International Journal of Research Studies in Science, Engineering and Technology
Volume 2, Issue 3, March 2015, PP 45-51
ISSN 2349-4751 (Print) & ISSN 2349-476X (Online)

Smart Shopper Using Intelligent Embedded Systems

[1]Girish Kumar Solanki, [2]Khyati Shah, [3]Asim Khan

[1, 2, 3] Dept. of Electronics and Communication, Anand International College of Engineering, Jaipur, Rajasthan, India

[1]girishslnk49@gmail.com,[2]emat.nyx@gmail.com,[3]asimadz@gmail.com

Abstract: *In this paper the idea of an intelligent embedded system and study over its different components is given. Artificial intelligence is the science and technology of creation of intelligent machines using smart computer software and programs. It finds solutions to complex problems in a more human-like way but without a biological point of view. Using the concept, idea of a smart shopper which use to navigate on a grid of black lines autonomously over white or any other color surface to its destination as desired by the user is presented here. The proposed model shows the application of IR sensors and microcontroller units to navigate smartly over a way to the desired shop. The shopper bot also instructs the shopkeeper by displaying list of things over LCD module and equipped with horn and alarm systems.*

Further the mode of giving input to the bot can be changed by gestures, ie. Bot will choose different locations or shops for different gestures by the user.

Keywords: *Embedded systems, line seeking, ADC, MCU, PWM, Accelerometer.*

1. Introduction

Artificial Intelligence is the human like intelligence exhibited by machines or software. If we look around us there are many examples of intelligent embedded systems, be it a smart home, magnetic doors and window contacts, cruise control etc. They are powered by something beneath the sheath that makes them do what they do. They are the microcontrollers or the microprocessors working on the assembly language given by the programmer. The basis of a logical artificial intelligence lies on computer and human interactions. Humans are the most advanced creation till now, but it's natural. On the other hand human is now in race of making the intelligent machines which can work efficiently like human beings using the essential systems and programs.

2. Concept of IR Sensors and Line Seeking

Infrared (IR) sensors are widely used as proximity sensors and for obstacle avoidance in robotics. They offer lower cost and faster response times than ultrasonic (US) sensors. Talking in a biological way it can be used as eyes for the robots. The IR sensor consists of an IR transmitter and an IR receiver. IR transmitter is basically IR LED continuously emits IR rays when switched ON. When these rays are obstructed by an obstacle in Path of IR rays, they get reflected (fig.2*).*

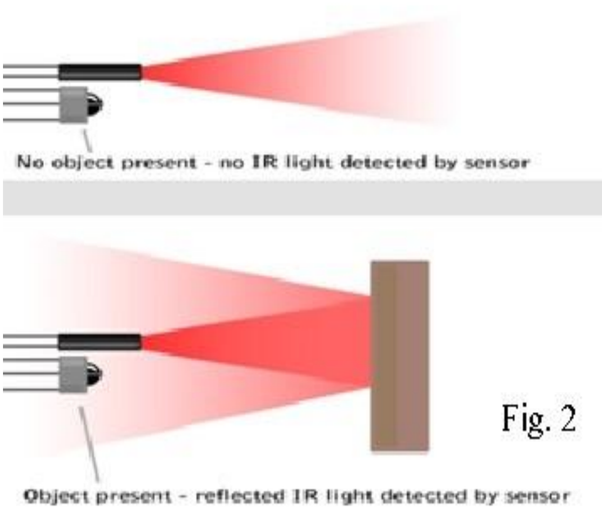

Fig. 2

These reflected IR rays then received by IR receiver/photodiode. The amount of IR received by receiver will generate a corresponding current, which is converted to corresponding voltage by a resistor.

Now, if the sensor is used in analog mode by sliding the switch, it will connect the analog voltage output directly to IR sensor output, which is connected to the ADC pin of microcontroller. The ADC values for reflection from different colors and objects can be measured and loaded in MCU to make it able to see different colored lines and surfaces. The algorithm is developed in such a way that robot moves and changes directions according to the signals received from the sensors.

The figure2.1 (a) & (b) shows a bot with two IR sensors on left side and right side, the digital values from sensors is described in table below.

Table1. *Digital Values from sensors in different scenarios*

Surface	**LS**	**RS**
White	1	1
Black	0	0
White below LS and black below RS	1	0
White below RS and black below LS	0	1

These values from sensors in the form of 0's and 1's can be used to sense line and instruct motors accordingly to move left and right.

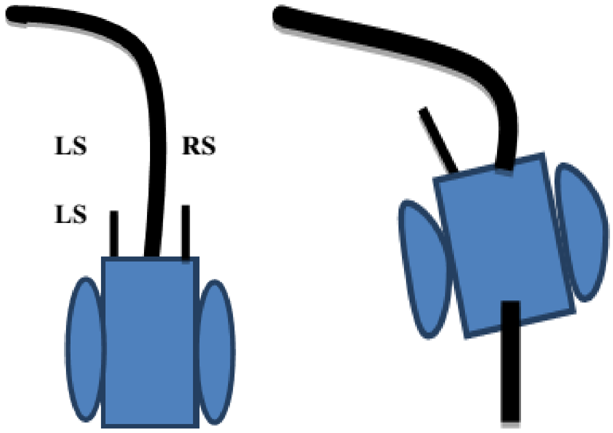

Fig2.1 (a) **Fig2.1 (b)**

Fig2.1 (a) *both sensors on white (moving straight),* **Fig2.1 (b)** *Right sensor on black (Taking left)*

Also, if the line is not purely black, say brown or any other close dark color, the IR sensor can be used in analog mode & ADC values corresponding to color is noted and used in navigation.

E.g. - ADC value noted for brown color duringobservations is between 800-900.

ADC will give us a number between 0-1023 for voltage between 0-5V. The relation between adcvalue and input voltage (V_{in}) is

$V_{in}=(adcvalue/1023)*5$ (1)

2.1. Line Seeking on a More Complex Path (Grids)

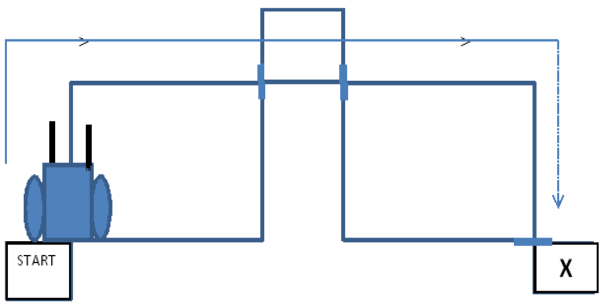

Fig2.1 (c). *Sample grid path*

In the proposed model bot needs to move on a complex path in the form of grids having different locations on different points. The algorithm can be modified accordingly. For example, in the following arena *fig. 2.1 (c)* bot start moving from start position and end at the cross (X) position.

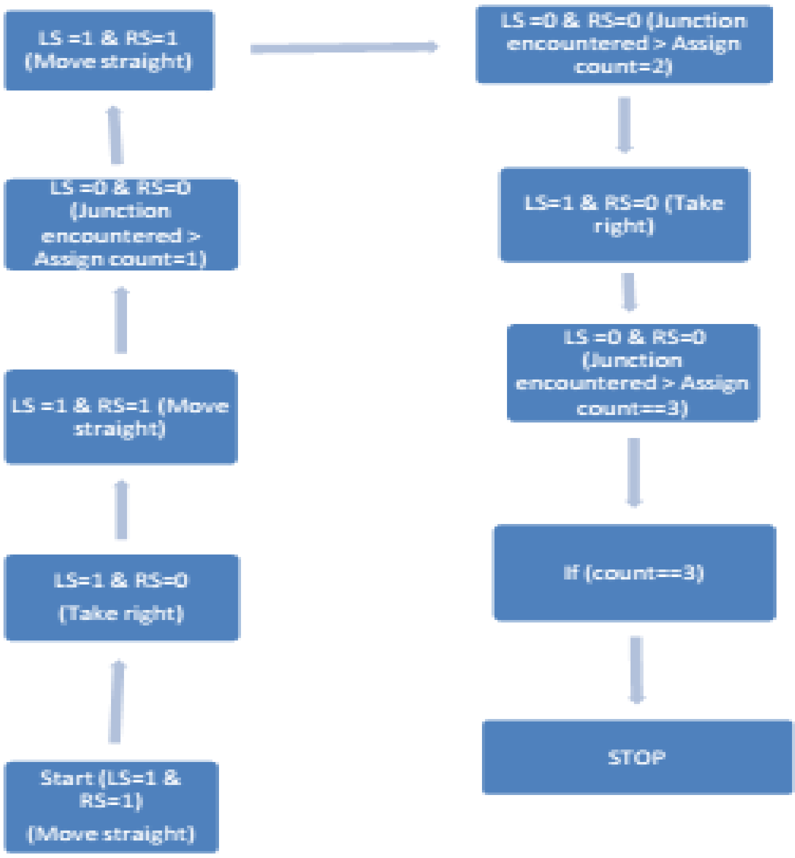

Fig2.1 (d). *Flow chart of the algorithm and values of sensors at different stages*

At certain positions sensors encounter the black junction where values from both sensors are 0. Counting of such junctions is performed to navigate bot and carry out stop, start or different turn functions according to the need. The flow chart of the algorithm and values of sensors at different stages is show in the flowchart *fig. 2.1(d)*

2.2. Proposed Model as a Smart Shopper

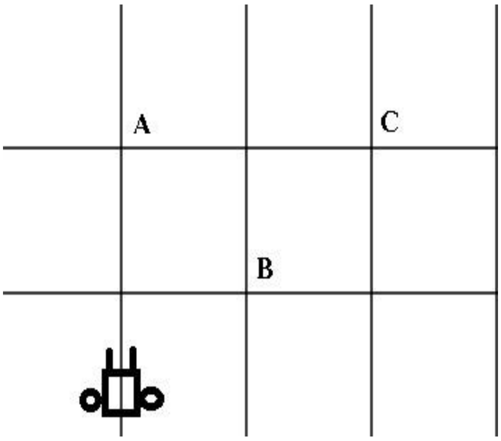

Fig2.2(a). *Arena map*

The arena shown in the fig.2.2 (a) represents a map where points A, B and C representthree different shops respectively. The bot is equipped with the IR sensors and MCU unit to navigate through the map.

For much better navigation over grid paths number of sensors and their location plays an important role. A line sensor array *fig: 2.2(b)* can be used for accurate navigation.

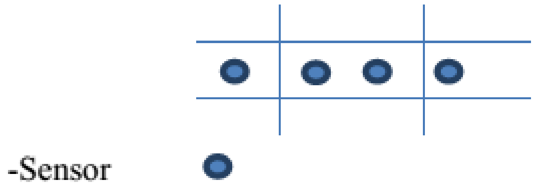

Fig2.2(b). *Single line sensor array*

It utilizes two middle sensors for line navigation; sensors S_R and S_L; and the other two outer sensors for junction detection; sensors S_{RR} and S_{LL}.

In terms of the 2 outer sensors, care must be taken not to place these sensors too far or too near to the line navigation sensors. If these sensors are placed too far from the navigational sensors, there may be sensor inaccuracy to differentiate junction if it enters the junction at an awkward angle. If the sensors are placed too near, the junction sensors may accidentally detect the line self rather than the junction. This is illustrated in figure 2.2(c) & 2.2(d)

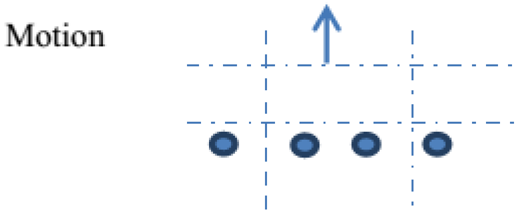

Fig2.2(c). *Sensors placed too near*

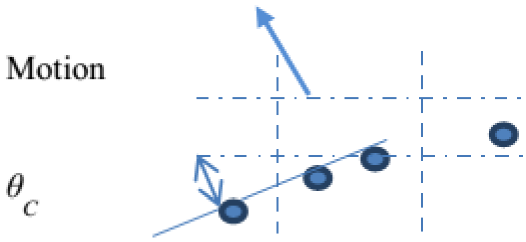

Fig2.2(d). *Sensors placed too far*

For positioning sensors more accurately equation 2 can be used to determine the exact distance between the sensors.

$$W<|S_{RR}\text{-}S_{LL}|<\frac{W}{\tan\theta c} \quad (2)$$

Where:

$|S_{RR}\text{-}S_{LL}|$– is the distance between the left most and right most sensors in mm, *w* is the width of the line being detected in mm and θ_C is the critical entry angle of the robot. Please refer to figure 2.2(d) for the angle θ_C.

Inequality 2 can be rearranged to calculate critical entry angle.

$$\theta_C<\tan^{-1}\frac{W}{|S_{RR}-S_{LL}|} \quad (3)$$

It gives the value of θ_C.If the robot attempts to enter the line at an angle above this value, it will not be able to detect the junction

Traits and components of bot:

It uses a 16X2 alphanumeric LCD module to display the list of items to be purchased to the shopkeeper.

As well as, to draw the attention of the shopkeeper it contains a buzzer which sounds after a certain period of time after reaching the shop.

Items are collected in a basket mounted over it which detects if the items are placed or not using another pair of IR sensors, & after collecting them the hood of the basket gets covered and can only be unlocked by entering a password. It then back tracks the same path to the initial point. If in the way someone tries to open the basket it would buzz an alarm. It can only be unlocked by entering a password.

2.3. Sound Generation for alarm using PWM

PWM is used to generate analog voltage levels by the digital device (say a MCU). Generally a digital device can only generate HIGH or LOW level signals on their I/O Ports. But by using PWM we can generate any analog voltage level on MCUs PORT, for example we can generate any voltage between 0 and 5 volts like 2.67V or 1.11V etc.

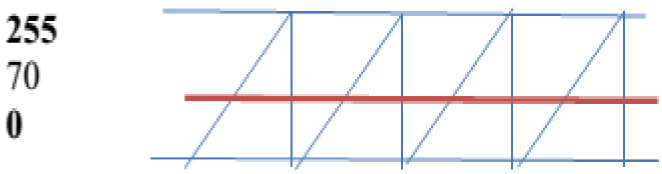

Fig3. *AVR MCU TIMER count sequence*

Now, the different analog values between 0-255 can be stored in OCR0 register (TIMER 0) of AVR microcontroller, say 70 shown in *fig: 3* representing different voltage levels leads to different sound patterns.

The voltage corresponding to the analog value or the duty value is given by:

$$V_{out} = (value/255)*5 \qquad (4)$$

We used following values to generate sound pattern for alarm 127,130,133,136, 139,142,145, 148, 151,154,157,160,163,166,169,172,175,178,181,184,187,190,193,196,199,202,205,208,211,218,225,230,238,245,250,100,103,108,110,250,250,222,50,45,35,25,20,15,10,5

3. Giving Input Command

3.1. Switches

The command for a location or shop is given using the switches interfaced with MCU. As, there are three locations. So, 3 switches are here to take input each corresponding to the path of different shops.

3.2. Gestures

Another way of giving input to the bot is by using gestures, i.e. For left movement of hand it will move towards point A, for right movement point B and for downward movement point C. This can be achieved by using Accelerometer sensor which senses the acceleration & motion and gives corresponding analog values. These values for motion in different directions are measured and codes for corresponding directions are assigned and transmitted wirelessly using RF module. At the receiver end, the codes corresponding to the movement are identified and the bot is instructed to move to desired location.

The transmitting unit contains an accelerometer (*fig.4)* interfaced with another microcontroller and RF transmitter. The whole arrangement is mounted on a glove which can be worn my human hand.

The table below shows the experimental ADC values from accelerometer for motion in different directions.

Table2. *Experimental Data- ADC values from accelerometer*

Motion	ADC Value range (x & y axis)	Transmitted Code
Right	310-350	001
Left	400-450	010
Down	375-399	100

Wireless Tx

Code check	Response
True	Move to A
True	Move to B
True	Move to C

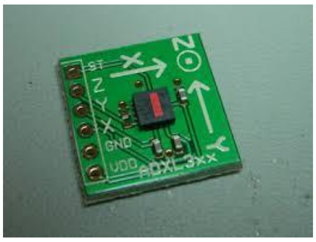

Fig4. *Accelerometer*

4. CONCLUSION

Artificial intelligence has been the subject of tremendous optimism but has also suffered stunning setbacks. Today it has become an essential part of the technology industry.In next few years technologies in narrow fields will continue to improve and will reach human levels.Combining the embedded systems and strong computational logics these intelligent systems has proven their milestone and of a great importance in industries and everyday life. Controlling machines with gestures is another factor that abridges the machines and humans. In 10 years AI will be able to communicate with humans in unconstructed English using text or voice, navigate in an unprepared environment and will have some rudimentary common sense (and domain – specific intelligence).

ACKNOWLEDGEMENT

Thanks go to the reviewers for the very detailed reviews and helpful suggestions

REFERENCES

[1] American Association for Artificial Intelligence

[2] Yan Shi“humanoid automata” , Needham 1986, p.53.

[3] Analysis of Line Sensor Configuration for the Advanced Line Follower Robot, Universiti Tenaga Nasional, Malaysia

[4] C. Thorpe et al., “Vision and Navigation for the Carnegie Mellon NavLab,” *IEEE Trans.Pattern Analysis and Machine Intelligence*,vol. 10, no. 3, 1988, pp. 362–373.

[5] R.A. Brooks et al., Alternative Essences of Intelligence, *Proc. 15th Nat l Conf. Artificial Intelligence* (AAAI 98)and *10th Conf. Innovative Applications of Artificial Intelligence* (IAAI 98), AAAI Press, Menlo Park, Calif., 1998,pp. 961—968.

[6] Bryan Adams, Cynthia Breazeal, Rodney A. Brooks, and Brian Scassellati, “Humanoid Robots: A New Kind of Tool”MIT Artificial Intelligence Laboratory

[7] http://extremeelectronics.co.in/avr-tutorials/pwm-signal-generation-by-using-avr-timers/

AUTHORS' BIOGRAPHY

Girish Kumar Solanki, IV year Electronics and Communication Engineering, Anand International College of Engineering, Jaipur, Rajasthan, India.

Khyati Shah, IV year Electronics and Communication Engineering, Anand International College of Engineering, Jaipur, Rajasthan, India.

.

Asim Khan, IV year Electronics and Communication Engineering, Anand International College of Engineering, Jaipur, Rajasthan, India.