Hospital/Home Medical Assistant Robot

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Abstract. Now a day’s health-care facilities increasingly depend on health-care staffs. By aging populace, there is an upsurge in number of old people present in the labor force and even in health-care division. It is significant to take care of aging workforce present in healthcare sector. So, for this process hospitals are providing an opportunity to mobile robots because of rapid technological progress accomplished of working and cooperating with humans and surroundings. This paper presents a design of Hospital/home medical assistant robot that consist of both combination of network system and robotics system for transmitting, receiving and sending information to care taker or doctor. As the robot gets a distress signal which is obtained from the patient, it tries to contact the care taker or doctor. If the robot is unable to contact, it will try to find out the location of doctor or the care taker and then display the condition of the patient so that the doctor can act as early as possible. Doctor or caretaker can access the robot at any time and get the live video feed of the patient at any time.

1. Introduction
In recent years, due to the increase in development in the field of Technology, robotics is rapidly making its way into new areas. Most of these were once completely under human labour. Nowadays robotics is applied in every field possible. There are fully independent mobile robots which can support humans, servicing devices besides it can also be used to perform other autonomous function [1]. Robotic markets are having a rapid development by introducing it in offices, hospitals, and homes. Robot development platforms basically uses service robots that can move from source to destination, this ability is used in several industries for automation and processes of collection [2]. Most of presently executed mobile robot works with respect to the changes made in the environment that can be altered to deliver artificial benchmarks which is used controlling the mobile robot from one position to another [3]. Some constrains are not always well recognized, especially in industries that has limited changing options [4]. There are other constraints that can be changed in the work area. Fixing of reflective markers in work area which is visible all the time is one of changes that can be applied. If something is obstructing the marker, the robot does not have the ability to reach destination. In order to avoid these kinds of situations, a path planning concept with an obstacle detection module can be used, such that it can follow a path at the same time it can avoid obstacles which may appear on the path. In many countries such as Singapore, Japan, India by 2035 one-fifth of total populace are over 65, by 2050 these countries will be the fourth, fifth and sixth oldest countries[5]. More people are affected with chronic diseases. By that time healthcare services increasingly rely on health care staffs and thus there will be need to upgrade healthcare staff workflow. It is vital to take care of aging
workforce present in healthcare sector. For this process hospitals are providing an opportunity to mobile robots because of rapid technological progress which can operate and interact in an environment[6]. Public health services always depend up on the people working in it. These health workers contribute almost 90 percentage of the total provided services. So, if the new technology can help these workers not only with the health services but also for their health improvement, then the overall working efficiency of the health system can be improved to a significant level[7]. Automated mobile robot platforms have high market for hospitals environment[8]. Calculations shows that, there is a steady improvement in work efficiency and reduction in annual cost by using robotic units[9]. However, there are certain things that needs to be discussed with consumers. For people who are completely new to this technology can react at first but once the popularity of the robotic technology rises, acceptance will be there [10]. Here we discuss main throwbacks that has to be evaluated when designing hospital-based systems. There are incidents where the healthcare personnel were unable to attend the patient at exact time frame which lead to the health issue of the patient. This paper presents a design of hospital/home medical assistant robot that consist of both combination of network system and robotics system for transmitting, receiving and sending information to care taker or doctor.

2. Methodology

![Methodology flow chart](image)

The methodology of the creation of this robot has been classified mainly into three parts which includes structural design, fabrication of the proposed model and test run analysis. Preferred steps taken in methodology of work is being shown in figure 1. Initial step is to distinguish the problem faced. The second step is to build up the idea which can overcome the problem.
Start

Initial the process

Check for error

If error observed

Stop

If no error observed

Check for function input

If no function input present

Analyse the function input

Surveillance Function

By-stander Function

Figure 2. Basic movement algorithm.
Start
initial the process

Check for error
if error observed Stop

If no error observed
Check for sensor values
(r1, r2, r3, r4)

Check for binary input values
If (r1=r2= r3=r4=0)
Check for binary patient input
If yes, turn towards patient and camera movement
Backward movement to reach black line

Check for binary inputs from movement
Turn left or right

Figure 3. Surveillance algorithm.
When the idea is developed for the recognized issue, the diverse conceivable outcomes of the idea is then portrayed out and examined. The ideal solution for the issue is obtained after the investigations. The following stage is to build a desired CAD model. With the help of the modelling software, the stability of the desired model is examined. Next stage is to fabricate the robot. After that point, an algorithm was generated for the path planning of the robot. The proposed design and basic program for the movement of the robot was done. And also, web-based program for data analysing was also designed. Whenever a signal is obtained by the robot, it first analyses the signal and check whether the signal is containing distress signal or not. The distress signal is defined as a particular word or any sound that determines the person is not feeling well and need medical assistance as early as possible so the robot, initially analyse for the distress signal and if there is a presence of distress signal it tries to contact the care taker and will try to reflect the condition of the patient. If the caretaker is not responding to the communication established by the robot, then the robot finds its way to the care taker and then display the condition of the patient. As the figure 2 illustrates, the robot initially starts and check basic movements such as, side wise, to and fro movements and also sensory input values. If error is found from these movements, it goes idle and a red light will be shown, which allows the user to correct these errors. If no errors are to be found, then the robot checks for function input details. The working of the robot can be classified into two functions.

Surveillance function: When the robot is in surveillance mode, it moves from patient to patient and then obtains data such as temperature readings, glucose level etc. which are displayed near the patient. All these data are obtained from the robot through a live feed and the care-taker can access this live feed as long he/she is in same network stream. Robot travels from one patient to another on a defined path which is the line follower concept. At the same time, it also has the ability to detect the obstacles present in between these defined paths and avoid it. As the figure 3 illustrates, initially the robot checks for errors and then function input. When surveillance mode is active, it checks for input sensory values. Sensory value determines whether the robot has to move or if it is near a patient. All these can be determined from binary data that we get from sensors. Here, the robot consists of four sensors. So, we can get up to sixteen binary data from the sensors. By adding more sensors, a greater number of functions and accuracy can be obtained. We have programmed these binary data as functions in such a way that every time when the robot recognises a binary data of a patient, it turns towards the patient and then loops the camera to obtain patient data and finally move backwards to black line. Similarly, these functions determine whether the robot needs to take a left turn or right.

By-stander function: When the robot is in by-stander mode, it closely observes the patient. At this point the robot is in need for a trigger. The word ‘help’ is the trigger for the robot. As the robot hears the word help from the patient it tries to go to some defined points on the path (figure 4). These points are where we can find care takers. Care taker or the doctor can access the robot network can see how the patient is doing at any point of time. In this way the doctor can attend to a lot of patients without even going near the patient. When the robot is in by-stander mode, it does not check for sensory values initially. But it always checks for movement errors. If no movement errors are to be found, it checks for the word ‘help’ from the patient. When the word ‘help’ is recognised by the robot, it triggers a function and the robot moves backward towards the black line. When the robot reaches the black line, if waits for the sensory input value from the IR sensors. Based on the input values obtained, it starts moving towards the care taker position.
Start

initial the process

Check for error

if error observed

Stop

If no error observed

Check for voice input

if no voice input present

If (r1=r2=r3=r4=0)

Check for sensor values
(r1, r2, r3, r4)

Follow the line

Backward movement

If voice input is present

Figure 4. By-stander algorithm.
2.1. Designing of CAD model
After considering different aspects which are important for a mobile robot that has to be moved on a plane surface, a CAD model was designed (figure 5). It was designed in a compact manner. Mecanum wheels were used as rotatory part so that direction of the mobile robot is controlled by changing the direction of rotation of mecanum wheels. Two layers separated with a space was used in the design, which can be used for placing drives and controllers.

![Figure 5. Designed CAD model.](image)

![Figure 6. Fabricated model.](image)

2.2. Materials
After analysing different materials that can be used in a light weight mobile robot, acrylic sheets were considered because of its durability and availability. As for the rotatory part, 12v of four dc motors with each having a 1 ampere rating was considered. Ultrasonic sensor is used for obstacle detection and a 5mp camera module is used for real time video streaming. A raspberry pi is used as the controller of the mobile robot (figure 6).

2.3 Path planning method
Communication of the robot is mainly done with help of a hotspot device. These hotspot devices act as a medium of data transmission between the user and mobile robot. For basic movement control and live video streaming, lighttpd server is used. Lighttpd server is light in case of data transmission and since it can be used to send stream of data and load these data at the same time. A basic html file is created for the access of mobile robot and the live video stream data display. Path planning comes when the robot travels from the patient position to the caretaker position. Each time when the robot moves from one position to another, it tries to determine if the care-taker is there or not. If the care taker is not there, it moves to next position and display the condition of the patient.

![Figure 7. Defined path.](image)

The above figure 7 illustrates the working area where the robot was tested out. As the diagram shows, different points are marked which represents positions of the robot. Here ‘A’ represents the initial position and ‘B’ represents patient position. Initially it moves from start position to patient position as shown below in figure 8.
As the robot reaches position ‘B’ it searches for any distress signal from the patient and waits for it. If any distress signal is obtained it, then the robot searches for caretaker in the nearest position available. Robot moves from position ‘B’ to available positions which are positions ‘C’, ‘D’, ‘E’. At each position robot reaches it tries to find the caretaker and then display the position of the patient. As the robot moves from one position to another there are chances of finding obstacles as illustrated below figure 9.

The robot was initially programmed to move from one position to another. But obstacles present in between the points should also be considered because it can affect the path which was already decided and programmed. In order to avoid any obstacles that appears, an ultrasonic sensor is installed and minor change in the path is programmed as illustrated below in figure 10.

As the figure 10 illustrates, the new algorithm allows the robot to deviate slightly from its actual path and then avoid the obstacle and then return to the decided path. In this way the robot can reach care taker positions by avoiding any obstacles present in between.

3. Experimental Trail
The tests were performed in an environment as shown in figure 7. Robot was programmed in a way such that, it moves to patient position initially and then after obtaining a distress signal it moves towards the care taker positions labelled as ‘C’, ‘D’, ‘E’. Movement from one position to other position is with the help of line follower concept.
As the robot moves towards the care taker positions, different types of obstacles were placed and tested out to understand how the robot reacts to the presence of obstacles in the pre-programmed path. Around 45 tests were run and results were satisfactory. Accuracy of the robot was increased by reducing the movement speed. As each time robot chose different path to find the care taker, obstacles were placed and tests were carried out. Path that connects the patient position and the robot position is the path planning concept used in a line follower. Instead of using two IR sensors, four were used to increase the accuracy. All other path is selected by the robot with respect to the presence of availability of care taker.

4. Conclusion
Main objectives of this work is to, obtain the distress signal from a patient, real time patient monitoring and display the condition of the patient to the care taker by locating different positions, results are satisfactory. The tests were conducted in a compact environment composed of four different rooms. The robot travelled correctly from the initial position to patient position and then went to locate the care taker position accurately. The results obtained from the experiment reflects the feasibility and efficiency of this developed technology. By integrating machine learning and machine vision in this robot which can yield high efficiency can be done as future work.

5. References
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