A Line Follower Robot for Transport Applications in Hospital Domain

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Abstract—**Medical robots are moving from the benches of laboratories to the bedside of patients rapidly. With advancements in technology, these are being used for minor services to diagnostic as well as therapeutic. The robots aims at saving human resources and also improving the hospital service. The navigation path planning can be concluded by an information decision making system. It is decided from the distribution of people in the hospital . There are many ways in which these robots can be performed. A few system uses appearance based approach, sensors or ultra sonic sensors. A few system found their paths using IR sensor. In this paper we compare such robots and propose a new hospital robot that works with IR sensor.**

***Keywords*—IR sensor, line follower robot, telemedicine, care taker.**

I. Introduction

"Telemedicine can be seen as an innovative form of healthcare delivery, telemedicine involves technology and process changes that will profoundly affect the organizations into which it is introduced."[1]. Telemedicine is the use of communication networks for the exchange of healthcare information to enable clinical care[2].

Telemedicine can be defined as diagnosis, consultation, treatment, education, and the transfer of medical data using interactive audiovisual and data communications[3]. Telemedicine is the use of telecommunications for medical diagnosis and patient care. Tele nursing is any nursing at a distance, mediated in whole or part through electronic means.

Patient care can be done by various new technologies. Robots can be helpful for the delivering of materials like food, medicines etc. Robots can be the newest members of the hospital support and nursing staff. From dispensing medication, to making deliveries and visiting patients, robots can improve the way hospitals function. Robots can help doctors reach patients across distance. They step in to handle nursing and support staff shortages and stream line many tedious administrative tasks.

In present time mobile robots can be use as Care taker in hospitals. They can assist but cannot replace the nurses. Rapid growth of robotic industry is leading to novel applications in medical field. Evolution of new terminologies like tele-presence, tele-medicine, tele-consultation, tele-diagnosis, tele-rounding, tele-health centers, tele-doctors, tele-nurses are overwhelming and required to be readdressed. Mostly these terms are overlapping. It may include consultation, assessment, diagnosis, treatment, transfer of health data, client education and professional development. Telehealth may use familiar technology such as telephone, e-mail, or personal digital assistants, or more complex technology such as remote control surgical instrumentation. Continuous monitoring of a patient is critical . For example, a lot of number of patients are admitted in hospitals. Regular check-up & delivery of medicine is highly demanded. Also effective technologies for remotely and monitoring the patient status is badly needed. The two key dimensions of telenursing are distance and electronic mediation. One part of telenursing involves the use of electronic networks, in the form of intranets, such as hospital-and community-based local area networks and wide area networks, while the other is found in Internet, which is a prime example of a global area network[4].

Robots can be the efficient messengers. They transport materials like food, x-rays, and linens throughout the hospital. Robot navigates itself to the room designated by room number on door plates. Doorplates contain valuable information for mobile robot localization, such as the different door numbers identifying different known locations. Localization is a fundamental and important capability for mobile robots to navigate in indoor environments. There are many methods to localize a mobile robot navigates, the known conditions of the environment, and the type of sensors with which the door is equipped. Effectiveness of everyday processes in hospitals can be improved. Staff can save considerable amounts of times, which in turn can be allocated to more patient related tasks. Therefore the quality of the service provided to the patient can be improved.

II. Review of the Automation Systems used in Hospital

Using robotic vehicles for transportation has been of a great interest in manufacturing sites for decades, where the environment often needed to be modified. In the last decade, these systems also became popular in hospitals as localization

techniques are more advanced, and range sensors are faster and more precise; which makes it possible to implement such systems with minor modifications in environments.
Recently, automation techniques are applied widely in many fields such as factory automation, office automation, hospital automation, building management automation. The purposes of automation are both to save time and manpower and to improve the service quality. Since the personnel of a hospital are always assigned several tasks at a time as a result of saving the hospital expenses. It makes the quality of the hospital service lower. Mobile robots stand out as the most prominent means of automation of transportation tasks in hospitals.

Mobile robots are extensive investigated in recent years. Their applications consist of labor, porterage, guidance, discovery. Since the increase in **DSP** techniques is **so** rapid, the research on mobile robots based on digital visual of processing are raised obviously. There are many ways in which these robots can be performed. A few system uses appearance based approach, sensors or ultra sonic sensors. A few system found their paths using MATLAB programming. In this paper we compare such robots and propose a new hospital robot that works on the principle of line follower. Generally, room recognition for the purpose of localization applies the same concept as pattern recognition. The development process can be separated into four major stages – the software development, the hardware design, integration of hardware and software, and finally the performance analysis for the overall system. let we discuss such system one by one.

A. *System Uses Appearance Based Approach*

The aim of system was to develop a room recognition system using appearance-based method for mobile robot localization. The room recognition was achieved by matching colour histogram of image using the Artificial Neural Network. A hardware module and a software module have been developed for the system. The hardware module consists of a catadioptric sensor system implemented on a mobile robot platform. The software module encompasses several sub modules namely image acquisition; image pre-processing; histogram plotting; histogram filtering, sampling and normalization; neural network for offline training and testing, and finally real time room recognition[5].

1) The Software

The operating system used for the software module is the Windows 98 or Windows 2000. The software was written in Microsoft Visual Basic 6.0 platform. Such system was developed on the basis of image recognition. The software includes functionalities for image acquisition, image conversion, plotting of colour histogram, filtering, sampling and normalization of histogram and finally a neural network for training and testing.

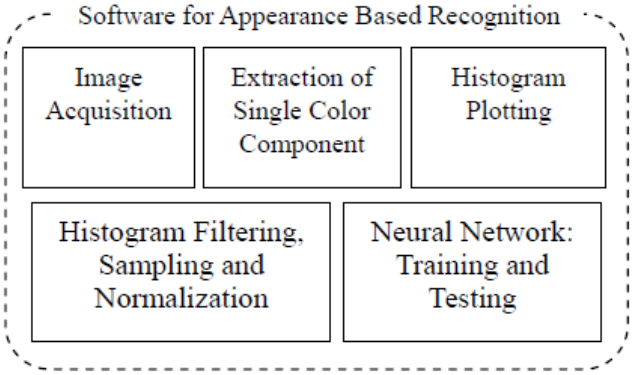

Figure 1:-Sub modules in the appearance based recognition software

2) The Hardware

Figure 2: BeMR with the catadioptric sensor

The mobile robot selected for sch system was the Bluetooth Enabled Mobile Robot (BeMR) from the UTM Robotic Research Laboratory designed by Yeong [6]. That robot had been equipped with multiple Human Robot Interaction methods and had the capability to perform domestic tasks under human control.*The* catadioptric sensor is constructed using a reflector ball, a shade and a webcam on an aluminium rod, then mounted onto the robot.

B. *System Uses Ultrasonic Sensors*

The ISHR was designed by combining information decision making system, image processing and ultrasonic sensing system . Since the hospital environment map can be regarded as known**,** the optimal navigation path can be concluded from information decision making system according to both the assignment of robots jobs and the distribution of people in each region of the hospital [7].

1) System architecture

In the system, the feedback signals was given by the visual system and ultrasonic sensory modules are provided the robot as the environment information for obstacle avoidance. Fig. 3 shows the system configuration of the IHSR (intelligent hospital service robot). In which, the visual system which consists of a CCD camera and the related image processing modules offers the processes and analyses of the images in front of the robot. It achieves the estimation of the relative obstacles' directions. Additionally, there are nine ultrasonic sensors set separately every 22.5" on the froe half circumference of the robot, whereby the distances between obstacles and the robot can he detected via the CPLD modules.

The PC serves as a control centre of the robot, in which, an integrated fuzzy controller infers navigation commands from the information of the visual system and the ultrasonic sensors. It then drives the motors to control the movements of the robot. The driver circuit is realized by DSP TMS320F2812. Besides, the power supply includes three 12V batteries, in which two batteries supply 1 IOV AC via frequency converter for the PC and the CCD camera, and the other directly supplies the DC power. The schematic plan of the robot is shown in Fig. 3.

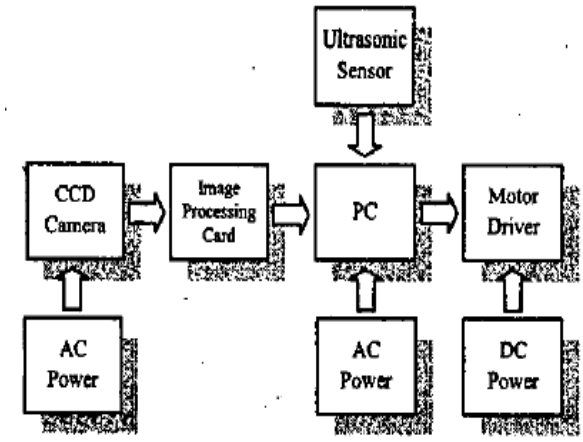

Figure 3: System configuration of the IHSR

2) Information decision making system

The information decision making system aims to integrate the task commands assigned to the robot and then to perform global path planning. 'Take the chart gather-dispatch as an example, since the charts of outpatient services are managed uniformly by personnel for filing, keeping and gathering-dispatching. However, in most hospitals, the charts always cannot be dispatch to each department on time owing to the shortage of manpower. It thus causes the clinic inconvenient and increases the waiting time. The IHSR was just designed to resolve such problems.

III. Line Follower as a Care Taker Robot in Hospitals

A. *Objective of Project*

The objective of the hospital transport mobile robot is to carry out such tasks **as** the delivery of off-schedule meal trays, lab and pharmacy supplies, and patient records. Unlike many existing delivery systems in the industry which operate within a rigid network of wires buried , a hospital transport robot is expected to be able to navigate much like a human would, including handling uncertainty and unexpected obstacles. This kind of robot can be used for military purposes, delivery services, transportation systems, blind assistive applications. Moreover, there are many annual line follower robots competitions organized by universities or industries around the world. They usually ask robotic teams for building a small robot with specific dimensions and weight according to the competition rules.

Generally, the line follower robot is one of the self operating mobile machines that follows a line drawn on the floor. The path is a visible black line.

The basic operations of the line follower based robot is capturing the line position with optical sensors mounted at the front end of the robot[8]. Most are using several numbers of photo-reflectors. Therefore, the line sensing process requires high resolution and high robustness.

This Project includes the mechanism of sensing the huddles while robot is in auto navigation system operation and it will be sensitive to the huddles in their path as well as if there will be any dump. While it is sensing all these huddles and try to self navigate itself.

This Is directed to the reflection of IR from any huddle and the receiving module which will detect a signal reflected by any huddle and give signal to the mother controller further it will follow an predefined logical operations to follow a right path via which it will easily step forward without touching any huddle.

This Project also includes the mechanism of line tracking with the help of IR based sensors. Here we used a

sensor plate which consist of 7 pairs of IR transmitter working in the concept of two pairs at a time. Transmitter transmits the IR and which will be reflected by the ground it depends upon the color of the floor that what strength of IR it will reflect back and then this reflected signal will allow to feed as the input to the comparator which takes the decision whether the color is odd or even then the pulses from this comparator will given to the controller as an input. With the help of predefined calculations controller will handle the pulses of the motor driver card according to that motors will work to make the robot path on the line always.

B. *System Architecture*

It consists of various aluminium base and stepper motors to transfer motion of a Robot.

Most of the motors we are familiar with spin when provided with electricity. The small DC motors found in toys have two wires coming out of them-- and batteries have two sides (+ and -), so it's pretty easy to figure out how to hook them up. Connect the battery to the motor one way, and it spins clockwise. Reverse the connection and you get counter clockwise. We can certainly use our parallel port bit wires to control the electricity feeding a DC motor, but because the motor spins freely, it is difficult to precisely control exactly how far it spin.

In the line follower robot project we have used pairs of IR (infra-red)emitter/sensor. The sensor on getting blocked or unblocked sends combination of high/low signals to AT89C51 microcontroller which are processed and appropriate signals are sent to L293D (motor driver chip) which switches on/off the motors so as to keep the robot moving in one direction

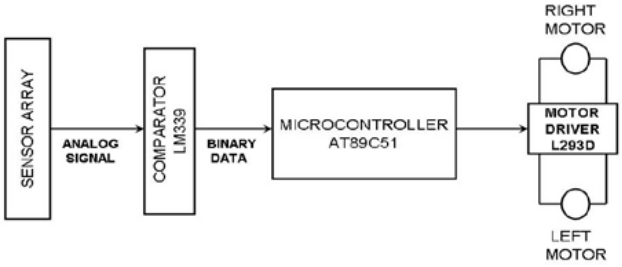

Figure 4. System Architecture

C. *Information Decision Making System*

Sensing a line and manoeuvring the robot to stay on course, while constantly correcting wrong moves using feedback mechanism forms a simple yet effective closed loop system. As a programmer you get an opportunity to 'teach' the robot how to follow the line thus giving it a human-like property of responding to stimuli.

D. *Working of Project*

The robot uses IR sensors to sense the line, an array of 8 IR LEDs (Tx) and sensors (Rx), facing the ground has been used in this setup. The output of the sensors is an analog signal which depends on the amount of light reflected back, this analog signal is given to the comparator to produce 0s and 1s which are then fed to the microcontroller.

Figure 5. Line follower based Hospital Service Robot

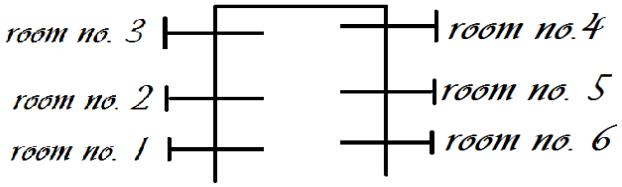

Figure 6. Hospital Corridor

A hospital corridor is given as shown in figure. HSR will start moving in direction of the path given. It will follow the line which is given to it. For example if we want to send our material in room no. 3 then we will input the room no. through input keys. Robot will move on the line.

As we are having in corridor figure lines in front of room no. are intersecting the main line. As the robot is moving on main line it will count 1 for first intersection, count 2 for the second intersection and so on. As we have input the room no. 3 system will count till 3. As soon as the count is equal to the input it will move to the left of its path. The robot will enter in the room and get stop as soon as got the next count. Now a massage will be displayed on the LCD "collect your material". Sensor on the top of the plate will sense the collection of the material. As the person will collect his material the robot will take **U** turn and will come back to its initial position.

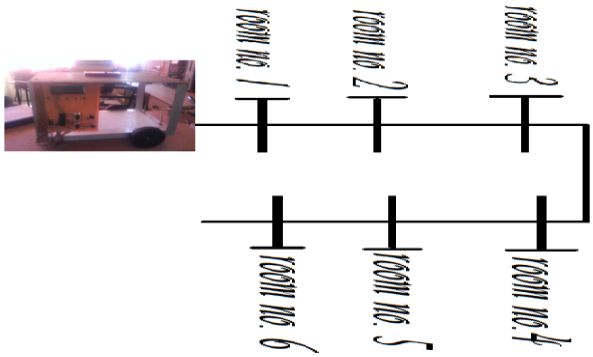

Figure 7. System in hospital corridor

Conclusion

In this paper different techniques and robots are review that are being used as hospital service robots and a system is proposed that is based on line follower concept and can be used in hospital items delivery purpose. An IR sensor based hospital service robot is proposed to assist us in hospital. After the task and material are assigned to the robot, the robot will follow the line to the destination and deliver the material. The navigation control is based on following of the black line. After the simulation results, it is seen that the system is indeed able to travel in a hospital collision free.

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