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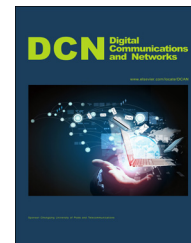


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Development of a hospital mobile platform for logistics tasks



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Abstract

Healthcare services heavily rely on healthcare staff and subsequently, there is the need to improve healthcare staff's workflow. The deployment of an automated mobile base will help enhance the productivity of logistics tasks in the hospital, like collection and delivery. By improving such logistic tasks healthcare personal is able to focus on other tasks to serve the community better. Currently there are commercial solutions to deal with these logistic tasks, where a mobile base is able to move from one place to another in a structured environment like a hospital. In this paper, we present our approach to develop a cost effective mobile base to be used for delivery in healthcare amenities. The proposed approach is able to navigate among stations in the hospital by first creating a map of the floor and then indicating the location of these stations. This reduces the additional cost of drawing lines on the floor or to put laser markers and many of the commercial solutions required. In addition, the proposed solution is able to navigate while being safe for the people moving around and to the transported items. The paper discusses the design consideration of the system, the navigation and the battery management to ensure that the system is able to run autonomously without the need recharge often.

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1. Introduction

In recent years, due to technological advancements, robotics are continuously making ways into new areas and the value of robots in areas like, domestic tasks, surgery, surveillance and for disposal of bombs and other hazardous materials; has been recognized. Semi or fully autonomous mobile robots that assist humans, service equipment and

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perform other autonomous functions have applications in almost every industry [1]. Robot markets are expected to have a dramatic growth by reaching homes, offices, and hospitals in the near future. Mobile robots or platforms are the first type of robots entering in many of these markets. Automated mobile platforms are service robots that are able to move between destinations, this ability can be beneficial in several industries to automate processes of delivery and collection. Mobile platforms for general use is a strongly growing sector in the service robotics as presented in the annual report in 2014 of the International Federation of Robotics [2]. It is estimated that about 16,000 mobile platforms will be sold in the period 2014-2017 as customizable multi-purpose platforms. In addition, logistic systems as service robots will increase considerably to more than 10,200 units of which about 9200 will be automated guided vehicles (see Figure 1).

Most of the currently deployed mobile platforms work well as long as the environment is modified to provide artificial landmarks to guide the mobile platform from a specific starting point to a well-defined destination. These constraints are not well accepted in some industries, changing the environment to permit the inclusion of these robots is not an option. For example, to lay marker lines on the floor and to maintain them in good state involved a cost; but to lay these marker lines in carpets might not be well accepted for the image of certain places. Other changes that might be requested in the environment are the placing of reflective markers that must be visible all the time. If something obstructs the marker the robot would not be able to find its destination. Another reason that has limited the inclusion of the mobile platforms in the market is their price. According to the payload and features the platforms' cost varies from few hundred thousand dollars to a couple of million dollars.

In Singapore by 2030 one-fifth of the population will be aged 65 and above, and by 2050 Singapore is expected to be the fourth oldest country in the world [3,4]. At the same time, more and more Singaporeans are coming down with chronic diseases. Healthcare services heavily rely on healthcare staff and subsequently, there are the needs to improve healthcare staffs' workflow. A graying population also means an increase in elders in the workforce particularly also in the healthcare sector, thus it is important to also cater for the aging workforce in healthcare amenities. Hospitals are opening their doors to these mobile robots due to the substantial progress in robots capable of operating and interacting in human environments. Increasing the productivity by the hospital staff is one of the key factors driving the growth in the number of application of mobile platform in hospitals. The healthcare services heavily rely on healthcare personnel working in healthcare amenities round the clock. As such, their workflow directly impacts the performance of health services delivered. Therefore, it is imperative and essential that new innovative technology and equipment are brought in to improve the working environment of healthcare personnel and boost productivity in the process performed by the personal.

Automated mobile platforms are identified as a potential market for hospitals. An analysis in showed that installation of 6 robot units reduces the annual cost by approximately 56% and improves turn-around time performance by 33% for

hospital transportation [5]. However there are several challenges that need to be addressed to be fully adopted by the consumers. Mainly to ensure the safety of the people when the mobile platforms need to navigate in a human populated environment. The mobile platform must be able to handle unforeseen events. Autonomous hospital logistic systems could include user interfaces, planners, stations, charging stations and special designed carts. This paper discusses the main challenges that need to be considered when designing such systems. The innovative approach that could be an efficient solution for hospital transportation is also presented.

This paper presents our approach for an autonomous mobile base to help improve the working environment of healthcare personnel and boost productivity in the process performed by the personal. The paper is structured as follows: Section 2 discusses projects and approaches explored by other researchers and also introduces new features that we have identified for our development. Section 3 presents the hardware design for our approach. Section 4 discusses the problems of power management, recharging and docking; and it describes in detail the proposed solution, including the experiments and results. Finally, Section 6 discusses conclusions and future perspectives of this project.

2. Design and features

There exist several commercial systems that are successfully installed in hospitals and there are also several research projects by different research groups [6-8]. Help-Mate is a robot able to transport unscheduled meal trays, lab, pharmacy supplies or patient records [6]. This robot uses odometry and natural landmarks, like hallway walls, to estimate its position continuously. Doors and elevators can be automated to communicate with the robot. A map can be generated and installed in the robot. TUG Smart Autonomous Mobile Robot is an autonomous mobile robots designed to haul and transport goods, materials and clinical supplies within the hospitals and the laboratories [7]. The robot is easy to and friendly to operate, once loaded the cart, it can be sent it to a destination, or multiple destinations by entering the command in its touching screen. TUG Robot detects obstacles through laser scanner and can provide free of collisions path. Aethon, the company that created TUG, has a system including a control system that monitors robot missions, solves failure situations, control robot's batteries level, etc. Let us know discuss the motivation for creating an autonomous platform for lab samples logistics in hospital amenities in Singapore.

Based on discussions and feedbacks with the healthcare personnel and observation of the daily workflow of with the trolleys, the hospitals request are to develop an automated mobile base that can help with the process of collection and delivery of items, samples, packages, and more between stations. The healthcare personal would then be able to load and unload these items that must be delivered to the next station. In addition, the staff could select the station to send these items and specify priorities for items deliveries between the stations.

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