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Design and Control Development of an Autonomous Visitor Guiding Robot in a Hospital Environment

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Abstract

Mobile robot technology, coupled with artificial intelligence, has reached a point where robots can now autonomously navigate and store area data, while the integration of smart sensor and controller technology enables them to detect and adapt to dynamic environments by making predictions under diverse conditions. In general, hospital visitors do not have sufficient preparation and knowledge accompanied by sudden situations, this often makes visitors, namely patients and patient companions confused and panicked. The reality is that until now, many visitors are still pacing in the wrong room, asking the officers many times, which eventually leads to misunderstandings by visitors to the hospital system, facilities, and services which are considered complicated and make visitors dissatisfied. Applied technology innovation Design and control of autonomous visitor guide robots in hospital environments (Viguro Robot) offers solutions using interactive robots that can provide location information and deliver visitors to their intended location. Artificial intelligence is employed through the utilization of sensors, digital data, or remote input, allowing the amalgamation of hospital patient data, instant material analysis, and the utilization of insights derived from Viguro Robots' sensors. This robot is designed by utilizing the development of autonomous mobile robot technology, interactive human machine interface, localization and mapping, and obstacle avoidance. The stages in making the robot begin with design planning, initial testing, stage I validation, stage II validation, and implementation testing. This applied innovation of technology is expected to offer solutions in order to improve facilities and quality of service to patients and patient companions in hospitals.

Keywords: Mobile Robot, Localization, Mapping, Medical Robot, Medical Robot, Interactive Robot

1. Introduction

In the current era, advances in mobile robot technology combined with artificial intelligence have made mobile robots able to maneuver to move locations and store area data automatically, smart sensor and controller technology makes robots able to detect dynamic surrounding areas and be able to make predictions with various changing conditions. Utilization of artificial intelligence is carried out using sensors, digital data, or remote input[1], [2], [3]. AI combines information from hospital patient data, analyzes materials instantly, and acts on insights gleaned from the sensors used in Viguro Robots. Applied technology innovation Design and control of autonomous visitor guide robots in hospital environments (Viguro Robot) offers solutions using interactive robots that can provide location information and deliver visitors to their intended location. This robot is designed by utilizing the development of autonomous mobile robot technology, interactive human machine interface, mapping, localization, and obstacle avoidance. The stages in making the robot begin with design planning, initial testing, validation stage I, validation stage II, and implementation test.

One of the digital transformations in the field of public services, especially in the hospital environment, is the application of the Viguro Robot. This applied innovation of technology is expected to be able to offer solutions in order to improve facilities and service quality to visitors at the hospital. This research is also in line with the objectives of the 2016-2020 Sanata Dharma University Research Master Plan, which is to develop knowledge, produce innovations that are able to solve independent and sustainable problems for the community, and be proactive in the demands of strategic environmental developments.

2. Material and Method

First, mobile robots are robots that have wheel or foot actuators to move dynamically from one place to another. autonomous mobile robot is a robot that works automatically based on sensor data that is integrated with a control system that has been designed and embedded in the robot, interactive human machine

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interface is a system that can connect humans with machine technology, this system is in the form of controllers, status indicators are presented in the form of computer visuals that are real-time or online, this system allows humans to interact with robots so that they can carry out two-way communication to meet information needs and fulfill certain conditions [4], [5], [6], [7], [8]. Mapping and localization is a technique used by mobile robots to build a map of an area that has been or is being explored as well as to determine the position of the robot in the map made [9], [10], [11], [12]. Information on the shape of the regional map from the robot is obtained from several types of sensors that support the navigation process, where the sensor is installed on the robot [13], [14], [15]. This sensor data will be sent continuously which will then be processed in order to produce a map shape and also the current position of the device in Cartesian coordinates obstacle avoidance is a technique in avoiding obstacles [16], [17], [18]. The robot can avoid obstacles and go to the targeted destination point by avoiding static and dynamic obstacles [19], [20]. Types of guide robot users in hospitals are usually mostly users who never came to the hospital. Guide robot will show directions so that hospital visitors will easily follow the robot arrives in front of the desired patient's room.

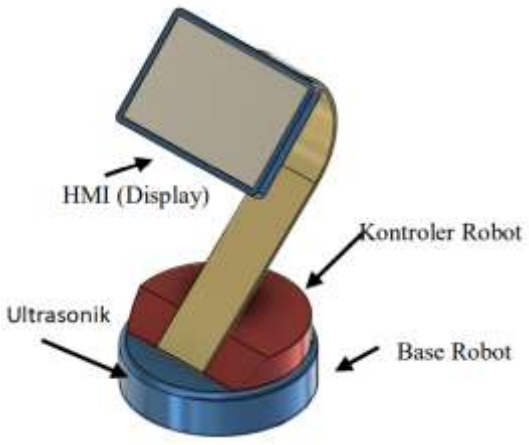

Figure 1. Design Viguro Robot

Figure 2. Display HMI Viguro Robot

A. Hospital visitor interface with Robot.

One of the most interesting capabilities for robotic hospital visitor guides is the interactive component provided by a human-robot interface using a touch-screen HMI. Interaction allows hospital visitors, can friendly interaction with the Viguro Robot. Furthermore, in this context presented, the interface allows for unconventional interactions To get a responsive and friendly Viguro Robot interaction, the robot must be able to serve Hospital visitors want any commands that can be directly understood by the robot. This understanding can only be achieved when the data synchronous exists between the internal state and external actions shown to the interlocutor a Viguro Robot.

Figure 3 shows a diagram block autonomous visitor guide robot in hospital environment navigation automatically outdoors by following the lines on the floor. On the input side, there are some components like line sensors for provides information about the current direction of the robot, rotary encoder sensors to provide information robot mileage, ultrasonic sensors to detect obstacles in front of the robot.

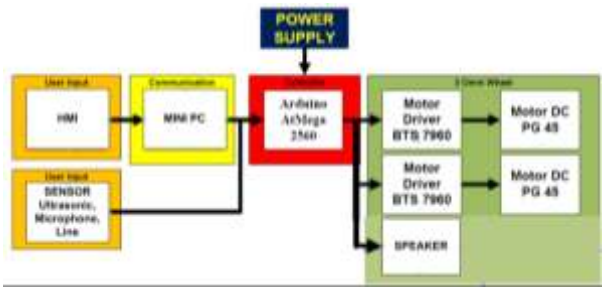

Figure 3. Diagram Block

The diagram presented above illustrates the block diagram of the Viguro Robot system. This particular robot incorporates a PG45 24VDC motor, BTS 7960 for motor drive, input sensors, and an Arduino Mega for system development. The operation of the Viguro Robot is reliant on gathering data from the input circuit, which detects the surroundings of the hospital room. These inputs consist of ultrasonic sensors, limit switch sensors, and line sensors. Each of these components will be elaborated upon in subsequent sections of the documentation. The data obtained from these input devices will be processed by a microchip, which, through its software program, will determine the appropriate direction for the robot to move by sending control signals to the driving motor.

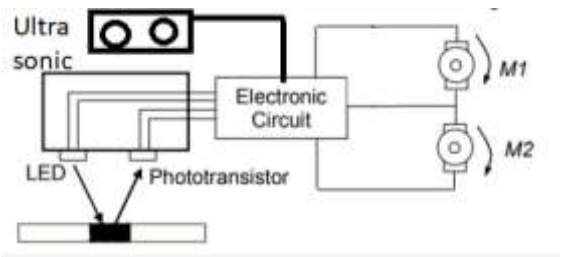

Figure 4. Diagram Block line follower Viguro Robot

At the bottom of the Viguro Robot there is a line that functions as a path to the intended patient's room, LED continuously illuminates the floor and then the photo-transistor senses the intensity of the reflected light and converts it into an electrical signal. Any change in the color of the floor causes a change in the intensity of the reflected light and thus - signal variations. This change is applied to electronics the Viguro Robot circuit leading to the relevant adjustment of the voltage across the motors (M1 and M2) running Viguro Robot wheels. As a result, the wheel speed varies make the robot move along the dark line where its intensity of reflected light is kept at a certain level on Arduino mega.

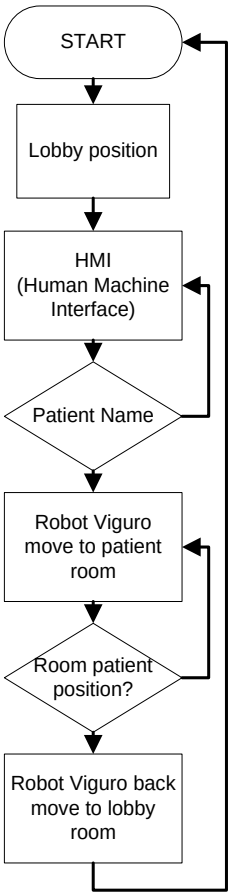

Figure 5. Flowchart program

3. Localization

In the context of navigating within a room environment, the sensor measurements of a robot can be influenced by the presence of individuals around the robot. Since the localization algorithm holds significant importance within our system, we conducted an analysis on the occlusions present in the range data. These occlusions occur when people partially obstruct the robot's field of view, impacting the accuracy of the sensor readings.

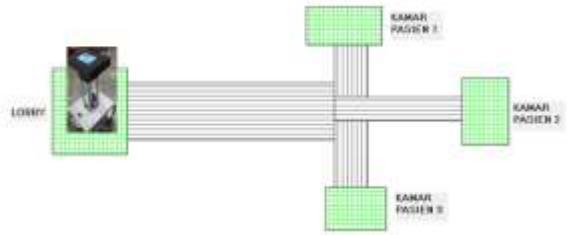

Figure 6. Maps Laboratory

In the experiment, the positioning function of the Viguro Robot itself uses some variable data from the sensor readings, after the Viguro Robot reaches the

next target position point confirmed and positioning successful, Viguro Robot can follow directions and walk the route to the destination by following the lines that have been marked on the floor.

Figure 7. Viguro Robot and its equipment.

Correct identification of obstacles is a critical component for autonomous navigation with Viguro Robots. Given that the robot platform can identify obstacles that have a height just above 2 cm and detect obstacles around the Viguro Robot.

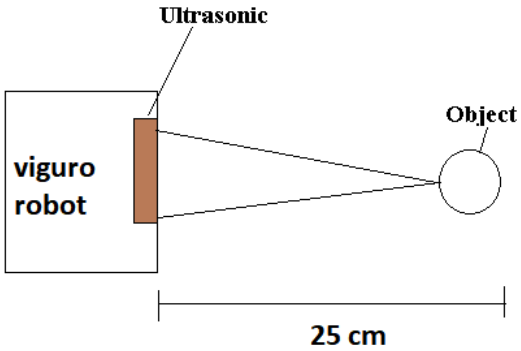

Figure 8. Obstacles

While driving independently, the Viguro Robot may encounter unexpected obstacles, for example, a passage may be blocked by another visitor or a parked object. The planner handles such situations by identifying edges in the topology that cannot be traversed in the current situation. The sides are temporarily marked infinity in the program which allows the Viguro Robot to determine another path to the destination.

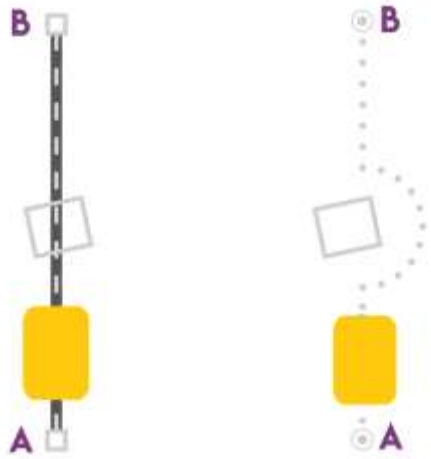

Figure 9. Robot route

Figure 10. Viguro Robot

4. Experimental Result and Discussion

A demonstration of how the Viguro Robot works has been tested inside the Sanata Dharma University campus building. In the Sanata Dharma University campus building, robots move along the corridors from one laboratory to another. This environment is divided into several space, but there is also many differences from the actual hospital conditions: for example: the number of people around, flat floor conditions, obstacles etc. Even though it's possible to adapt that environment to resemble a hospital..

Durring the course of the experiment, the autonomous Viguro run encountered two interruptions. The first occurrence was attributed to accidental activation of the robot's emergency stop button, which can be attributed to human error. In the second instance, a localization error occurred approximately 14 minutes into the run. The robot continued to navigate over a considerable distance while receiving predominantly erroneous measurements, resulting in an estimated positional error of approximately 2 meters. As a result, the robot came to a halt, necessitating the need to re-establish its position through localization techniques.

Sometimes the floor that is passed by the robot path is uneven so that the line sensor distance with the floor is too close to cause the sensor to collide with the floor, this damage to the line sensor will result in an error reading. The robustness of the line sensor in the installation must be given the right distance so that it can read the track conditions that have been made.

The sensor for detecting obstacles in front of the Viguro Robot is only one ultrasonic so the data obtained is still lacking precision reading objects in front of the robot, this may lead to inappropriate actions. In this experiment, the robot successfully reached its goal location without any problems and along a slightly different path of 1 m length. The trajectory line was estimated correctly throughout the whole experiment. Using the forecasts recorded, the estimates calculate the mean position and the corresponding standard deviation two laboratory locations on campus. The standard deviation is an indicator for localization accuracy however also experienced a small position error due to the condition of the Viguro Robot's wheels also slipping.

5. Conclusion

In the experiment, it was found that there were deficiencies or difficulties for the existing Viguro in-service robot to provide appropriate feedback emotions of hospital users or visitors, which makes people feel happy when interacting with robots. This research provides navigation options based on the Viguro Robot's HMI input, which allows the guiding robot to predict the destination of hospital visitors.

Currently, only commands have to be pressed on the HMI. For further showing a human face that describes the emotions of a machine, wish a more precise emotional space could be used to describe the emotion of the machine to better assess user emotions.

Adding HMI menus and displays, as well as using more informative hospital maps to increase the base that the guiding robot can use for predicting preferences of hospital visitors.

Once navigation is started, input is only available from one hospital visitor. so the robot has to finish one job first. In the future research, real-time communication and field scene analysis will be used to improve strategies to achieve goals by taking multiple inputs from different hospital visitors.

Increase the use of ultrasonic sensors for Viguro Robot navigation, optimization and deployment to more hospital services.

In the future, with this study, we aimed to study various biomedical sensors, controllers, and actuators in detail.

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