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System Design Approach for Library Guidance

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ABSTRACT— Mobile robots are used extensively now a days that not only used in production lines, mobile robots are even used for household tasks, such as vacuum cleaning and garbage collecting. Mobile robots can now plan their path, do their tasks and then come back to charge up batteries and repeat the cycle for tomorrow and the days after. A line following robot is designed using sensor operated motors to keep track the line path predetermined for branch searching in library. The robot is programmed to move left, right, forward and backward. The robot guides the user depending on the input given to the robot using a push to on momentary switch. If the robot reaches the branch of books which is to be found out, then the robot gives location of the book to the librarian or the person visiting the library, in which the robot is used for searching purpose. This helps and simplifies the job and reduces the manual routine work done by the library staff and also helps the visitor. Microcontroller is one of the many types of controller that are used to control automatic machinery. It is popular due to its low cost, wide availability, large user base and an extensive collection of application notes. This work intends to design and implement a line following robot to search branch books in a library from different points in open space. This work requires the construction a line following robot and microcontroller control board for controlling the robot movement such as line following and identifying the destination points. This will save human energy and time for searching branch of books in a large library. Once the prototype is complete its use for application can be upgraded. A GSM module has also been interfaced with the microcontroller so that there is a communication between the librarian and the robot.

Keywords—Microcontroller, Library Management System, GSM module

I. INTRODUCTION

Globally emerging knowledge-based societies of the twenty-first century will need information to sustain their growth and prosperity. With intellectual capital as investments, knowledge and information have become wealth generators. In this scenario, who can deny the importance of libraries, which are repositories of knowledge resources? A library stacked with books and other information dissemination processes has a physical presence. A library is an institution of knowledge acquisition and learning; it provides invaluable service to its members, patrons, and to a wider community. Libraries are interested in saving time, money, and labor.

Libraries, however, often place excellent public services as their first priority, while still looking to save money and time. Shrinking budgets may dictate that fewer resources will be available for providing the same amount of services. Libraries are searching for ways to control costs, but without having to compromise their lifeblood - providing free materials and a full range of superior services to their users. Currently, technology is most often the hoped-for solution to tightened budgets. When budgets fail to keep pace with use or inflation, less staff is used to do more. Libraries are the source of knowledge and wisdom, but with the increasing education branches and new researches, million of the books are being added to libraries. Manual sorting and placement of these books in shelves is a time consuming and cumbersome process for humans. This often results in incorrect placement of books on shelves. Consequently people find it difficult to locate the book because the exact location of book returned by the database differs from its present location. Thus an efficient and automatic book placement system is required to facilitate the people in locating the desired book in a short period of time. If the book is not available or issued to some other person, then more time is wasted. A distant search mechanism is therefore desired so that the users get information regarding the availability of book and its location inside the library without coming to the library thereby saving the traveling time in case of non-availability.

II. LIBRARY MANAGEMENT SYSTEM

Library management is a sub-discipline of institutional management that focuses on specific issues faced by libraries and library management professionals. Library management encompasses normal management tasks as well as intellectual freedom, anti-censorship, and fundraising tasks.

For library management system, OPAC (Online Public Access Catalogue) is a computerized library catalogue available to the public. Users search a library catalogue principally to locate books and other materials physically located at a library. If the book searched by the user through OPAC is not located in the rack and shelf mentioned by the catalogue, then the user takes more amount of time to the particular book and also it is not very easy to find out single copy of any specific author in a very big library. In many modern libraries, library RFID management systems were implemented to make the search and inventory by reading the RFID using portable reader and portable computers [9]. It is possible to look up the misplaced materials, quick inventory and search for certain materials. But this method requires portable RFID reader, portable computer - Notebook PC or PDA (Personal Digital Assistants) and inventory and searching software. Book searching using RFID is much costlier. The electromagnetic tapes are to be pasted on all the books in a library. Further, to search for a book in a library, the user has to carry the portable RFID reader cum portable computer and searching software. The RFID has the limitation to work in the specific range and also it increases the initial cost of the system to make it operate on a wide range [17].

III. LIBRARY GUIDANCE SYSTEM

In modern days, a library is a collection of information, sources, resources, books, and services, and the structure in which it is housed. Apart from books many libraries are now also repositories and access points for maps, prints, or other documents on various storage media such as microform (microfilm/microfiche), audio tapes, CDs, LPs, cassettes, videotapes, and DVDs. Libraries have materials arranged in a specified order according to a library classification system, so that items may be located quickly and collections may be browsed efficiently. Reference stacks are different which has only reference books and only selected members. That means as big as the library the number of sections will also increase. Now with so many different sections it is not an easy task for a visitor to locate the desired section of his or her choice. That is why a library guidance system is important in a comparatively big library for guiding the visitor about the different sections inside a library so that the visitor at least gets some help to get familiar with the environment of the library. And the librarian can freely do the other worthy jobs of library and saves the valuable time and energy [18].

IV. PROPOSED METHODOLOGY

Once the main configuration is chosen, the first thing to do seem to be to make a functional block diagram as shown in Fig 1. It consists of a line follower robot which is being able to follow a line on the ground without getting off the line too much. The robot is built with ATMega32, L293D, IR sensors LM324, platform consisting of a toy car chassis (or handmade Al sheet chassis). The robot as shown in Figure 1 is designed using two motors controlling wheels. It has infrared sensors on the bottom for detect black tracking tape .It captures the line position with the help of these optical sensors called opto-couplers mounted at front end of the robot [12].Each opto-coupler consists of an IR LED and an IR Sensor) when the sensors detect black surface, output of comparator, LM324 is low logic and for white surface the output is high. It reports to the microcontroller for accurate control and steering of motors. Microcontroller ATMega32 and motor driver L293D were used to drive the motors. The robot has sensors installed underneath the front part of the body and two DC motors drive wheels moving forward. A circuit inside takes input signal from sensors and controls the speed of wheels' rotation. The control is done in such a way that when a sensor senses a black line, the motor slows down or even stops. Thus the difference of rotation speed makes it possible to make turns.

LCD for displaying the menu, motor for the movement of the wheels, switches for pressing the desired location. The block diagram of the Library Guidance System now includes the GSM module for the wireless communication between the librarian and the library guidance system. The Rx Tx pin of ATMega32 is connected with the Rx Tx pin of the GSM module via MAX 232. The SIM used by the module is SIM900. HyperTerminal is used for communicating with GSM modem through a basic set of AT commands.

The commands are:

AT+CMGF=1 is used to set the text mode

AT+CMGR=1, 2, 3 is used to read the short messages

AT+CMGD=1, 2, 3 is used to delete the short messages

AT+CMGS= "Cell No." text body ctrl Z" is used to send the short message etc.

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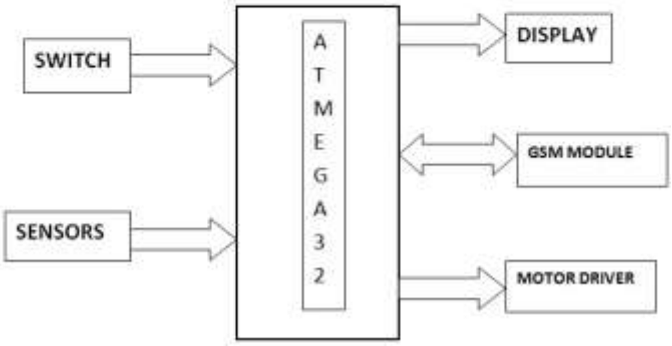

Fig 1: Block Diagram of the Proposed System

V. WORKING PRINCIPLE

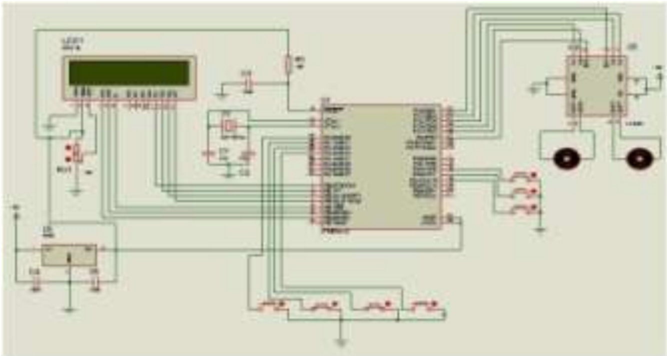

Fig 2: Circuit Diagram of the Proposed System

The circuit as shown in Fig 2 is designed around commonly available components like IR sensors, DC motors, etc. and popular AVR series microcontroller ATMega32. To provide the regulated power supply LM7805 is used where pin 1 is input where we can give 7-18 V DC. Pin 2 is ground and pin 3 is regulated output. To eliminate any noise in power section two 100 nF capacitors across pin 1 and 2 and 2 and 3. To provide power we are using step down transformer of centre tapped type, 220 primary, 12-0-12 secondary with 750 mA current rating. For rectification two IN 4007 is used parallel along with a filter capacitor of 100 uF/25 v.

The heart of the circuit is AVR ATMega32, which is using 40 DIP type pin layout. It has four ports of 8 bit registers. Pin no. 1-8 is PORT B, 9 no. pin is reset. According to datasheet if pin no. 9 is grounded the device will restart. For normal operation it has to be pull down near about ground, hence a 10 K resistance is pulled up at pin 9. A momentary tactile switch is connected across pin 9 and ground. Pin 10 is Vcc where we have to provide regulated 5V and pin 11 is ground. Pin 12 and 13 is for crystal oscillator. Here we are using 16 MHz external crystal with two 22 pF capacitor for noise reduction. As by default ATMega32 works with 1MHz internal RC oscillator (factory fixed) and has 2 MHz and 4 MHz internal RC but according to Atmel it is specified that instead of internal RC external oscillator must be used to prevent malfunctioning under noisy environment. But to use external oscillator we must have to set fuse bit. The fuse bit is configured for external oscillator with rail to rail frequency generator.

For controlling the motor we are using PORT C. but again by default PORT C is used for JTAG. The JTAG is debugger port for AVR. By default we can use PC0, PC1, PC6 and PC7. PC2, 3, 4 and 5 are dedicated for JTAG. To make the PORT C all bit usable we have to disable JTAG through fuse bit setting.

The electronic circuit is based on AVR Atmega 32. It is responsible for monitoring the IO pin status of the specific IO pins which are connected to four independent IR photodiode. As the IR photodiode provide very few current which is not enough to specify the digital status of the microcontroller. We need to gain the output for increasing the sensitivity of the circuit. The IR photodiodes are connected to the non-inverting output of OPAMP LM358. LM358 is having two

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independent comparator which can drive by +5V. Pin no. 1 of LM358 is non-inverting input of the 1st comparator. Pin no. 2 is the inverting input for the 1st comparator. The OPAMP is using in differential mode, where a threshold voltage is set at inverting input (pin 2) through a potential divider circuit (10K variable resistance). When the threshold input level at pin3 crosses the threshold value set through pin2, it will set high the non inverting output i.e., pin1. In LM358 the output at pin1 is almost equal to Vcc. As we are using 5V for LM358, the output will be enough to represent logical high (more than 3.3V). We are using four such comparators for the sensors as LM358 is having two comparators we are using two LM358. The 2nd comparator of LM358 is wired around pin 5, 6 and 7. Pin 5 is non-inverting input for channel 2. Pin 6 is inverting input and pin 7 is non-inverting output of channel 2.

The sensors (IR photodiode) are arranged as pair of Rx Tx in such a way that when the reflective surface is encountered by a IR Rx Tx pair, the transmitted IR will reflect back to IR photodiode which is using as input device for OPAMP input(non inverting). If output pin goes high, it will give us visual indication through the LEDs connected to pin 1 and pin 7 of the OPAMP through 470 ohm resistance. The program executing in the microcontroller is responsible for monitoring the status of the OPAMP output continuously.

As the BOT is black line follower, the algorithm is written is such a way that all sensor output will continuously monitored and if middle two sensor get reflected IR, microcontroller will assume that the BOT is going out of track. If the left sensor is getting high signal, it will assume that the BOT has to turn at the right side. Eventually if the right sensor is getting high (due to reflection of surfaces) it will turn the vehicle towards left. The four pair of sensors are using so that it always maintain the track.

Table 1: The Input Signal for L293D

A	B
PIN 2	PIN 7
PIN 15	PIN 10
0	0 STOP
0	1 CLOCKWISE
1	0 ANTICLOCKWISE
1	1 STOP

To control the rotation of the motor, we are using L293D which works as XOR gate. The input signal for L293D as given in Table 1
The control pin of the L293D is connected to PC0, PC1 for input signal of channel 1. PC6 and PC7 is connected to channel 2.
As the BOT is currently designed through delay implementation, we are using a delay function with variable input parameter.

The robot will move in four different directions: forward, backward, clockwise and anticlockwise depending on the particular switch that has been pressed after going through the menu displaying on the display unit. For displaying the menu and other related information a 16x2 LCD (JHD162A) has been used with 4 bit mode. Pin 11-14 (higher nibble) of LCD port is used for transferring data or/and command. Pin 15&

16 are having no relation with programming. It is just used for providing power supply for backlight LED. Pin 15 is known as LED+ and pin 16 is known as LED-. Pin 1 of LCD is ground, pin 2 is Vcc and pin 3 is for contrast control. Where a 10 K pot is connected to pin 3, one terminal of the pot is connected to Vcc and other is connected to ground. By providing different reference voltage the contrast of the output can be optimized. The next important pin in LCD is pin 4, 5 & 6 i.e. RS, RW and EN respectively. As to provide data or command we are having common path, we must have to specify whether

we are providing data or command to LCD. If RS=0, means we are providing command, RS=1, data. The RW pin is used to specify whether we are writing into the LCD (40 K internal memory and 4 buffers). As most of the time LCD's are used as output device (writing mode), the RW pin can be grounded directly. The EN pin of the LCD (pin 6) is known as enable but actually used for strobbing (high to low).As the BOT is currently designed through delay implementation; we are using a delay function with variable input parameter.

The BOT will move for a specific time period on the track to specify a distinct branch of books.

To interface with the user a 16x2 LCD and push to on momentary switch are connected in the circuit. The display unit will keep displaying the

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selection of branches by prompting and wait for key press. For simplifying the task we are using 3 switches. One for scroll up, one for scroll down and third for confirmation. When a particular branch is selected a predefined delay value will be used for travel the predefined distance. The robot is placed at a center point inside the library from where it will move in different directions as per the selection of the branches given on the menu. Suppose that switch 1 is allotted to Computer Science branch and switch 2 is allotted to Electronics Engineering branch, then after pressing switch 1 by a visitor it will move towards that direction where Computer Science is located and after showing the location the robot will move back to its original location. In a similar manner for switch 2 it will move in some other direction towards the location of Electronics Engineering branch.

VI. EXPERIMENTAL RESULTS

The prototype as shown in Fig 3 is successfully working and giving the desired output. The system will be kept in a center point from where it can move to different location as per the manual. When the momentary switch is pressed, it shows the Menu as shown in Fig 4 that has numbers allocated to different branches which are again accessed by pressing different switches. Depending on the switch number that has been pressed the robot will move in that direction to show the location of the branch to the visitor as shown in Fig 5. The librarian can be free to do the other valuable works of the library.

The Library Guidance System after interfacing with the GSM module, it can communicate with the librarian and gives the information of its whereabouts to the librarian as shown in Fig 6. The librarian can now easily be able to know whether any visitor is using the guidance system or not and if using then what is its present location.

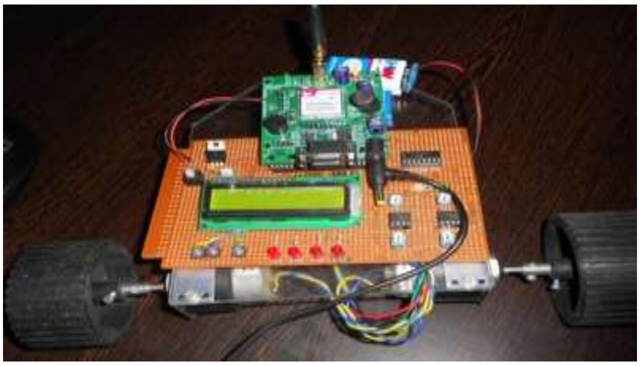

Fig 3: Figure showing the Library Guidance System.

The moment when a visitor comes and presses a switch of a desired location, the guidance system sends a message via SMS to the phone number of the librarian. The message consists of the present location or the location chosen by the visitor after pressing a switch.

Fig 4: Figure showing the display of Menu.

Fig 5: Movement of the LFR to reach the desired destination.

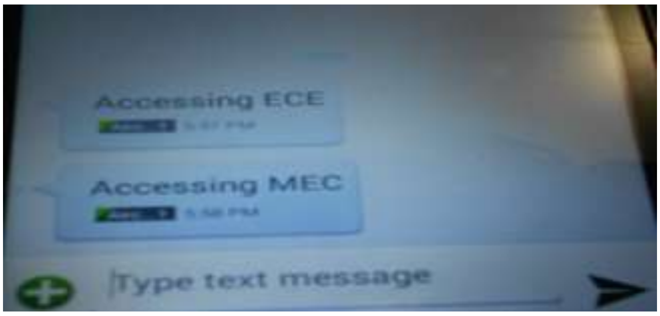

Fig 6: Picture of Mobile showing that a SMS has been received by the Librarian

VII. CONCLUSION

Making the Line Follower Robot was just the initial part of the work. After the movement of the LFR now it can be programmed to work as a Library Guidance System. The LFR has been interfaced with different other components to make it work as a Library Guidance System. Library Guidance System using Line Follower Robot is one of the many methods using which we can realize the system. There are of course some advantages and disadvantages of all the methods. In this system also there are some disadvantages. For example power is one of the problem, it continuously needs battery backup and should remain in ON state all the time. Also in case of any hindrance faced by the robot, it will remain stopped at that position and unable to do its task that has been asked to do. Some advantages are also there like we can use this type of LFR in many other places for different type of other tasks. It can be used in hospitals for serving patients with foods, water

or medicines in different beds. It can also be used in shopping malls for carrying loads and many other different advantages are there. Another advantage is that it is a cost effective system light weight and easy to handle. The robot reaches the branches of books which are to be found out, and then the robot gives location of the branch to the librarian or the person visiting the library, in which the robot is used for searching purpose. In case of any hindrance faced by the robot when it does the searching process, the robot halts. The prototype helps and simplifies the job of searching the branches of books in a comparatively large library and also reduces the manual routine work done by the library staff or the visitor in a library. This will save human energy and time for searching branches of books in a library. The limitation of the work is that the librarian cannot communicate with the robot. The librarian is now unknown about the location of the robot i.e. whether the system is in its working state or the system is not working. If there is a provision of communication between the system and librarian then the librarian can be able to know the location of the robot, whether it is working or not, and if working then what is its present location. Though there are many advantages of wireless communication, some disadvantages are also there. The disadvantage is wireless communication is paid service and so costing rate is high for every visitor visiting the

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library in a whole day and using the guidance system, because for every pressing of the switch it will send a SMS. Another disadvantage is that if there is no network or the network is down for any particular service then the system cannot communicate with the librarian.

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