Automated Robot for Field Navigation in Multi-Floor Environments

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Abstract
In certain situations people need to go some places without having any previous knowledge about the locality. This condition may occur when the place is not visited ever before, or even when there is not any available sources to situate them in the current position. In those cases, the marks of the environment are essential for achieving the area. The same condition may happen for an autonomous machine, i.e., robot. This kind of robots must be talented of solving this problem in a talented way. In order to do this, the robot must use the resources present in their atmosphere. This paper offers a RFID based system, which has been developed to guide and give important information to an autonomous robot. This robot will detect the patient's abnormal condition and it immediately communicates it to the doctor. This system has been implemented in a real indoor environment and it has been successfully proved in the autonomous and social robot. At the end of the paper, some experimental results, carried out inside the hospital building, are discussed.

Keywords: *Autonomous robot, navigation, RFID, social robot, path finding*

INTRODUCTION

In a large multi floor hospital consisting of various medical departments, it will be too difficult for the peoples visiting to reach the place they need. In case the patients get appointment to visit the particular medical department at specified time, they may get lost, finding throughout the hospital. This may happen exactly to the elderly peoples. Many guidance systems have been proposed for them. For example Wi-Fi positioning system enables the user to find the exact location. But it uses the frequency of 2.4 GHz radio waves affects the working of medical equipment. On the other hand

Received Signal Strength Indication (RSSI) and Dead Reckoning with acceleration methods rectifies the disadvantages in Wi-Fi positioning but it produces some errors. The error values further increases with respect to the RSSI values.

To overcome the above hindrances, an RFID based autonomous robot is designed for field navigation for elderly peoples who were in need of guidance to reach their destinations [1]. And also in case of delivering the equipment or files to the specific user, it can be used to reduce the man work. The temperature, heart beat and other parameters of the patient are monitored and in abnormal situations it is communicated to the doctor for providing the first aid. Here, our robot uses advanced technologies for elderly and severely diseased patients for their health and transportation needs. Our autonomous robot finds the shortest path to reach the destination via routing algorithm. If any obstacles found, it will wait for some time for the route clearance and in case the obstacle is immovable then the robot finds the alternate way to the destination [2].

The majority of smart-home applications are oriented to make the environment more comfortable for people. However, our objective is to incorporate radio frequency identification (RFID) technology in those environments to facilitate the navigation of autonomous robots, as future human companions. In order to implement the proposed system, it is necessary to slightly modify the environment by adding the signals. Therefore, the robot has access to the needed information to guide itself in the environment and to carry out its navigation task successfully.

RELATED WORKS

Guidence in Hospitals

The various guidance schemes proposed earlier for the simplicity for the peoples are discussed below. As we know that there are various medical departments in multi-specialty hospitals [3]. Many guidance systems were introduced in hospitals demonstrating the direction of the various medical departments. The peoples should visit a lot of checkup rooms (e.g., XRAY scan, ICU, endoscopy, etc.) that are apart from each other. For this reason, route of medical examination is complicated and guidance in a hospital is an important issue. The people may feel difficult to reach out the department they need to visit. However, automated guidance which can lead visitors to an appropriate place at an appropriate time has not been established yet although IT is utilized for various activities (e.g., Electronic Health Record) in hospitals.

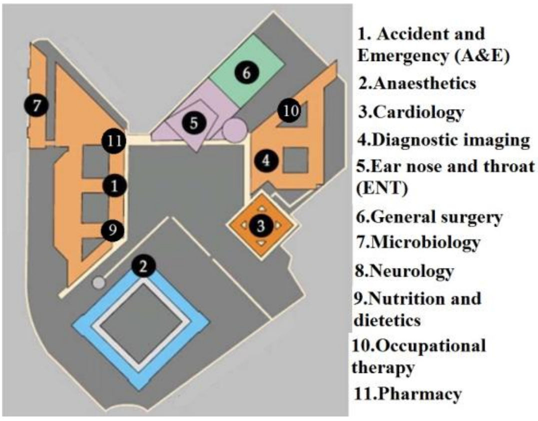

Fig. 1: *A Lot of Destinations Listed Above in a Hospital.*

Existing Studies

The term Indoor Positioning Systems (IPS) primarily concerns location-based services on mobile phones where GPS does not work. The term Real Time Locating Systems (RTLS) primarily concerns locating people and things at a distance, securely, using second generation RFID. This subject heavily involves short range communications notably Wi-Fi and Bluetooth and inertial navigation and advanced RFID as it progresses to determining 3D position including orientation and line of travel [4]. Real-time locating systems (RTLS) are used to automatically identify and track the location of objects or people in real time, usually within a building or other contained area. Wireless RTLS tags are attached to objects or worn by people, and in most RTLS, fixed reference points receive wireless signals from tags to determine their location. Examples of real-time locating systems include tracking automobiles through an assembly line, locating pallets of merchandise in a warehouse or finding medical equipment in a hospital.

Wi-Fi positioning system (WPS) is used where GPS is inadequate. The localization technique used for positioning with wireless access points is based on measuring the intensity of the received signal strength (RSS) and the method of "fingerprinting". Typical parameters useful to geolocate the Wi-Fi hotspot or wireless access point include the SSID and the MAC address of the access point. The accuracy depends on the number of positions that have been entered into the database. The possible signal fluctuations that may occur can increase errors and inaccuracies in the path of the user. Radio Frequency (RF) trilateration uses estimated ranges from multiple receivers to estimate the location of a tag [5]. RF triangulation uses the angles at which the RF signals arrive at multiple receivers to estimate the location of a tag. Many obstructions, such as walls or furniture, can distort the estimated range and angle readings leading to varied qualities of location estimate. Estimation-based locating is often measured in accuracy for a given distance, such as 90% accurate for 10 meter range.

Systems that use locating technologies that do not go through walls, such as infrared or ultrasound, tend to be more accurate in an indoor environment because only tags and receivers that have line of sight (or near line of sight) can communicate. But the main disadvantage is that GPS positioning system may produce inaccuracy in indoor areas while positioning using Wi-Fi, may not available in hospitals [6].

Objectives of this study

Considering these situations we propose a guidance system which utilizes RFID technology to identify the exact place the people need to visit with the help of autonomous robot. The aim of our study is to develop a guidance system on device including smart user interface which can be used by elderly people [7].

PROPOSED SYSTEM

Overall Structure of Proposed System

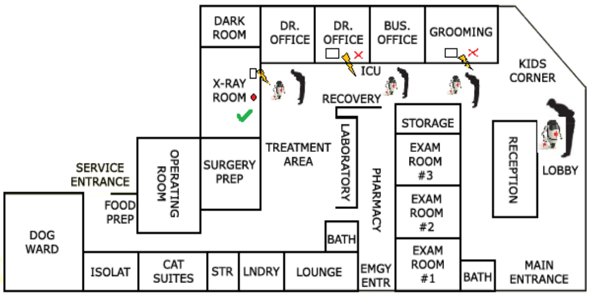

Fig. 2: *Overview of the Guidance System in a Hospital using RFID.*

Figure 2 shows an overview of the proposed guidance system in the hospital. The autonomous robot guides the people to reach their destinations in the simple approach.

The procedures of the system are given as follows:

1. First of all user need to enter their destination in the robot.
2. The robot searches for the paths available and locates the destination by finding shortest path among the routes available.
3. The RFID tags are placed in the walls of every room.
4. Then the robot guides the people to reach the destination when the tag matches with the frequency preset earlier.

In this study, the user needs to select the destination where they need to reach. It can be used to carry or transport the equipment to certain places. It also monitors and reports the abnormal conditions of people who are accompanying with to the doctor.

Fig. 3: *RFID Tag.*

Real Time Experiments

In real life, generic signals are used to indicate common places such as the "Exit" signals, the "All directions" found in highways and so on [8]. In our design, connections to generic places are proposed. Therefore, the robot has other options in case of being in case 4 so, if it wants to go to another floor, it will look for the "Escalators or Elevators" generic signal. In summary, the process can be described as follows.

1) The assigned goal is compared with the place indicated by the signal.
2) If there is a coincidence, then this means that the robot has arrived at its destination.
3) If the current place does not coincide with the goal place, then the robot looks for a connection which indicated how to get to the goal.
4) In case of coincidence, the action (or set of actions) to reach the goal or the next signal is executed.
5) In the case of no coincidence, the robot can select among the actions previously explained in case 4).

REAL TIME IMPLEMENTATION

The implementations of this real time system are easy to design and are discussed below. The exact floor plan of the hospital is first considered. Then the algorithm is designed to calculate the shortest path to reach the medical departments form the lobby. The Radio Frequency Identification tags are placed on the walls of the each medical departments, reception, escalators and floors, which will be very useful for the robot to locate where now it is.

Whenever, the people enter the key for where they need to go for, the robot locates the place where it is and finds the shortest path for the medical department. The robot follows the path calculated and RFID tags placed on walls. Occasionally, if any obstacle is detected on the path then it calculates another path to go through and follows it. When the destination place RFID tag frequency matches with the frequency set by the user by entering the key, then that will be the destination. The robot can be used for carry out the medical equipment. And also in addition to this the patient's normal and abnormal condition are monitored regularly and it is communicated to the doctor when it goes to serious level.

Fig. 4: *Model Robot.*

EXPERIMENTAL RESULTS

Here, we present two experiments made to prove the successful performance of the signage system and the navigation algorithm proposed in this paper. These experiments were carried out on the third floor of the Apollo Hospital building shows a view of the navigation area of the robot and its initial location.

Experiment 1

Objective

The robot must go to the XRAY Lab (1.3.C.13).

Description

Initially, the robot is beside the reception, which is located in the corridor in the zone C. The robot does not know its own location until it reads the RFID signal located on the wall. The autonomous robot identifies its exact position once it reads the Radio Frequency Identification tag (RFID tag), which is also situated next to the reception. This experiment tests the behavior of the robot when mobile obstacle is situated at the goal's position. Therefore, the robot will not be able to read the signal goal.

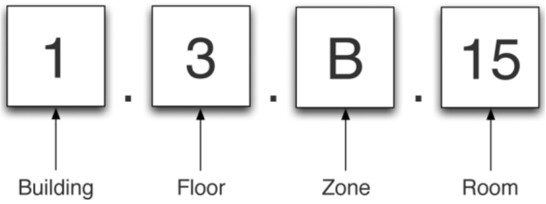

Fig. 5: *Alphanumeric Code for Identification.*

Input Data

Assigned goal: *XRAY LAB-1.3.C.13*.

First detected signal: place: *Reception-1.3.C.f.*

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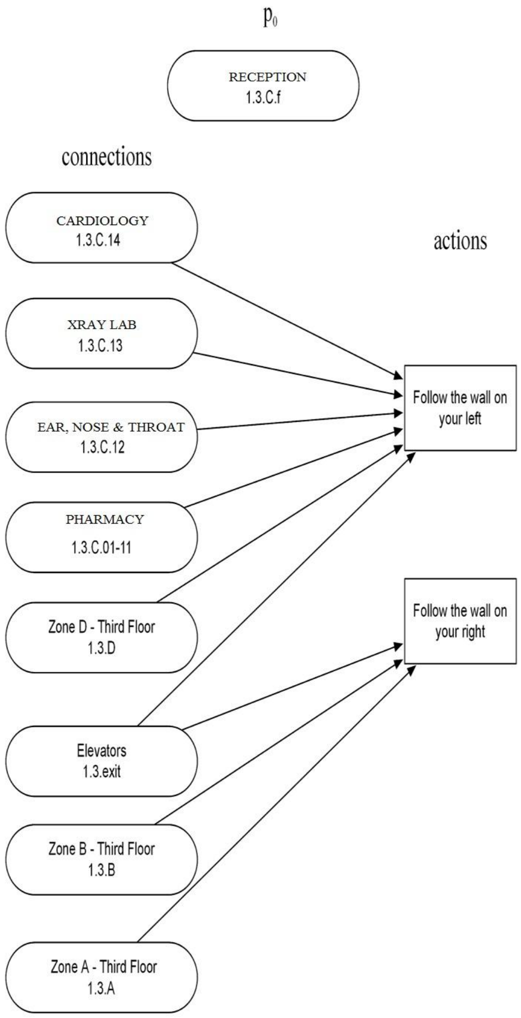
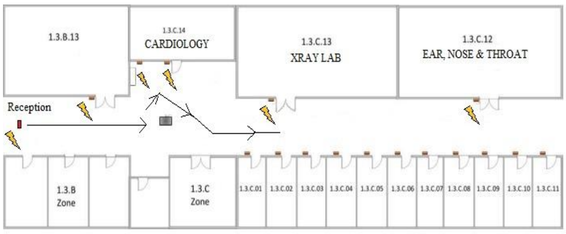


Fig. 6: *Information Stored in the First Signal.*

Process

Initially, the robot detects the first signal and reads the information about its current location and the possible places where the robot can go to from that place.

As already explained, the robot compares the assigned goal with the place indicated by the signal. If those places are different, then it starts to compare the goal with the places indicated by the connections. In this occasion, the assigned goal corresponds to one of the connections. Then, the robot activates the "follow the wall on your left" skill and is executed until it finds a new signal. As shown in Figure when the robot arrives to its destination, it is not able to read the correspondent signal since there is an object (the grey square) in front of it. Therefore, the robot finds another route with the help of RFID tag placed on another side of the wall.



CONCLUSION

Thus, the low cost public service robot is easy to implement as it takes almost care for the elderly people who were to search for the examination room among the multi-floor building. In the experimental result it has been proved that signals are a great support for autonomous robot navigation, when they do not have a previous knowledge of the environment.

FUTURE WORK

Finally as future works it can be expanded from RFID signals to various convenient signals to the environment. Whenever if the RFID signal is lost, then it should works with the alternate signal. The navigation algorithm can be proposed in new way to increase the performance of the public health care robot.

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