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Presenting a new approach in detecting colored lines using CNY70 sensors in the line following robot

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Abstract:
In this article, a new approach is presented to receive information and recognize colored lines by CNY70 transmitter and receiver sensors in wheeled line following robots. Here (racing track), the robot must follow a line with a width of approximately 1.8 cm, which can be black with a white background or vice versa with colored lines and different elements, and after passing the obstacles, it must achieve the necessary goals. These types of robots are mostly laboratory-based, and many scenarios and technologies can be implemented on them and after testing and if the results are obtained, they can be used in commercial, industrial, medical, etc. Those that bring patients to the intended units in hospitals using specified lines can be mentioned. From the observed laboratory results, due to the use of cheap sensors and the reduction of used electronic parts (elimination of op amp and potentiometer) with the same number of sensors, this method reduces energy consumption by 30% compared to other methods and significantly reduces costs. It makes more and more useful use of microcontroller bases.

Key words: line following robot, microcontroller, sensor, potentiometer and op amp.

1. Introduction

Automation has emerged in various sectors of industry and production work in the last few decades and is developing day by day. It has not been more than a few decades since the emergence of fully mechanized factories in which all processes are automatic and manpower does not play an executive role in it. But in the last few years, we have witnessed the emergence of mechanized factories, whose design, construction and working methods are really amazing. The idea and knowledge of automatic control and the use of mechanized systems in factories dates back to World War II. But its huge and significant changes have taken place in recent years. Making a robot is one of the very interesting and informative topics that gives a practical look to the collection of information from mechanics, electronics, computer (hardware and software) and artificial intelligence in the form of an intelligent device. Maybe making individual components used in a robot (such as control circuit, software program, communication with computer, sensors, actuators, motors and body) is not a difficult task, but putting these components together, providing communication appropriate and optimal, compensating for the weaknesses of one block with the help of other blocks and finally creating a robot that until a few days ago was nothing but a few parts, a body and a circuit, and now it has moved in an intelligent wave and what is yours; It does what you expect, you command, an engineering student in any of the disciplines (mechanics, electricity, computer, industries, etc.) will be able to do it.

Robots are used to perform hard and difficult tasks that sometimes humans are unable to perform or are dangerous for humans, such as robots that exist in nuclear power plants and iron smelting furnaces.

The work that robots do is controlled by microprocessors and microcontrollers. By mastering the programming of these two,

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you can do exactly what you expect the robot to do.

Human-like robots have also been created that are able to perform human-like actions. Some of them even have feelings like humans. Some of them have very simple shapes. They have wheels or arms that are controlled by microcontrollers or microprocessors. In fact, the microcontroller or microprocessor works like the human brain in the robot. Some robots, like humans and warm-blooded animals, react intelligently when faced with various incidents and issues. An example of these robots is the agent robot.

2-A review of the literature

2-1- Robot

A robot is an intelligent machine that is able to perform a defined task in the specific conditions in which it is placed, and it may also have the ability to make decisions in different conditions. With this definition, it can be said that robots can be defined and built for different tasks. Like things that are impossible or difficult for humans to do.

For example, in the assembly part of a car factory, there is a part where the spare wheel of the car is placed in the trunk. He used an electromechanical robot for this job, or for welding and other difficult factory jobs.

The robots that are used for exploration in other planets are the types of robots that

Some robots also perform a series of tasks repetitively with high speed and accuracy, such as the robots used in automobile factories. Such robots perform tasks such as welding the car body and painting the car with higher accuracy than humans without fatigue and interruption.

Next, in section 2, we have an overview of the robot work literature. In section 3, we will present the proposed method and the superiority of this method over the analog method, in section 4, we will draw conclusions from the proposed method and state future works. In section 5, we also mention the sources.

are used in places where human presence is impossible.

The word robot was invented by Karel Capek, the author of the play R.U.R (Russian World Robots) in 1921. The root of this word is the Czech-Slovak word (robotnic). It had the most power and at the end of the show, this car was used to fight against its creators.

Of course, before that, the Greeks had made a moving statue that was the prototype of what we call a robot today.

Today, the word robot is usually used to mean any human-made machine that can perform a task or action that is naturally performed by humans.

Most of the robots today are used in factories to make products such as cars; Electronics are also used for underwater explorations or on other planets.

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A robot is a mechanical device for performing various tasks. A machine that can be programmed to act on different commands or perform a series of special actions. Especially those tasks that are beyond the limits of human's natural abilities. These mechanical machines are produced to better perform actions such as feeling, understanding and moving objects or repetitive actions like welding.

2-1-1 Robot definitions

There has always been a debate between robotics experts and robotics activists in universities about the definition of a robot, sometimes based on the production of a robot, in a company, an industrial definition of a robot is given based on the production of that company, and in some cases, it is related to the technology of the robot. is described.

However, at the present time, the technology of making robots is at such a level that by relying on the current new and advanced technology and with a bit of foresight, an objective and achievable definition of a robot can be made.

Here are some valid definitions:

An intelligent robot is a multipurpose automatic machine that performs a wide range of different tasks, under conditions that it may not even have sufficient knowledge of, just like a human.

Two other definitions related to the word robot are as follows:

□ Definition made by Concise Oxford Dic; A mechanical machine with the appearance of a human, which is intelligent and obedient, but has no personality. This definition is not very accurate, because not all existing robots have a human appearance and there is no desire to do so.

□ The definition made by the American Robot Institute; A device with high operational accuracy that can be reprogrammed and has the ability to perform several tasks and is designed to carry materials, parts, tools or specialized systems and has different programmed movements and the purpose of its construction is to perform various tasks. Be Robotic science consists of three main branches:

-Electronics (including robot brain)

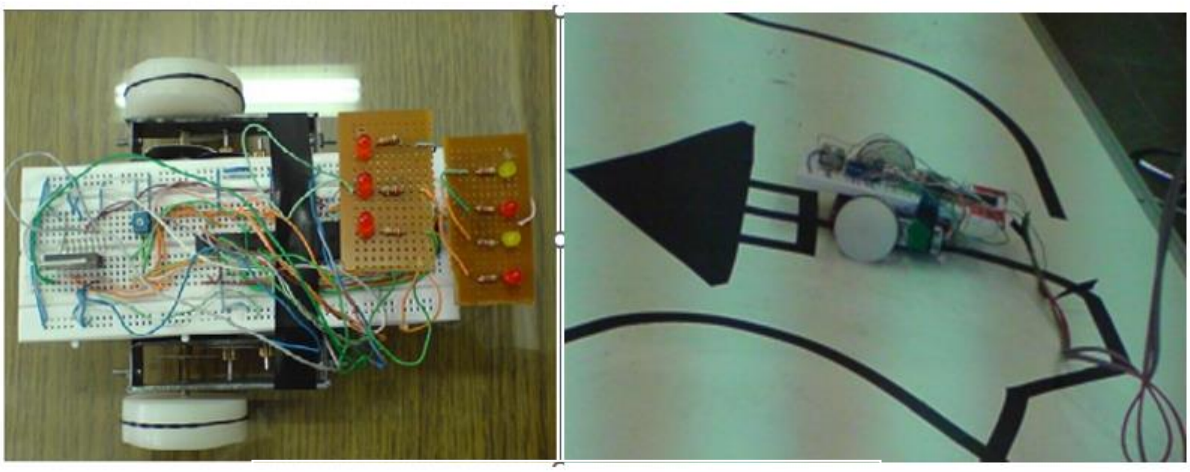

Figure-1 (Example of line-following laboratory robot - SCOT team)

An autonomous device or device that is capable of performing actions that are usually attributed to humans or is equipped with capabilities that are similar to human intelligence.

-Mechanics (including the physical body of the robot)

• Software (including the thinking and decision-making power of the robot) If we compare a robot to a human, the parts

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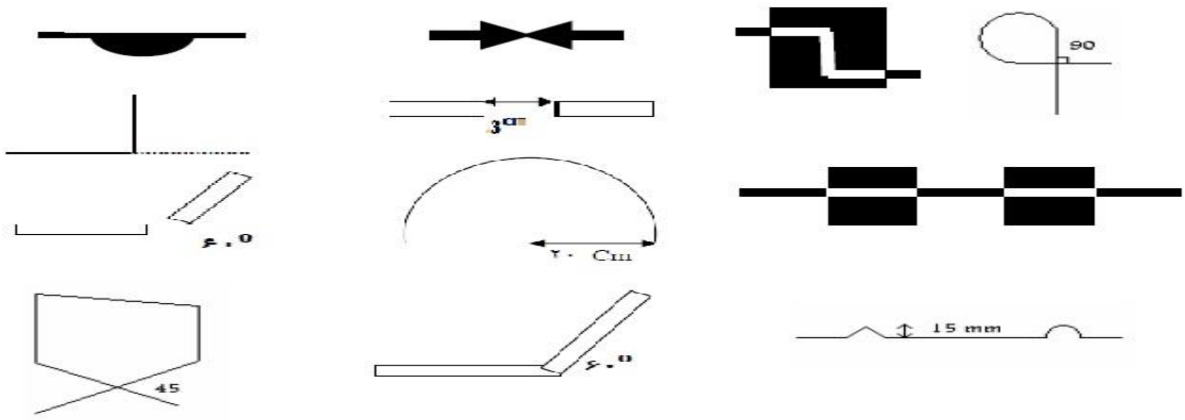

related to the physical appearance of the human are made by mechanical specialists, the brain of the robot is designed and made by electronic specialists using complex electronic circuits, and the software experts simulate the power of thinking through computer programs for the robot. They make it to perform the appropriate activity in special situations.

2-1-2- Advantages of robots

• In many cases, robotics and automation can increase safety, production rate, benefit and quality of products.
• Robots can work in dangerous situations and thus save the lives of thousands of people.
• Robots do not pay attention to the comfort of their surroundings and human needs have no meaning for them.
• Robots never get tired.
• The accuracy of robots is much higher than humans, they are accurate to milli or even micro inches.
• Robots can do several tasks at the same time, but humans can only do one task at a time.

2-1-3- Disadvantages of robots

• Robots do not have the ability to respond appropriately in emergency situations, which can be very dangerous.
• Robots are expensive.
• They have limited capabilities, that is, they only do what they are designed for.

2-2- line following robot

It is a type of robot whose main task is to follow a path with a color such as black in a background of a certain different color such as white (Figure 1). One of the main uses of this robot is the transportation of various items and goods in factories, hospitals, stores, libraries, etc. The line-following robot is able to perform the librarianship of libraries to some extent. After giving the code, the robot follows the path determined by the code, goes to the place where the book is placed and picks up the book and brings it to us. Another example is the use of this type of robot in advanced hospitals, the floors of advanced hospitals have lines of different colors in order to guide the finder robots to different places, for example, red to the surgery room or blue to the delivery room. Patients who are unable to move and need to use a wheelchair, this wheelchair plays the role of a line-following robot, and takes the patient to the desired location along a specific path. And in short, it has many uses and if one day we use it in our life, it will be a lot of fun.

2-2-1- Routing algorithm:

The routing algorithm must be written so that the robot can follow any path, with any size of the maze and any element you see in Figure 2, so that its error is minimal. Experience shows that the best way to find

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and follow the path is to use a linear arrangement to increase accuracy, an octagonal and half-moon arrangement to increase speed and enable recovery in case of losing the path or going off the path. Regarding the number of sensors used in the robot, it depends on the type of goal, the accuracy of the work and the cost, then we enter the algorithm writing phase. The important thing here is that we need to know what task each sensor should perform individually or as a group in the algorithm, for example you can see in Figure 3 which is the example used in the SCOT robot.

2-2-2- Sensors

A sensor is a sensing element that converts physical quantities such as pressure, heat, humidity, temperature, etc. into continuous (analog) or discontinuous (digital) electrical quantities.

In the line following robot, the function of the sensors is to receive information from the line identification environment and convert the signals into suitable electronic signals for the control/command part. The output of the sensor circuit will be the voltage according to the TTI standard. For example, we can refer to separate receiver/transmitter sensors, Sharp (GP), CNY70, etc. We will have an overview of the CNY70 sensor, which is widely used in line-reading robots.

2-2-3- CNY70 sensor

This sensor is a package containing two infrared sensors (Figure 4). One sensor is the transmitter and the other sensor is the receiver. In order for the robot to work better, it is better to use this sensor pack instead of using two infrared sensors separately. In this sensor, the longer legs on each side are the anode and the shorter legs are the cathode. By using this sensor, the amount of errors is significantly reduced[1].

Figure-2 (examples of elements)

L33	L22	L11	SCC	R11	R22	R33

Figure-3 (arrangement and naming of

3- Suggested technique

In general, every robot should:

•Collect information from the outside world through its sensors, convert this information into under standable information of your processor's brain and transfer it to it.

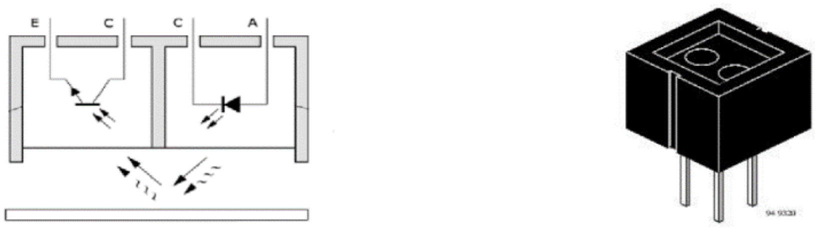

Figure-4 (CNY70 sensor)

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•According to the previous planning, process the information and make the appropriate decision.
operators • Implement final decisions with the help of its.
The difference between different robots is due to the nature of these steps in Figure 5.

3-1- SCOT robot diagram

specifying the value that is zero or one, it is sent to the pins of the microcontroller to execute commands and motion commands through the written program. and there, after making a decision, the necessary signals are sent to its drivers according to Table 7 to move the motors.

In our proposed method, PWM (Pulse Width Modulation) method should be used

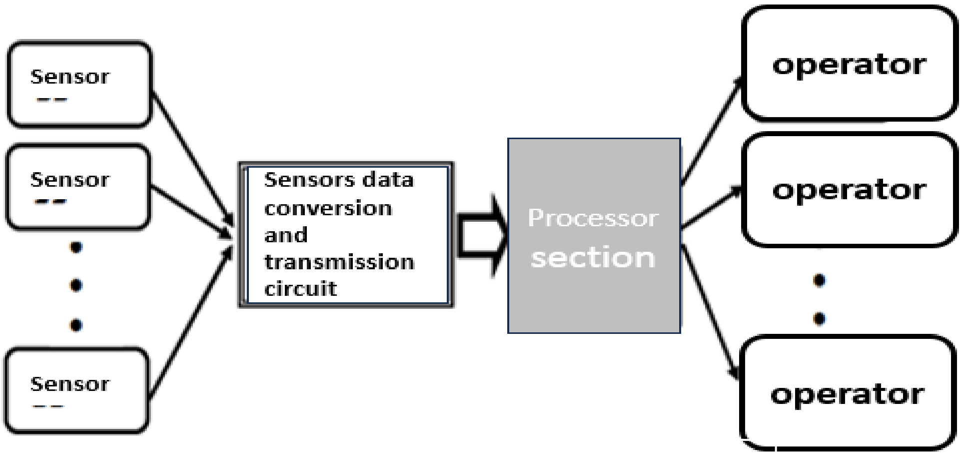

Figure-5 (diagram of receiving information by sensors)

In Figure 6, as you can see the block diagram designed for the line following robot; At first, the sensor arrays receive

for better control of motors, which is a technique in microcontrollers to convert analog signal to digital, which includes

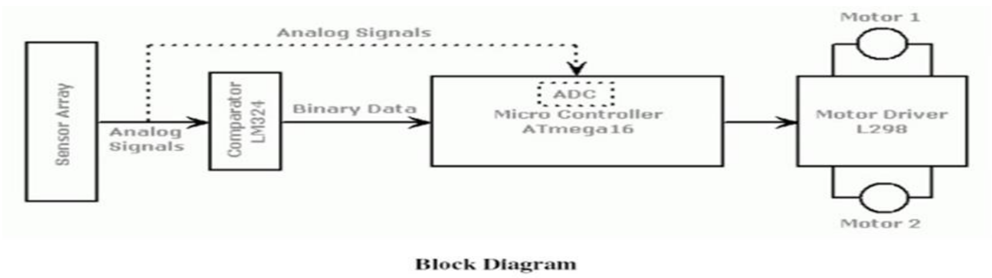

Figure-6 (block diagram of line following robot - SCOTT team)

data from the environment (racing track) (the black line is equal to one and the white line is equal to zero, which can be changed depending on the program code, this zero and one) and this data with the help of electronic parts Another one called potentiometer is sent to LM324, which is an op-amp, and each sensor is connected to a pin of the AVR microcontroller, and after

two important factors of conversion speed and high sampling accuracy. In this method,Figure8, the electronic components of the potentiometer and LM324, which is an op-amp, are removed, and fewer ports of the microcontroller are involved, unlike the previous method, we use the ADC method; In this way, the analog signals that are sent directly to the microcontroller

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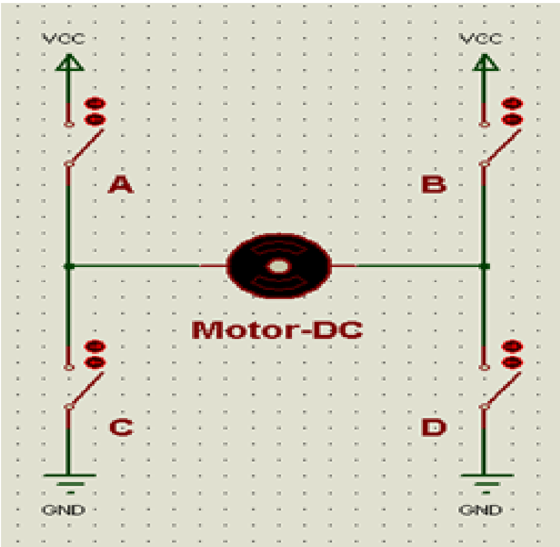
through the sensors and are first calibrated by the programmed codes and then converted to zero and one (black and white line respectively).

3-2- Explanation of the program

moves, it is necessary to specify the sensor sampling and face calibration and the range of logical zero and one (black and white line), which is done by the sensor-sampling() function of lines 29-37 will be done.



D	C	B	A	عملکرد موتور
0	0	0	0	چرخها آزاد
0	0	0	1	چرخها آزاد
0	0	1	0	چرخها آزاد
0	0	1	1	ترمز
0	1	0	0	چرخها آزاد
0	1	0	1	اتصال کوتاه
0	1	1	0	حرکت معکوس
0	1	1	1	اتصال کوتاه
1	0	0	0	چرخها آزاد
1	0	0	1	حرکت مستقیم
1	0	1	0	اتصال کوتاه
1	0	1	1	اتصال کوتاه
1	1	0	0	ترمز
1	1	0	1	اتصال کوتاه
1	1	1	0	اتصال کوتاه
1	1	1	1	اتصال کوتاه

Figure-7 (schematic diagram of H-bridge circuit for motor

As we can see in Figure9, the program needs to be placed in an infinite loop (lines 11-20) and these commands are executed until the condition is met.

At the beginning and in line 10, before the while() loop is executed and the robot

Then, in the while() loop, the reading of the sensors should be done consecutively and in a unit of time, which is done by the read() function in lines 22-27, and in the sensor-sampling() function, the logical range is converted to zero and It takes one form.

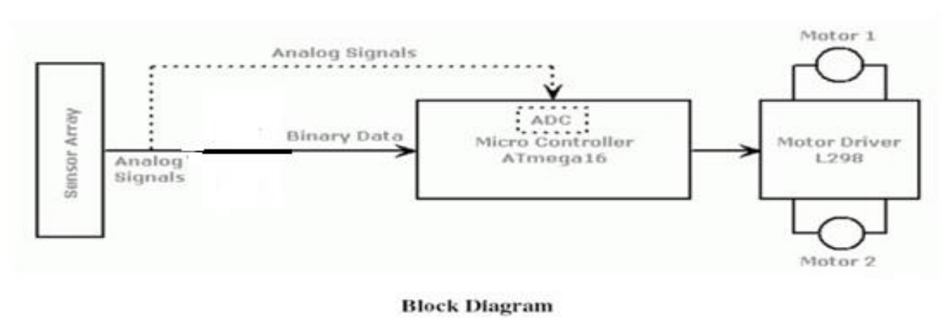


Figure-8 (block diagram of line following smart robot - SCOT

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Vol.4, NO.1 , P:93 - 100
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```
int z=0;
int min=255;
int 13,11,sc,r1,r3;

bit r33,111,scc,r11,133;

void read();
void Sensor-Sampling();

Sensor-Sampling();
while (1)
        {
        read();

        //masir sadeh
        if(133==1&&111==0&&scc==0&&r11==1&&r33==1)center();
        if(133==0&&111==0&&scc==0&&r11==1&&r33==1)right();
        if(133==1&&111==1&&scc==0&&r11==0&&r33==0)left();
       };
}
```

```
void read()
{
        z=read_adc(0);
        if(z>13+1){133=1;PORTB.1=1;}
        else {133=0;PORTB.1=0;}
}

void Sensor-Sampling()
{
          for(13=0;13<min;13++)
          {
                z=read_adc(0);
                if(z>13){PORTB.2=1;}
                else {PORTB.2=0;break;}
          }
}
```

Figure-8 (Line-following robot intelligence program code - SCOT

The point that is important here is that instead of using color sensors, before the robot starts moving, the sensors on the colored lines of the race track (green, yellow, red, etc.) need to be sampled once, then the calibration process is performed and from then on, the robot starts moving based on the algorithm of the program and the rules of the competition.

4- Conclusion and future work

Instead of using color sensors in the robot, which have a high price in the market, you can easily add this feature to the robot using an innovative method that consists of a few lines of program code and a CNY70 sensor, which will be very affordable.

In addition, there is a significant percentage (30%) reduction in battery energy consumption, and the reason is the reduction of electronic components used, and in this method, instead of occupying a microcontroller base for each sensor, using the number bus method More sensors can be assigned to microcontroller bases that have limitations.

In the future works, we will add the mapping capability on the line following robot and use image processing for line following, which is the result of laboratory experiences.

5- Resources:

1. Priyank Patil. Line Following Robot. Department of Information Technology K. J. Somaiya College of Engineering. Mumbai, India.
2. Muhammed Ali Mazidi and et al, PIC Microcontroller and Embedded Systems", Prentice Hall, 2007.
3. Muhammed Ali Mazidi and et al, The 8051 Microcontroller and Embedded Systems, Prentice Hall, 2006.
4. Omer Gumus and et al, The use of computer controlled line follower robots in public transport, Procedia Computer Science 102 (2016) 202 – 208.
5. Stelian Emilian Oltean, Mobile Robot Platform with Arduino Uno and Raspberry Pi for Autonomous Navigation, Procedia Manufacturing 32 (2019) 572–577.
6. http://www.alldatasheet.com
7. http://www.johnsonmotor.com
8. http://www.avrbeginners.com
9. http://www.williamson-labs.com