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Intelligent TransHosp Medibot

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Abstract— Robots are fast gaining popularity in every field as they reduce human effort. In the medical discipline too, the uses of automatons are tremendous. They can be used in hos[itals for transport of drugs and other medicinal supplies, cleaning purposes as well waste management and disposal. In this paper, we propose a line following robot which modifies and adapts to the working environment of hospitals. We look to improvise the current line follower robot so that it can meet the needs of a hospital, by combining line following, obstacle avoiding, and an automated transporting. This medibot can be used in hospitals for transporting medicines, food, X-ray reports, linens and other materials. This, in turn, frees up the human resources of the hospital so that their ability to think can be put to better use which can lead to a lesser amount of patient casualties and provide better patient care.

Index Terms— Adaptive programming, Line Following Robot, Hospital Mapping, IR Sensors, Obstacle avoider, Path optimization, Proximity sensor

1 Introduction

In the modern age, the introduction of robots to replace manual labor has increased to a great extent. It is very likely that at the current rate of technological growth, robots would replace humans at all tasks including household, machine operation, etc.

In the existing working conditions of the world, hospital staff is burdened with a lot of tasks and work pressures [1]. Doctors, nurses, janitors have too many tasks to perform. This reduces their efficiency and leads to faults in the working mechanism of the hospital. Also at times of shortage of staff or emergencies, it can lead to chaos at the hospital. This calls for the need to develop a system that reduces work load and increases their effectiveness. The line follower transportation robot aims to lend out a helping hand and create a better working environment.

Fig. 1: A basic line following robot (Prototype of driving unit)

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In our project we aim to develop a robot that can be used to transport medicines, surgical instruments, patient clothing to their corresponding destinations as well as manage waste disposal.

2 Sysytem Design

This robot uses the basic hardware used in a line follower along with other hardware to implement decision making and interaction with humans.

The robot is mainly made up of a line following robot with additions and modifications done to its hardware to support the application. The additional parts include a small cabinet with shelves for various departments, distance / proximity sensors for obstacle avoidance, and electronic displays (LCD's and LED's) with switches for interaction with user.

2.1 Line Follower Robot (LFR)

The line follower is made using a sensor module and a motor driver circuit along with the microcontroller. The microcontroller takes the output of the sensors and depending on whether the robot is deviating left or right, the robot is realigned using the Pulse Width Modulation (PWM) channels given to the motors using the motor driver circuit using ATmega 640 and L293D.

2.2 Sensors

Decision making of travel path depends on the surface on which the track is made. Either the hospital floor or the ceiling can be used to mark the track. IR sensors are used for following tracks made on ground level while ultrasonic sensors are used for following tracks made on the ceiling. General IR sensors have a range of 5-10 cm although there are a few expensive sensors that offer a greater range.

Along with the above mentioned sensors, we also make use of proximity sensors. These sensors are mainly used in the task of obstacle avoiding. They ensure that the robot travels smoothly without collisions with a wall or human or any other object in its path. Proximity sensors generally come of the range of at least 20-25 cm.

The range of both types of sensors can be varied by potentiometers attached to sensor modules, which are desired to the application. The output of sensors is also affected by ambient

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light.

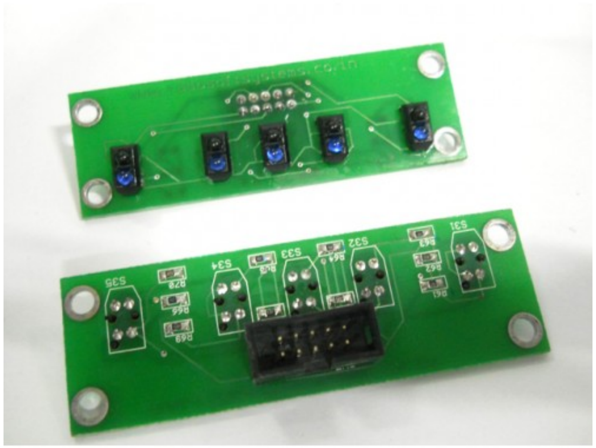

Fig. 2: Analog line sensing module with 5 IR sensors [2]

2.3 Microcontroller

There is a wide range of microcontrollers available that can be used to control the functioning of the robot. The use of ATmega IC's and ARM chips is common. A combination of different high speed microcontrollers enables faster processing and execution of instructions and commands. In this robot we have made use of the ATmega 640 chip. The requirement of higher memory chip comes with fact that the microcontroller controls movement of direction (line following and proximity sensing), speed of the robot (pwm to motor) and implementation of various functions such as running the LCD's, led's, switches, etc.

2.4 Chasis

The chassis of the robot is divided into major parts. The first being the driving section consisting of the line follower and the second being the attachable drawer with multiple shelves.
The driving section contains the IR and proximity sensors along with main body of a line follower robot. The top half of the driving section consists of all the major circuitry needed to power, drive and instruct the robot. The bottom half consists of the motors and the high grip tires and its circuitry.
The drawer section consists of multiple shelves stacked above each other. Each shelf is allotted to a particular department. It could include medicines, surgical instruments, sanitizing liquids and cloths, linens, etc.
The material used for building the entire chassis is a mix of acrylic, aluminum, plastic and metal. This allows the robot to be light as well as sturdy.

2.5 Motors

Considering the weight of the entire robot along with its load, motors are chosen to facilitate faster movement without overloading the power supply. DC Motors within a range of 200-500 RPM with a torque of 6-10 kilograms are used. These motors are controlled by a motor driver IC (L293D).

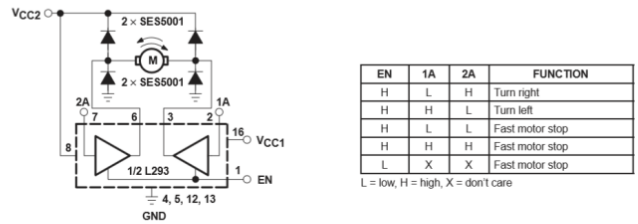

Fig. 3: Bidirectional DC motor control[3]

2.6 Interactive Devices

The use of interactive devices like LCD (liquid crystal display), led's makes usage of robots and machines much easier. LCD's combined with led's and switches help in decision making of which room requires the service of the robot. Led's are indicators of active functions as well as abnormalities in circuitry. Switches are used to activate or deactivate functions.

3 Algorithm and Working

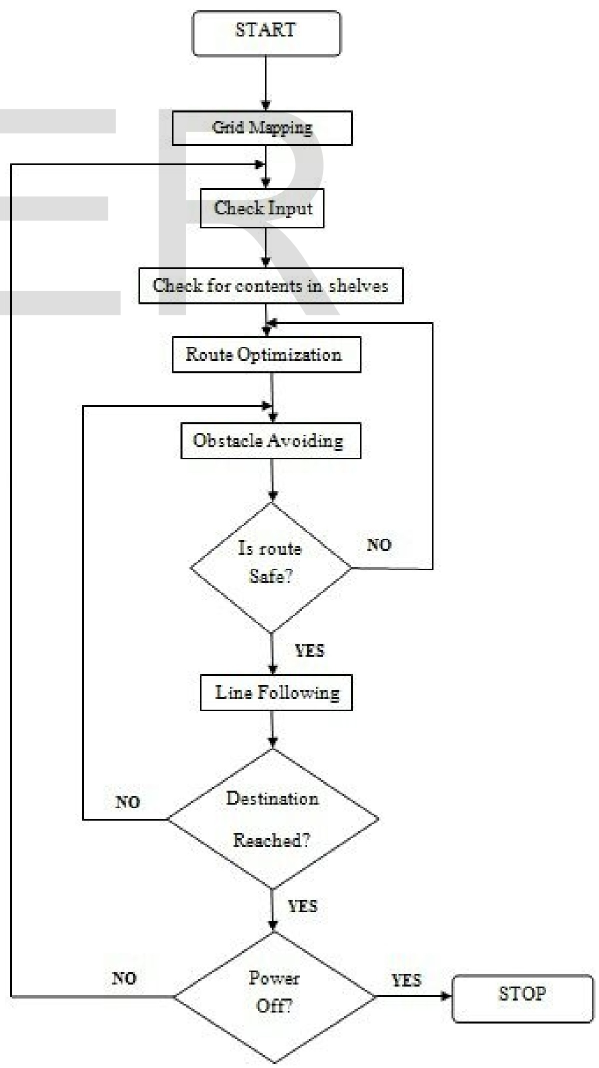

Fig. 4: Flowchart of code

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The main working of this robot is greatly understood by kmowing the operation of the software designed for it. We have used a single but larger and faster microcontroller to decrease the execution time of various functions. The ATmega 640 is ideal for such large and complex task management.

3.1 Code

Coding has been done in C language for easier understanding. This also facilitates greater compatibility and reduced complexity.

3.2 ATmega 640

The initial task of the microcontroller is grid mapping. Grid mapping is done only once. This involves scanning the layout of the whole hospital and knowledge of the track to various rooms and corridors. It thus determines all the paths it can use to reach its destination quickest. Fig. 8 gives a sample possible layout of a hospital with the tracks for the LFR.

The next part is taking input from its user (doctors, nurses) regarding its destinations. Input is taken with the help of the interactive LCD and switches. On basis of the input, the microcontroller maps out the fastest and shortest possible route to the destination. This is done via logic of path optimization.

This then activate the functions of line following and obstacle avoiding. The robot is coded to act as smart maneuvering vehicle with intelligent turning and rotational capabilities [4],[5]. The microcontroller rechecks input only on reaching its destination. This process continues in a loop all day long.

The prototype that we have can perform one task at a time and reach only a single destination at once.

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Device	Flash	EEPROM	RAM	General Purpose I/O pins	16 bits resolution PWM channels	Serial USARTs	ADC Channels
ATmega640	64KB	4KB	8KB	86	12	4	16

Fig. 5: Configuration Summary of ATmega 640 [6]

4 Advantages

The essential movement of supplies (medication, linens, food, etc.) from inventory storage to the patient happens in an uncoordinated and redundant manner. Our proposed system of the hospital transport robot can increase delivery efficiency, allowing clinicians to focus on patients and other staff to complete more essential, high-value tasks. It assists in most medical services of equipment distribution, pharmacy, food services, lab result delivery and waste disposal.

5 Disadvantages

The main disadvantage faced by our proposed system could come with different ambient lighting of various hospital rooms. Ambient light affects the movement of the robot. Rooms like OT's are brightly lit and rooms like morgues are dark. This affects sensor readings and hence the movement.

6 Experimental Results

The LFR unit shown below in Fig. 6 is the basic prototype of the driver unit used in the hospital transport robot application explained in this paper.

The LFR was tested under various test conditions like different ambient lights, power supply etc. Also the LFR movement was tested on various tracks such as straight paths, smooth curves and sharp turns.

6.1 Initial Testing

The initial testing began with tuning of the potentiometric sensors. The analog sensors give different values under various ambient conditions. The change in surface (i.e. black track on white background and vice versa) also affects sensor output values.

Once sensor settings were fixed, testing began on speed, turning and maneuverability. Motor speed varied by different pwm cycles were tested on a white track with black background. Speeds along straight paths and curves adjusted depending on sharpness of the turns. Test results show that maximum speed is attained on straight lines while minimum on sharp curves. Smoothness of movement is similar on straight and sharp curves while varying on smooth curves.

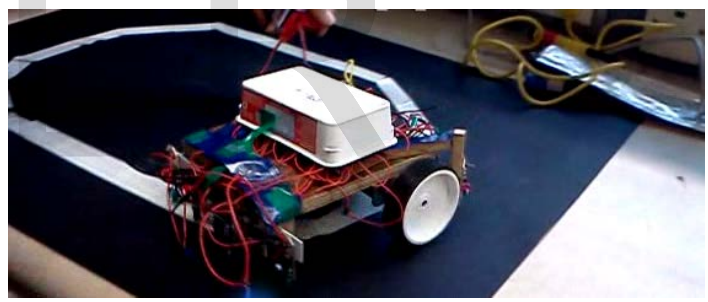

Fig. 6: Line follower unit under testing.
Surface: Chart paper; Track: smooth curve

6.2 Surface Testing

The next phase of testing came with the type of surface. The different surfaces used were chart papers, printed flexes, painted wooden floors and marble. The LFR was tested on parameters such as sensor readings, motor speeds, maneuverability, etc.

Experimental results determine painted wood as the best surface with greatest maneuverability and almost perfect readings. Chart paper comes as the next best surface for the LFR to work on. Printed flex and marble surfaces provide distortion in sensor readings due to excessive reflections. Also the smoothness of the surface leads to overshooting at turns. To avoid this we reduced speed, making the LFR slower.

6.3 Grid Solving Coding

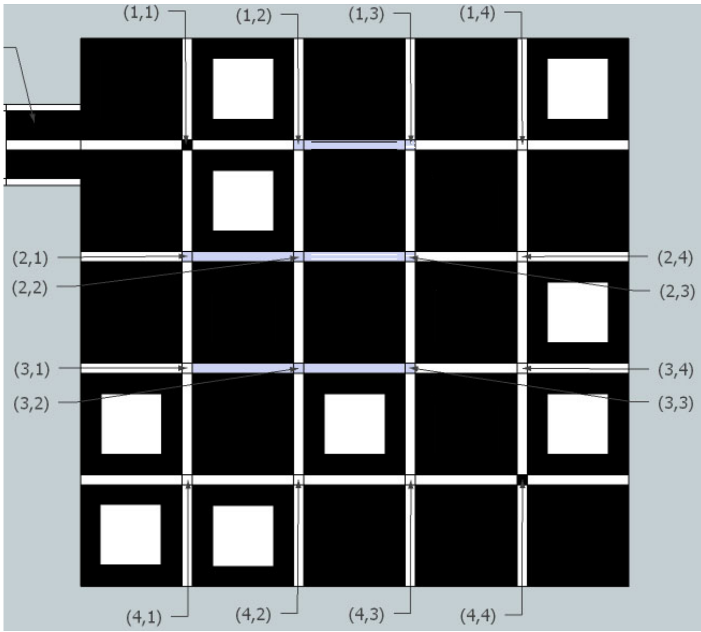

Fig. 7: 5×5 grid used for gridsolver testing with coordinate layout

The LFR was then coded in C to work as a gridsolver robot. The platform used to code was the Arduino platform and code was initially burnt on the ATmega 328 microcontroller. A 5×5 grid was used as the testing grid to verify the coding logic. The grid was comprised of 25 squares of dimensions 30×30 cm and 16 coordinates at the intersecting nodes of all squares. The width of track used is 3 cm and dimension of node / coordinate is 3×3 cm. The LFR was coded to move from one coordinate to another based on difference in distance between the coordinates. Coordinate system has been shown in Fig. 7.

The LFR code was verified by successful coordinate mapping and movement from one inputted coordinate to another.

6.3.1 Grid Solver Algorithm

Step 1*: Input sensor reading and find start of track*

Step 2*: Locate first node and proceed to find all other nodes&*

*** If s1=1 & s2=1 & s3=1 & s4=1 & s5=1 then motors= stop*

Step 3*: if node = found then node counter +1, locate the two black nodes. Finding of black node is indicated by LED*

*** 5 sensor module used (s1-s5). Node found when all sensors give a high output.'*

Step 4*: Finish memory mapping of grid*

Step 5*: Restart from start point and travel to the two black nodes*

Step 6*: Distance travelled = | f(x2, y2) – f(x1, y1)|*

Distance along x axis = | x2 - x1|

Distance along y axis = |y2 - y1|

Step 7*: A positive difference is treated as a right turn at next intersection while a negative difference is taken as a left turn*

Step 8*: LFR travels the |difference| (modulus of difference) and reduces the difference counter by 1 at every node passed.*

Step 9*: When difference counter = 0, LFR takes a turn depending on the sign of the difference.*

Step 10*: LFR moves along X-axis first and then Y-axis*

Step 11*: Reach of the destination is indicated by LED*

If x-axis counter=0 & y-axis counter=0 then led = glow

6.4 Hospital Grid Map

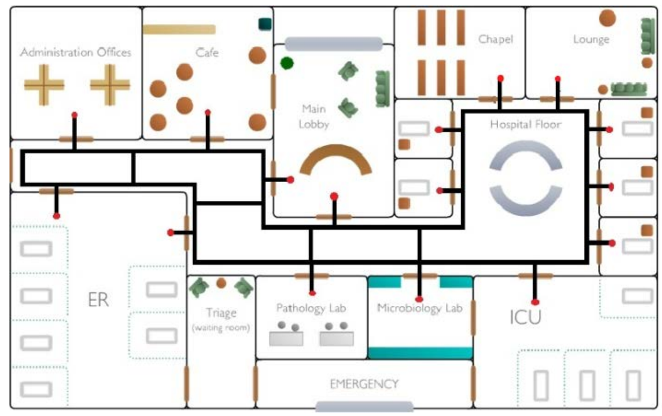

Fig. 8: Prototype of Hospital layout with track
Black line represents the track while the red dots represent the destination

The next phase of testing was mapping of the given hospital layout in Fig. 8. Although looking random, the track is created according a grid with the destinations being placed on nodes of intersecting grid lines.

7 Future Scope

The robot given above is coded as a single task robot. We plan to improve its performance by making it a multi tasking robot. It can take multiple inputs and sort them in a prioritized manner (e.g.: OT / surgical instruments, medicines, linen, etc.).

Another upgrade that can be made is to attach an arm to the automaton, and thus introducing it for hospital waste pick-up and disposal. This waste is generally harmful if it comes into contact with humans and with this method it is possible to eliminate the need of humans in waste disposal

This robot executes instructions coded into its memory. Its actions never change. A major improvement can be brought about by introducing RF into the application. With the help of RF, we can transmit snippets of instruction that are to be executed on the go. This is called adaptive programming and will help make the robot more versatile [7].

With upcoming improvements in technology, far more superior robots can be made that will assist doctors in surgeries or, maybe someday, even perform surgeries themselves.

8 Conclusion

With the ever increasing work load, patient casualties in hospitals, the need for a robot to assist in daily tasks has grown.

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Robot developers and manufacturers need to look into this field to and tie up with medical specialist to build robots to help out hospital staff and ease workload.

Our hospital transport robot aims to provide the basic help to nurses by taking care of most of the transport facilities.

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REFERENCES

[1] *Sumit Mittal, Dr. Neelam R. Prakash, Dr. Sanjay P. Sood, "A Line Follower Robot for Transport Applications in Hospital Domain", International Journal of Artificial Intelligence and Neural Networks, pp. 75-79.*

[2] *www.robosoftsystems.co.in*

[3] *Texas Instruments, datasheet "L293D Quadruple Half H Drivers", pp. 9, November 2004.*

[4] *M. Zafri Baharuddin, Izham Z. Abidin, S. Sulaiman Kaja Mohideen, Yap Keem Siah, Jeffrey Tan Too Chuan, "Analysis of Line Sensor Configuration for the Advanced Line Follower Robot"*

[5] *www.aethon.com/solutions*

[6] *Atmel Corporation, datasheet "ATmega 640/V 8-bit AVR microcontroller", pp. 7.*

[7] *Anjum Khalique Bhatti, Muhammad Iqbal Bhatti, Kamran Khowaja and Asadullah Shah, "Command Based Line Following Robot using RF Technology", Journal of Advanced Computer Science and Technology: Research 1, pp. 25-35, 2011.*

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