



INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Case Study: Line Follower Robot Analysis

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Abstract:

The selection which is to be done for any mobile device depends on some high pricing to low pricing tools. The functionality of these techniques would concentrate on the requirement for route planning. The more common the criteria for direction, the more expensive the required tools are. This paper provides an alternate solution to choose the appropriate configuration for better quality for navigation. Moreover, the LFR should have another ability of avoiding collision Without the application of complex sensor like camera and processors.

In this paper introduces a Smart Device having the ability to choose a selected line colored lines. The Mechatronic Device can differentiate among different colors and choose a selected one to find its aim using Bluetooth devices. From the android mobile, commands are given to the LFR that senses a line and endeavours itself accordingly towards the selected target by correcting the wrong moves using a simple feedback mechanism but yet very effective closed loop system.

Keywords: Android Smartphone and Bluetooth module, IR Sensor, Photo Transistor, Gear Motor, Arduino Microcontroller, Motor Driver

1. INTRODUCTION

In this we are selecting an approach in which we select an Robot which is specifically designed to take our instructions and follow the guidelines. Though, many researchers are studying and comparing regarding line follower Mechatronic Devices but most of the ideas are concentrated on theoretical design. A mobile LFR controlling algorithm is developed having the ability of avoiding barriers. Another algorithm for multiple controlling mobile LFRs is where prescribed in where performance is shown also through simulation results. Most researchers preferred to show their designed LFR performance through simulation.

As a consequence a line follower LFR is consisting using Bluetooth for autonomous driving and to stay on the line. This design procedure is capable of tracking destination and avoids collision through *obstacle* sensors. Mostly, in all industrial areas, where the automation is very much desired and needed, Line follower LFR(LFR) are mobile LFR having the ability to follow a line very accurately which has an on Arduino board. Usage of line follower Mechatronic robotic Device is also increasing day by day.

To meet the requirement of autonomous line based transportation, a new kind of line follower LFR has to be designed.

2. MOTIVATION

In order to reduce the human work, it is necessary of automation of color line following LFR, this LFR can be used in library to carry books from one place to another place, and it can be used for home automation, like in restaurant it is used as LFRic waiter. A restaurant in downtown Harbin, China, employs 20 LFRs instead of humans that cook, serve and entertain its guests. The restaurant was opened in June 2012, in this restaurant, line following LFR is been used as a LFR waiter running along tracks on the floor which carries the dishes to the desired table and it also serves dinner to the family. They are well trained, efficient and fast and they won't expect a tip for their efforts. This is 21st century customer service; they can work continuously for five hours after a two- hour charge. But the worker will not work for free or a cheap labour - each LFR costs between 200,000 to 300,000 hinese Yuan (US\$31,500 – US\$47,000) with an additional 5 million Yuan (US\$790,000) invested into the restaurant itself. China is expected to be the world's largest market for LFRs by 2014 [Source: arkazlive via YouTube].As the technology improves and the cost to build and run the LFR drops. So large country like India, it is necessary to use of line following LFR in restaurant, libraries, etc., but it is necessary to equip restaurant, library with colored line tracks.

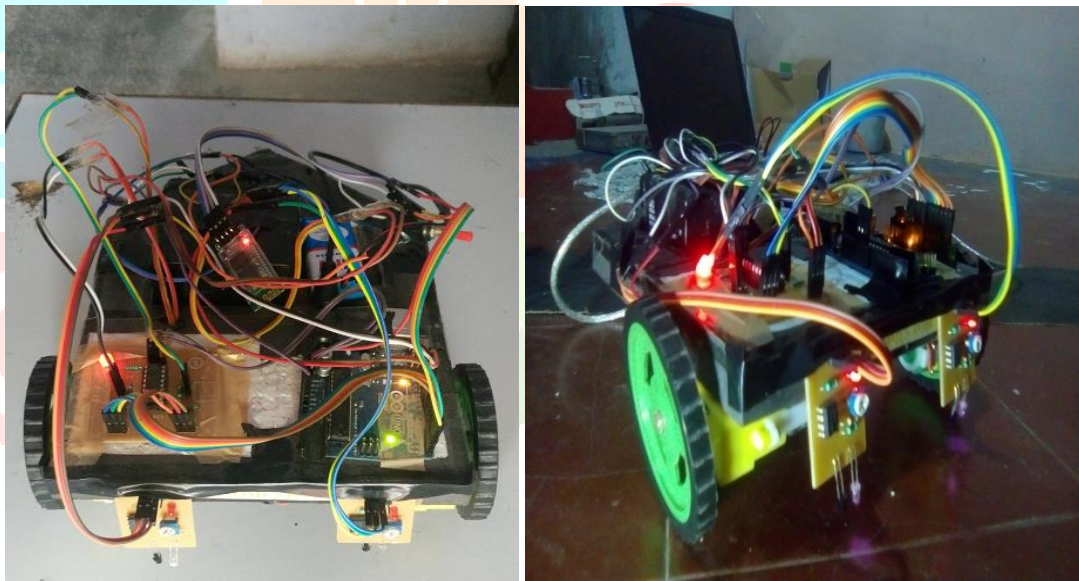


Fig:- 1 Coloured Line Follower Mechatronic Device (LFR)

3. RELATED WORK

In LFRics theory there are many system invented which has different applications in different areas.MechatronicDevice is very popular field for research and manufacturing. It has suggested a small line following LFR which used IR sensors to detect the line drawn on floor

We have developed and designed an line following LFR which can detect the line drawn on the floor with the help of IR sensor . When its IRsensor is passing through the line drawn on the way then it reads 0 and vice versa . That system has designed for the LFR competition. We defined a line following LFR to use in the shopping malls for entertainment and different application areas. In this paper The system used 4.8 cm wide black line to carry maximum load of 5 kg. Which has the line following capability and for balancing it, they used infrared distance sensor to solve the problem .They also used a manual control with the help of remote controller.

They used a comparator circuit to improve the sensitivity of the system. That comparator compares the voltage with the predetermined amounts from which a LFR can move in accurate real time. This LFR can follow not only black and

white colors but also some other different colors. This LFR includes electronic logic gates as brain instead of Arduino board .

4. SYSTEM OVERVIEW

The Android mobile sends commands to Arduino board the using Bluetooth and UART communication. The controller then takes action depending on the command and directs the LFR into the required Path. The LED and phototransistor based sensors are used here to sense the line. Four LEDs (TX) and phototransistor sensors (Rx) facing the ground has been used in this setup.

The proposed system consists of a Arduino board interfaced with two IR sensors for detecting the direction of movementfor the LFR. These sensors will be detecting and finding the color difference between the black and white for the smooth following of line. Further, an obstacle detector prevents the LFR from hitting any obstacles by stopping the LFR once any object is detected. The Controller takes action on the feedback from the sensors and accordingly the motors are controller for forward, reverse or turning movements. The targets in the track for LFR are detected by using coloredIR sensor, this sensor detecting green, blue, red and yellow.

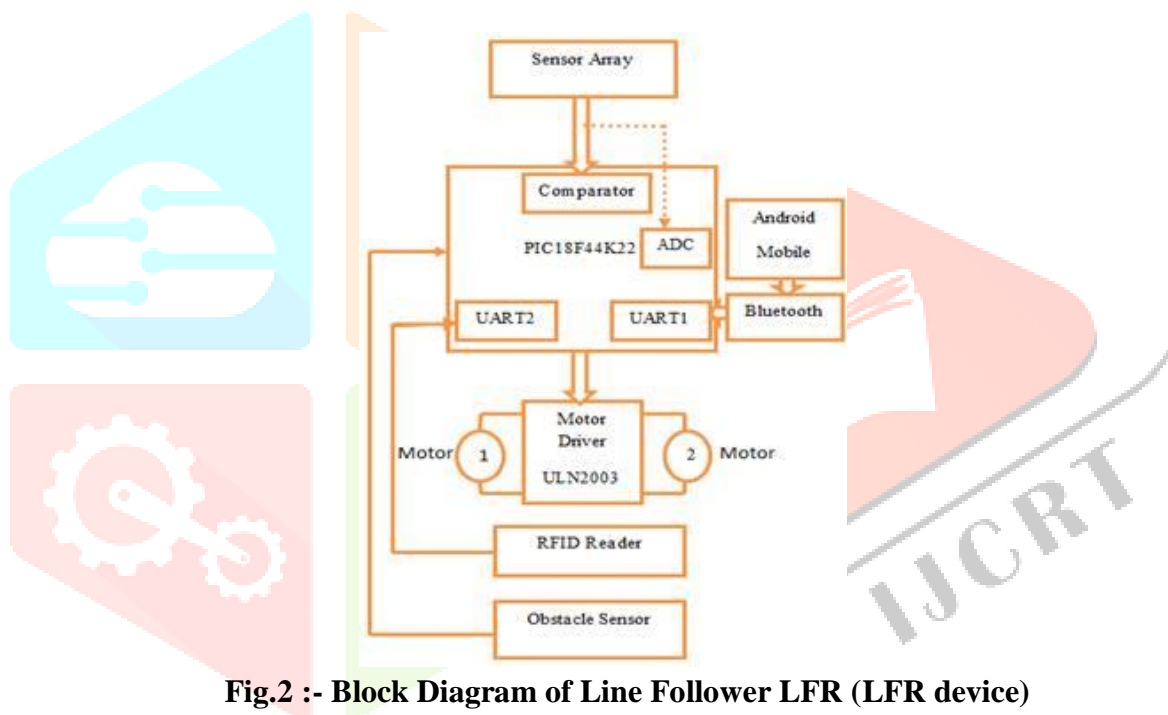


Fig.2 :- Block Diagram of Line Follower LFR (LFR device)

Two of them are used as line detectors and rest of them is used for detecting targets. The output of the sensors is analog in nature which depends on the amount of light reflected back. This analog signal is then processed to produce digital data containing information about the line and color. An IR obstacle sensor is used to gather information about the nearby obstacle present, which may block the line. Processing all those data from the installed sensors, the LFR's brain generates control signals automatically to perform the desired movements. Suppose ambient light interfacing with sensor, it may disturb the transition of data at that time. Sensors are not going to identify the color lines. In these conditions RFIDreader detect the desired target by detecting RFID tag placed at the destination. RFID reader reads the desired tag only when the instructions are given to the LFR through android mobile.

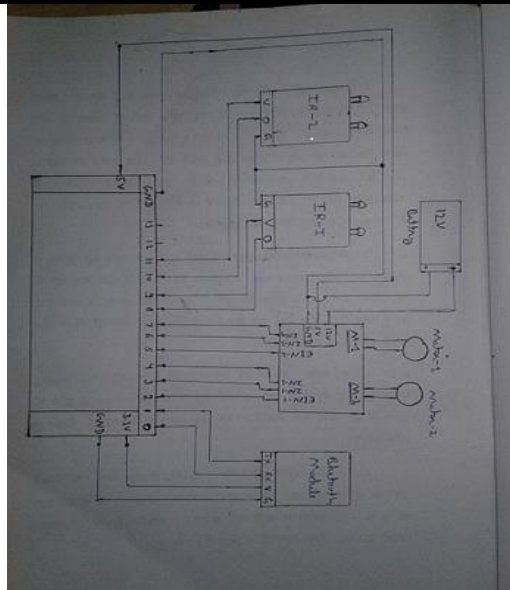


Fig.3 :- Circuit Diagram

4.1 Sensors

The LFR uses two sensors to gather all the necessary and needed information. The sensors are line sensor and IR obstacle sensor.

4.1.1 Line Sensor

An infrared emitter is an LED made from gallium arsenide, which emits near infrared energy at about 880nm. The infrared phototransistor acts as a transistor with the base voltage determined by the amount of light hitting the transistor. Hence, it acts as a variable current source. Greater amount of IR light cause greater currents to flow through the collector-emitter leads. The phototransistor is wired in a similar configuration to the voltage divider. The variable current traveling through the resistor causes a voltage drop in the pull-up resistor.

4.2 Comparator

Comparator is used to make the system sensitive as per the requirement. It usually compares the voltages between the inverting and non-inverting terminals. A threshold voltage is set on the reference voltage in the operational amplifier in inverting or non-inverting terminal. If another terminal voltage that is input voltage is greater than this threshold voltage then it gives the output. And if the input voltage is less than threshold voltage then it cannot give any output. The sensitivity of the sensor can be varied by setting a threshold voltage in the comparator circuit. By using this circuit a Phototransistor can be used for low beam of light and an IR sensor for detecting the obstacle from a large distance.

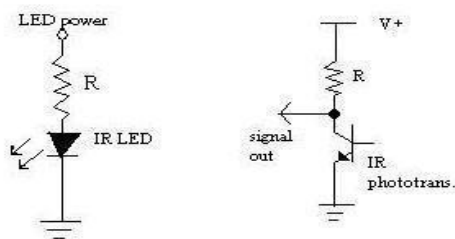


Fig-4: circuit diagram of infrared sensor

An IR emitter

An IR phototransistor

IR reflectance sensors contain a matched infrared transmitter and infrared receiver pair. These devices work by measuring the amount of light that is reflected into the receiver. Because the receiver also responds to ambient light, the device works best when well shielded from ambient light and when the distance between the sensor and the reflective surface is small. IR reflectance sensors are often used to detect white and black surfaces. White surfaces generally reflect well, while black surfaces reflect poorly. All the other colors have voltage drops in between white and black color.

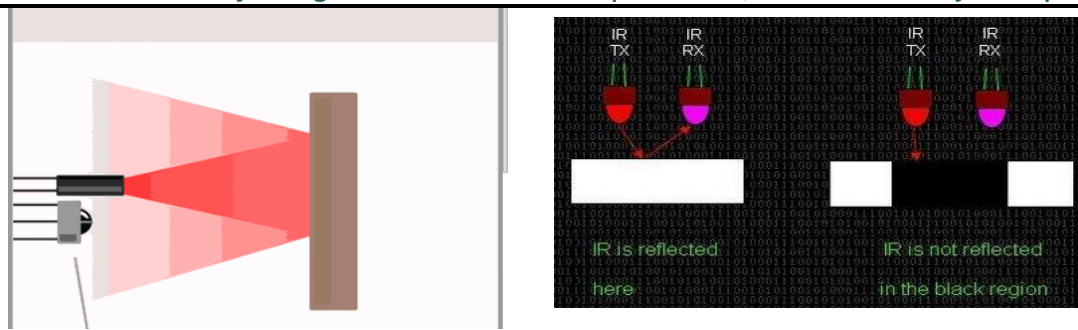


Fig-5Line sensor arrangement and working

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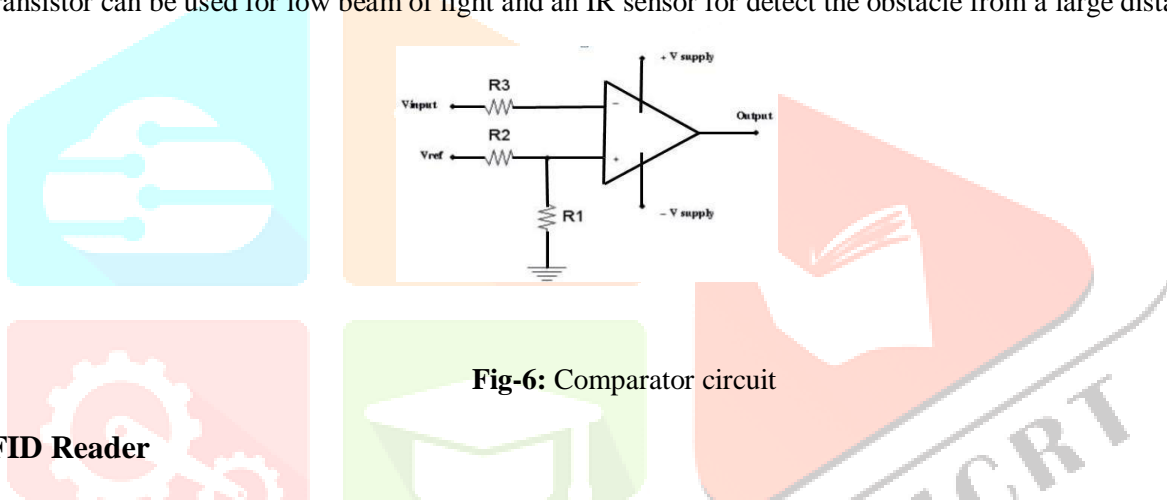


Fig-6: Comparator circuit

4.3 RFID Reader

RFID is a method of identifying unique items using radio waves. It includes readers, antenna, mixed signal IC, RF receiver and RF transmitter, Software based communication protocols and networking. A non-contact system that can monitor and track items or individuals. Provide unique identification that allows for a wide range of applications Perform the operation using unobtrusive, “low cost” components. Use Wireless Communications techniques to facilitate the system design. Main purpose of radio frequency identifier in this paper, suppose ambient light interfacing with sensor, it disturb the transitions of data at that time sensors are not going to identify the color lines. In these conditions RFID reader detect the desired target by detecting RFID tag placed at the destination. RFID reader reads the desired tag only when instructions given to the LFR through android mobile.

4.4 Algorithm

In start microcontroller check the sensor unit or receiver unit. Then verifies this address if it is correct then it continue process else it waits for appropriate address. If address is correct then it moves towards sensor array. If center sensor activate then all motors rotates and line follower move forward. Else if right sensor activates then motors rotates in manner that line follower move toward right. Else if left sensor activate then line follower move towards left. Else if left, right and center sensor activate at same time then all motors stop and transmit signal. It stops till not received appropriate address signal. For destination RFID reader or color sensor address matches then LFR stop for that position else moves forward to other position

5. MOTOR INTERFACE AND CONTROL

HARDWARE

5.1 Motor Driver

Motor driver act like the current amplifier. It is use for controlling the current in the motor. The motor drive provides high current as the dc motor need when it receives low current in the circuit. For drive the motors a high value of the current is needed. ULN2003 IC can control the two dc motor simultaneously. It can rotate the motor in the forward and reverse direction. By using the motor driver a line following LFR can be move in clockwise and in anticlockwise directions. It completely controls the movement of the dc motor that's why it has been called as motor driver.

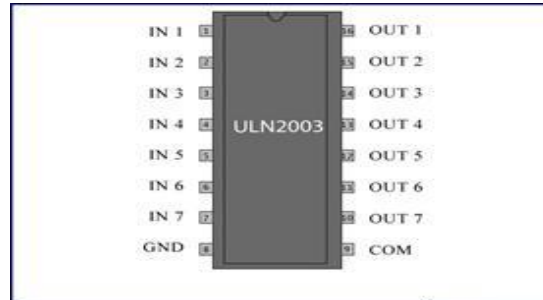


Fig-7: Motor driver IC

5.2 Motors and Wheels

For the proper movement of the system two dc motors has been used in the circuit and a castor wheel is attached in the front side of that Line Following LFR. Caster wheel enable the movement of the LFR is easy in every direction. Two dc motors at the end side of the LFR is controlled by the motor driver. For controlling the complete system a microcontroller is used, which set its flag bit as per the different situations. And this complete system need a small power supply of 6-12V, which can be provided form a battery. That is why this system is cost effective and operates in very low power supply.

5.3 Voltage Regulator

This LM7805 series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices 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.

5.4 Comparators, Voltage Divider and Controller

Color separation requires comparator and controller for their implementation. Voltage divider networks provide necessary reference voltages. Controller act as brain of the LFR which makes it extremely cost effective and reduces complexity.

6. ANDROID CONTROL

Android is a mobile operating system that is based on modified version of Linux. Android applications developed using tools such as JDK, Android SDK, eclipse and Android development tool. Architecture of Android consists of four layers such as Linux kernel, Libraries, Application framework, Applications. Kernel layer contains all the low level device drivers for the various hardware components of an Android device, Libraries contain all the code that provides the main features of an Android OS. For example, the SQLite library provides database support so that an application can use it for data storage. The Web Kit library provides functionalities for web browsing. Applications layer is top layer, here we will find applications that ship with the Android device (such as Phone, Contacts, Browser, etc.), as well as applications that we download and install from the Android Market.

Bluetooth Module :-Bluetooth module is an easy to use Bluetooth SPP (serial port protocol) module designed for transparent wireless serial connection setup

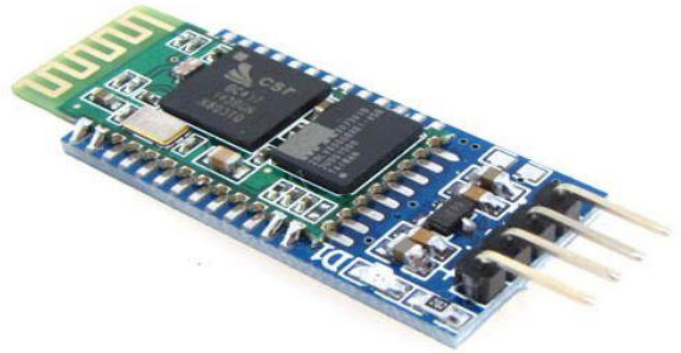


Fig.8 ANDROID CONTROL and Bluetooth to TTL 5V module

7. Arduino board(Microcontroller)

- A microcontroller (sometimes abbreviated μC or MCU) is a small computer on a single IC containing a processor core, memory, and programmable input/output peripherals.
- It is a decision making device used widely in embedded systems and all intelligent devices.

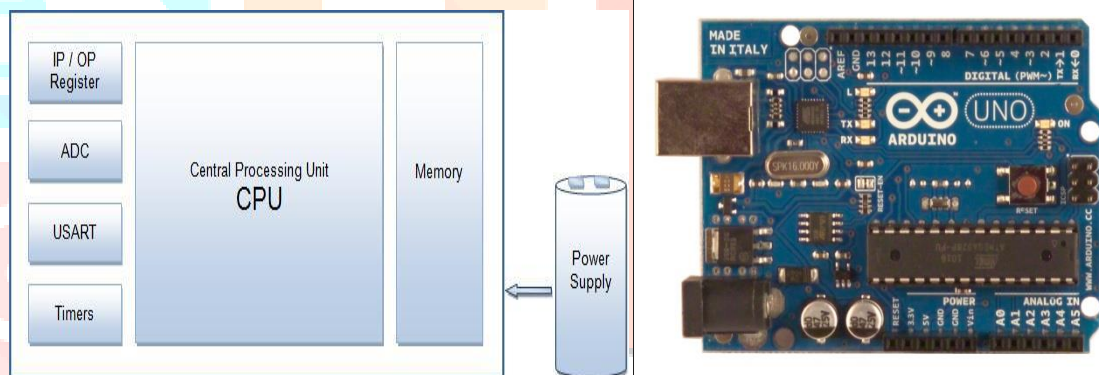


Fig.9:- Basic Block Diagram of Microcontroller

7. EXPERIMENT RESULTS

Phototransistor is basically acting as a variable current source which changes with different intensity of light. With the help of comparator circuit it can give the output when it comes under the contact of that line drawn. By using motor driver it follows the line drawn on the floor. At the turn of the line drawn, phototransistor doesn't get any output. DC motor must be controlled by the motor driver for movement of the LFR. For left movement the left side DC motor should be stopped and the right side DC motor should be run in forward direction. Table I shows the different necessary conditions for the movements of the motor. When the system detects any obstacle in its path then the DC motor stops its rotation and a buzzer is activated with the help of Arduino board can be used for controlling the LFR system in every possible case.

Table-1: Direction movement of LFR**Truth Table**

A	B	Description
0	0	Motor stops or Breaks
0	1	Motor Runs Anti-Clockwise
1	0	Motor Runs Clockwise
1	1	Motor Stops or Breaks

For above truth table, the Enable has to be Set (1). Motor Power is mentioned 12V, but you can connect power according to your motors.

Different paths for LFR movement as showing in table 1 interfacing of the Arduino board with the sensors and RFID reader is shown in the figure 3 and also a snapshot of the color line following LFR with the line drawn on the floor as shown in the figure 4

8. CONCLUSIONS

In this paper, the concept of the android based LFR is practically implemented in this paper based on PIC Microcontroller, RFID reader and sensors. Simultaneously it makes the use of instructions from sensors and on board PIC Microcontroller which performs the physical movements. The LFR is succeeded to locate and follow the target by giving instruction through android mobile. This LFR can follow not only black and white colors but also some other different colors

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