 rectifier diodes.

Each bridge is provided with enable pins (ENA, ENB) and current sense pins (CSA, CSB). Current sense pins can be tied to ground but we can also insert low value resistor and its voltage reading is proportional to current. Both enable pins can be used at the same time which makes all for outputs active at the same time.All the four inputs and Enable pins work on 5v TTL logic which makes the connection easy with microcontrollers.

- ENA=5v, High logic (Amplifier A1 and A2 on)
- ENA=0v, Low logic (Amplifier A1 and A2 off)
- ENB=5v, High logic (Amplifier B1 and B2 on)
- ENB=0v, Low logic (Amplifier B1 and B2 off)

The H-Bridge driver circuit has the advantage of high noise immunity protection as well as has output clamp diodes for inductive transient suppression(Ref fig 5.6)

DC Motor

Figure 7

Features

- RPM: 60 at 12V
- Voltage: 4V to 12V
- Stall torque: 15Kg-cm at stall current of 4.0A@12V
- Shaft diameter: 8mm
- Shaft length: 17.5mm
- Gear assembly: Spur
- Brush type: Carbon
- Motor weight: 290gms
- Dimension: Refer to diagram above

The movement system is an important part of a robot. And its objective is how to move robot from one point to another one. This system has some details shown us how we should use motors and wheels. We use motors to convert electrical energy to the mechanical energy. There are a lot of kinds of motors and we must choice the best one that we

need. Our choice is depended on the robot function, power and precision. Undoubtedly, one of the agents of success of our robot is to choose good motors. Motor gearbox is one of the best motors for line follower robots. Because it has some gears and axle and its speed doesn't change in towards the top of a hill or in downhill.

60RPM Centre Shaft Economy Series DC Motor is high quality low cost DC geared motor. It has steel gears and pinions to ensure longer life and better wear and tear properties(ref fig.5.5). The gears are fixed on hardened steel spindles polished to a mirror finish. The output shaft rotates in a plastic bushing. The whole assembly is covered with a plastic ring. Gearbox is sealed and lubricated with lithium grease and require no maintenance. The motor is screwed to the gear box from inside. Although motor gives 60 RPM at 12V but motor runs smoothly from 4V to 12V and gives wide range of RPM, and torque. No load current as a function of voltage and stall torque, stall current as a function of voltage.

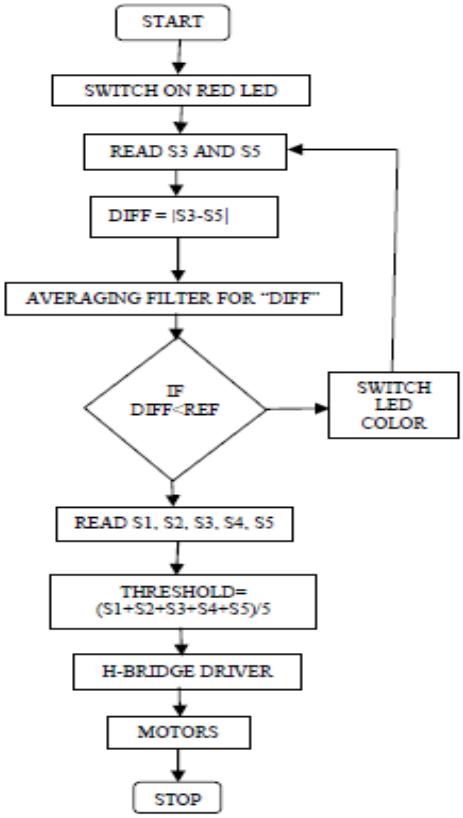
VIII. Ultrasonic Sensor

Figure 8

Features

- Operating Voltage: 5V DC
- Operating Current: 15mA
- Measure Angle: 15°
- Ranging Distance: 2cm - 400cm
- Working Frequency : 40Hz
- Trigger Input Signal : 10uS TTL pulse
- Echo Output Signal : Input TTL lever signal and the range in proportion

WORKING



As the supply is turned on, the sensor board receives regulated 5V. At first, the LED color is adjusted to red. This can be done setting pin 1 of the RGB LED to Vcc . The sensor is an array made up of 5 RGB LEDs and 5 Photo transistors (paired as S1-S5). The readings of S3 and S5 are collected from the Phototransistor output which is in the form of photo current value. This value is sensed by the ADC channel of the microcontroller.

The ATMEGA328 has 10-bit ADC and hence maps the current into a 10-bit digital output value. The difference between these values is taken. The difference here is considered to be an unsigned value. At this stage, an Averaging Filter is implemented . The averaging factor in the proposed system is

assigned to 5. The controller will take 5 sample readings of the difference values of S3 and S5 and store it in a buffer. Averaging filter technique is applied and one averaged value of difference is obtained. For any line follower robot to follow the line effectively, the difference between the surface and the line should be a significant value so as to allow the robot to easily distinguish between the color of its surface and line. Here, a reference value (REF=25) is set to check if the difference between the sensor values (S3 and S5) present on the surface and the line is large enough for differentiation. If the difference is greater than the reference, it indicates that the color chosen is right and will successfully detect the line over the surface. If this difference falls below the reference, it indicates that the LED color must be switched to another color. After setting the color, the threshold value is defined by calculating the mean of all the 5 sensor readings. This threshold value is further used by the controller to detect the current state of the sensor and with respect to these states it will generate the control signal to keep the robot moving on the line.

LINE WIDTH AND COLOUR

The line width and color is an important factor for an efficient line following robot. If the line width is less than minimum line width required or if the line color is not properly tuned then the robot will not be able to track and follow the line. The line width must be at least equal to the separation between the sensors. Once any particular color is tuned, the position of the sensors (height from line) must not be changed.

TURNING ANGLE

Turning angle of the robot depends mainly on the speed and motor breaking. Larger turning angle and efficient motor breaking mechanism are required for greater speed. The robot presented here has moderate speed of about 0.2ms-l. The minimum turning angle is 110°. Any angle less than 110° will lead the robot missing the line.

ADVANTAGES DISADVANTAGES AND APPLICATIONS

Advantages

- Robot movement is automatic.
- Fit and forget system
- Used for long distance applications
- Defence applications
- Cost effective
- Simplicity of building

Disadvantages

- Line follower robot follows a different line about 1 or 2 inches in a width on a white surface
- Line tracing robots are simple robots with additional sensors placed on them.
- Slow speed and instability in different line thickness or hard angles.

Applications of line Follower Robot

- Line follower Robots are commonly used for automation process in industries, military applications and consumer applications.
- They are very useful as they can work without any supervision i.e. they work as automatic guided vehicles.
- With additional features like obstacle avoidance and other security measures, line follower robots can be used in driver less cars

IX. FUTURE SCOPE

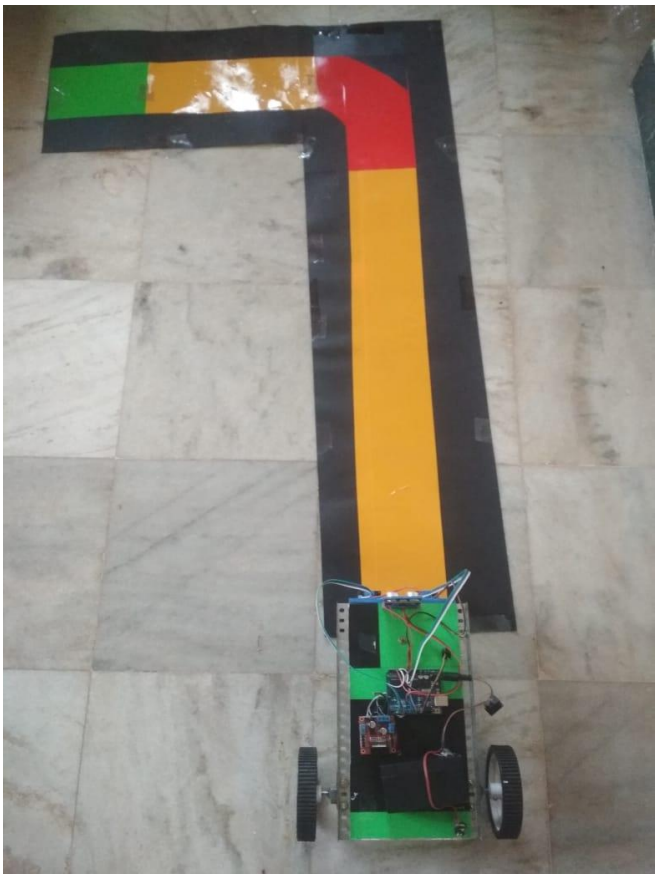
Line following robot based materials supply system can play a vital role in the field of hospitality. Line following robot's application over electronics engineering can't be underestimated. In India many people show reluctance to get admitted in a hospital

because of cost issues. The cost for cure can be reduced by using the robots in government and private hospitals. It can be very beneficial for the patients as well. Also, monitoring of every patient is very difficult for the nurses, given the fact that there are very few of them. So a camera can be placed in the line following robot, from which the status for every patients can be handle from a single room. In the bed of the patient an accelerometer can be placed from which if a patient have a heart attack then that device can operate an alarm circuit. A GSM module can be placed with the line following robot so that if any untoward incident occurs then that system can make a call to the doctor, it also helps the doctors for remote diagnosis of patients even when he is away from hospital by remote presence. The line follower robots can also be improvised by using RFID tags so that accuracy of the system increases. Robotics is very big field for the new innovation and research. By using the robot in real time applications, a health care system can be manage in an effectively way.

Line following robot with obstacle detection system can play a vital role in various field such as hospital and logistics industries etc. Robotics is fast grooming technology. By using robot in the industries the cost and work can be reduced, making it an efficient industry. In India there is a high demand of various material or services which can be efficiently met by the use of robots. Live monitoring of environment is difficult so a camera can be placed. An accelerometer can placed on the line following robot to check and control the speed of robot. A WI-FI module can be integrated with it so we can also monitor it through our computers.

X. RESULT

Robot follows all color line. It doesn't follow black color. If it detects black color robot will stop. Color sensors will detect all color. The transmitting LED can switch between the three colors depending on surface and line color. The threshold is automatically set which gives the robot an autonomous locomotion without any human interface. Robot has a ultrasonic sensor to detect the object.



XI. CONCLUSION

Robotic system designed in this project has been able to recognize input from the transmitter and prove theory of theory of reflection of color light as theoretical basis of color color sensor system. we have introduced switches so that it can be easily operated. The robot is able to detect red, blue and green color. Light calibration was challenging task. The system have optimum result of color line detection and successfully move towards the lane with 0.082 m/s movement speed.

The idea of the robot which has been presented in this project employs instructions from sensors and on board logic circuits to achieve its physical movement. One of its significant attribute is controlling efficiently with very much accuracy. It does not use complex algorithms for line following applications. Controlling process has been made automatic by straightforward controlling mechanism. Simple basic electronics is used instead of costly microcontrollers which made it very much cost effective. Further modification of this robot includes additional sensors like sonar and infrared so that the robot will be able to follow a line having the ability to avoid obstacle.

XII. REFERENCES

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