DEVELOPMENT OF LOW-COST ROBOT FOR MEDICAL ASSISTANT

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Bachelor of Engineering

Electrical and Electronics Engineering with Honours

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Final Year Project Report [/]

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DEVELOPMENT OF LOW-COST ROBOT FOR MEDICAL ASSISTANT

Development Of Low-Cost Robot For Medical Assistant

HAFIZ BIN ASLAN

A dissertation submitted in partial fulfilment
of the requirement for the degree of
Bachelor of Engineering
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ABSTRACT

Covid-19 pandemic has caused many problems in the country's healthcare system. With the availability of the sophisticated technologies, health facilities are required to be emphasized to assist in medical practices. Therefore, a low-cost robot is designed and developed to assist in simple task, which aims to design and develop a low-cost robot for the medical industry. The main goal is to build a robot to help with delivering medicine. Three (3) Designs of Experiments (DoE) are carried out to examine various facets of the robot's operation. DoE 1is emphasized on the robot movement on various surfaces. From DoE 1, it is found that, the proposed robot can move steadily on flat, smooth surfaces but erratically on flat and rough surfaces. DoE 1 is essential to ensure optimum movement performance that able to run on various surfaces at the medical facilities. DoE 2 concentrated on the ESP32 module and the Blynk IoT platform's Wi-Fi capabilities. Based on the signal intensity from mobile hotspots and home Wi-Fi, the Wi-Fi connection's range has shown a robust connectivity within a range of 0–10 metres from both networks, albeit the signal strength decreased as the distance rose. This emphasises on how crucial proximity in maintaining a trustworthy relationship. Four Infra red (IR) sensors for reading branches and one ultrasonic sensor for obstacle detection are tested as part of DoE 3. The findings have shown various branches can be tracked and detected successfully. Overall, the project has been succeeded in creating an affordable medical support robot with promising outcomes for mobility, Wi-Fi connectivity, and sensor functioning. Further study and testing are recommended to enhance the robot's ability to recognise obstacles and guarantee safe navigation in medical settings.

ABSTRAK

Pandemik Covid-19 telah menyebabkan banyak masalah dalam sistem penjagaan kesihatan negara. Dengan ketersediaan teknologi yang canggih, kemudahan kesihatan diperlukan untuk membantu dalam amalan perubatan. Oleh itu, sebuah robot kos rendah direka dan dibangunkan untuk membantu dalam tugas-tugas mudah, yang bertujuan untuk merekabentuk dan membangunkan sebuah robot kos rendah untuk industri perubatan. Matlamat utama adalah untuk membina sebuah robot yang membantu dalam penghantaran ubat. Tiga (3) Reka Bentuk Eksperimen (DoE) dijalankan untuk mengkaji pelbagai aspek operasi robot. DoE 1 ditekankan pada pergerakan robot di pelbagai permukaan. Daripada DoE 1, didapati bahawa robot yang dicadangkan boleh bergerak dengan stabil di permukaan rata dan licin, tetapi tidak menentu di permukaan rata dan kasar. DoE 1 adalah penting untuk memastikan prestasi pergerakan optimum yang mampu beroperasi di pelbagai permukaan di fasiliti perubatan. DoE 2 memberi tumpuan kepada modul ESP32 dan keupayaan Wi-Fi platform IoT Blynk. Berdasarkan kekuatan isyarat dari hotspot mudah alih dan Wi-Fi rumah, julat sambungan Wi-Fi telah menunjukkan kestabilan yang kukuh dalam julat 0–10 meter dari kedua-dua rangkaian, walaupun kekuatan isyarat berkurangan dengan jarak yang meningkat. Ini menekankan betapa pentingnya kedekatan dalam menjaga hubungan yang boleh dipercayai. Empat (4) sensor Infra Merah (IR) untuk membaca cabang dan satu sensor ultrasonik untuk pengesan halangan diuji sebagai sebahagian daripada DoE 3. Hasil kajian menunjukkan bahawa pelbagai cabang dapat dikesan dengan berjaya. Secara keseluruhannya, projek ini berjaya mencipta sebuah robot sokongan perubatan yang berpatutan dengan hasil yang menjanjikan untuk mobiliti, sambungan Wi-Fi, dan fungsi sensor. Kajian dan ujian lanjut disyorkan untuk meningkatkan keupayaan robot dalam mengenali halangan dan menjamin navigasi yang selamat di persekitaran perubatan.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
AC	Alternating Current
AGV	Automated Guided Vehicle
AMA	Automated Medical Assistant
AI	Artificial Intelligent
AR	Augmented Reality
DC	Direct Current
GPS	Global Positioning System
IC	Integrated Circuit
IDE	Integrated Development Environment
IoT	Internet of Things
IR	Infrared
LED	Light Emitting Diode
PCB	Printed Circuit Board
PWM	Pulse Width Modulation
UI	User Interface
USB	Universal Serial Bus
VR	Virtual Reality
Wi-Fi	Wireless Fidelity

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter provides an overview of the research project. It also covers several sections, including a project overview, problem statement, project objective, project scope, and thesis outline, which are presented in Section 1.2 to 1.6, respectively. A summary of the chapter is then provided in Section 1.7.

1.2 Project Overview

A robot is a machine that is operated automatically and replaces human labour, even if the machine does not resemble humans or performs duties similar to those performed by humans. Robotics is a subfield of mechanical engineering that focuses on the design, development, and operation of automated machines and devices [1].

Artificial intelligence and robotics have proven the ability to address and provide solutions for various issues prevalent in current society. Robotics have been put to use in the manufacturing sector for a considerable amount of time. However, throughout the previous years, robots have been deployed in various industries, including laboratory research, earth and space exploration, transportation, and many more. The utilisation of robots has led to a reduction in the expenses associated with production and an increase in productivity, which has led to the expansion of the economy and the development of many new jobs in the technological sector.

Robots are a revolution in the surgical processes used in the medical business. They are also helped to speed up the delivery of supplies and the cleaning process, which also assist doctors to focus on patient care. Intel offers a diverse portfolio of technologies that can be utilised to create medical robots. These technologies include mobile robots with surgical assistance, modular components, and autonomous operation.

Robots are increasingly being used in clinical and surgical settings to assist medical practitioners and enhance the quality of care provided to patients. During the COVID-19 pandemic, hospitals and clinics are employing robots for various jobs to reduce the number of patients exposed to pathogens [2].

The application of robotics and automation extends to research facilities, which automates laborious, repetitive, and high-volume processes. This frees up technicians and scientists to focus on more important responsibilities, speeding up the discovery process.

In the not-too-distant future, when technology has advanced sufficiently, robots will be able to carry out specific tasks independently. Consequently, medical professionals such as doctors, nurses, and others can devote more time to providing direct patient care.

As a result of this research, a robot that can transport medication from one location to another was developed. The term "logistics robot" refers to a newly developed category of robots that can now be purchased and used in hospitals to perform various logistical tasks. Within a healthcare facility, the logistics robots are equipped with navigation systems, which enable them to carry out routine tasks such as delivering food and water, laboratory tests, bedding, and medicines to patients.

The use of medical robots can result in several benefits, including the simplification of processes and risk reduction. For instance, robots can clean and prepare patient rooms independently, thereby reducing patient-to-patient contact in infectious illness wards [3]. In addition, robots equipped with AI-enabled medicine identifier software reduce the time needed to locate, pair, and dispense medication to hospital patients.

Inside hospitals and other medical facilities, there are many applications for robots. They have either a direct or an indirect influence on the patient's quality of life. Even the elderly and those with disabilities are given care and kept busy with discussion to ensure they do not suffer from pain or boredom. In addition to this, the use of medical robots has several other advantages. A further key advantage of medical robots is that they can work precisely within the time and work parameters given to them. Additional benefits associated with medical robots include precise monitoring of the patient, faultless performance, a lower danger of infection, and the elimination of time loss.

1.3 Problem Statement

The Covid-19 pandemic has shown serious flaws in healthcare systems throughout the globe, placing a heavy burden on medical staff and service provision. The pandemic's effects on healthcare workers' exhaustion and workload highlight the need for creative ways to improve the effectiveness and calibre of healthcare facilities. This project aims to create a low-cost, IoT-enabled robot specially designed for delivering important medical supplies, such as medications, inside healthcare facilities. We want to reduce the workload on healthcare professionals and further optimise the healthcare infrastructure to provide better patient care and results by offering an automated and dependable method for item delivery.

1.4 Project Objective

Based on the aforementioned problem statement, the following are the three (3) main project objectives:

i. To develop a low-cost robot for medical assistants.
ii. To develop robot app to direct the robot to a specific location.
iii. To evaluate the effectiveness of the robot assistant.

1.5 Project Scope

The research or project scopes are stated as follows:

i. The Arduino Uno is used to properly programme the robot in this project.
ii. This project also utilizes Fritzing to simulate the Arduino in order for it to operate with the other components.
iii. This robot's construction is accomplished with low-cost components.
iv. This robot is mostly employed to transport light medicine from one location to another.

1.6 Thesis Outline

This thesis contains six chapters, which are listed below:

- Chapter 1 – Introduction
- Chapter 2 – Literature Review
- Chapter 3 – Methodology
- Chapter 4 – Experimental Method and Result
- Chapter 5 – Discussion
- Chapter 6 – Conclusion and Recommendation

From the list, Chapter 1 covers the introduction, which mainly introduces robotics systems in the medical sector. This sector also emphasizes project overview, problem statement, project objective, project scope and thesis outline.

The second chapter is the literature review. This chapter analyses current research on robot systems in use worldwide and recent medical sector developments using robot systems.

This project's methodology, including its overview, research approach, research type, research tools, research variables, and research process, are discussed in details in Chapter 3.

Chapter 4 focuses on experimental method and result. All data throughout implemented experiment is presented in this section.

Chapter 5 focuses on the discussion. The data obtained from chapter 4 will be discusses in this chapter.

The last chapter, chapter 6, summarises the fundamental research or project findings. The recommendation to further improve the proposed project is also provided.

1.7 Summary of Chapter

In summary, this chapter has presented an overview of the research, problem statement, project objective, project scope and thesis outline. Based on a previous study, the implementation of robots for delivering medicines to the has been widely used in Europe countries. Thus, with the references from the previosu studies, it is utilized in

this project as a guidelines in designing and developing a low-cost robot for hospital use to assist in delivering medicines to the patients in need.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Chapter 2 is the literature review section, where it discusses briefly on robotics in the medical sector, the research gap, current related robotics in the medical sector from previous research and a summary of current research in robotics in the medical sector. The discussions are presented correspondingly in section 2.2 to 2.4.

2.2 Background of Robotic in Medical Sector

The 1980s was the introduction of the first medical robots, which utilised robotic arm technology to assist with surgical procedures. Medical robots have been modified over time, and their capabilities in various healthcare contexts have been considerably enhanced due to advancements in computer vision and data analytics powered by artificial intelligence (AI).

In addition to robots used in operating rooms, robots are then being used in clinical settings to assist medical professionals and enhance the quality of care provided to patients. In order to automate high-volume, repetitive, and manual tasks, robotics and automation are also used in research laboratories. As technology continues to improve, robots has became self-sufficient, eventually able to perform specific tasks without human assistance. As a direct consequence of this change, medical professionals such as doctors, nurses, and others can focus more on their patients on the significants matters need.

By utilizing medical robots, medical professionals can provide their patients with more effective and comprehensive therapy. When nurses and other medical professionals are overworked, it can cause to more emotionally exhausting. Medical robots can be used in easing the works and less tasks burden. There are many different types of robots, such as nursing robots, sanitation robots, exoskeletons, robotic

companions, artificial intelligence physicians and microbots are currently in the market, as presented in section 2.3.

2.3 Current Studies from Previous Research

In this section, it presents various types of robots that have been used in various applications. Details are explained in Sections 2.3.1 to 2.3.3.

2.3.1 Robotics in Delivery Sector

In the delivery sector, various types of robots have been developed. The examples of the robots are presented in section 2.3.1.1 to 2.3.1.5.

2.3.1.1 Autonomous Delivery Robot

Those who are confined to their homes as a result of the global coronavirus outbreak face a significant challenge in finding home delivery services that are trustworthy and convenient. In conjunction with that, the researchers as in [4] developed a prototype robot that has the potential to significantly contribute to lowering the risk of infectious disease transmission along the supply chain during times of extreme sanitary and medical emergencies. Using the Global Positioning System (GPS), a low-cost prototype of an autonomous mobile robot capable of delivering products safely to the designated location has been constructed. This prototype can be found displayed in Figure 2.1. Because the robot utilised a container that required a secret code for access, the gift was safely delivered without the participation of any human beings. The GPS coordinates of a predetermined place can be obtained from satellites by the four-wheel drive robot, and then the robot's trajectory can be modified using a digital compass. This allowed the robot to travel successfully to its destination. When it reached its location, the robot waits for the user to activate it so it may open the container. After the item has been delivered, the customer must provide a password to unlock the container and retrieve the item requested. This password could be included in the confirmation message that the customer receives after placing their order. After completing the mission, the package delivery robot was able to go back to its starting point. The robot's precision was evaluated based on tests measuring the heading angle and the correctness of the completed trajectory. The robot could be an efficient technical solution to the problem

of last-mile delivery. In addition to provide a risk-free product delivery, this would significantly reduced the cost of last-mile delivery.

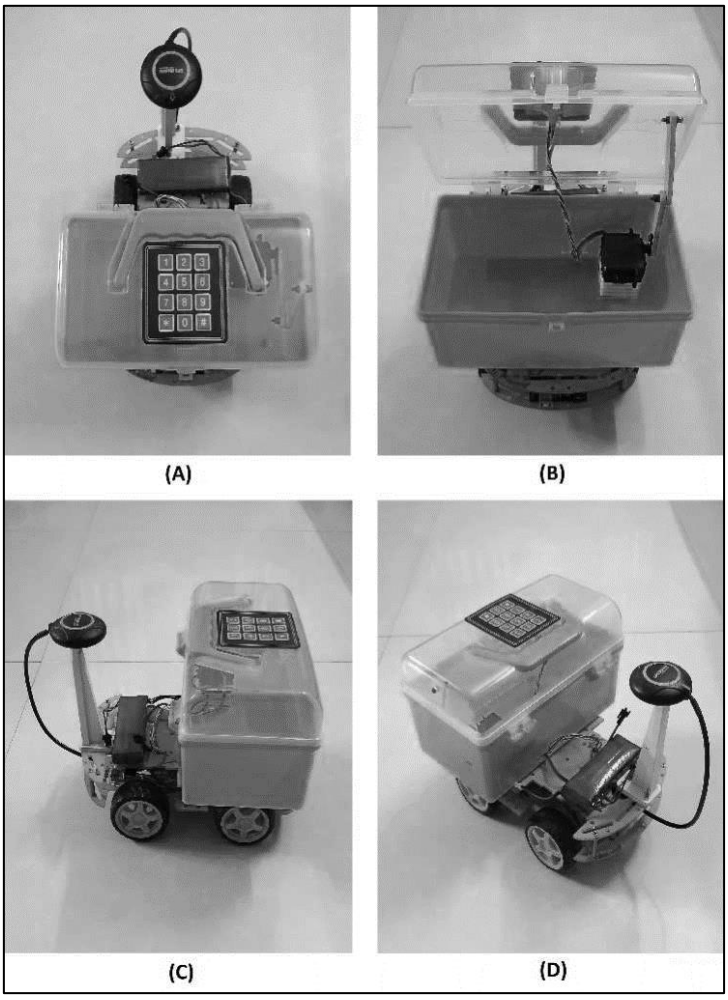

Figure 2.1: Autonomous package delivery robot prototype [4]

2.3.1.2 Assistive Delivery Robot Application for Real-World Postal Services

According to this study carried out in [5], postal workers in challenging urban settings like apartment buildings could benefit from using a robot carrying essential things. Because most places do not have access to reliable GPS signal reception, it is advised that a 3-D point cloud map-based matching localization strategy with a solid position estimate and a perception-based visual serving methodology be presented. The operator was able to monitor both the present and the past with onboard movies, information about obstacles, and emergency stop recordings, by integrating the delivery robot's with the control room. In addition, postal worker can use their mobile device to

choose between a mode that allowed for autonomous driving. The purpose of this study was to collect data regarding field operations in order to validate the performance of the suggested robot system, and it did so in collaborating with individuals who worked full-time at the post office for more than four weeks. Using this data, it was possible to verify that the suggested method for map-matching performs effectively in circumstances where the robot is able to manoeuvre with reliable location precision and the ability to avoid obstacles. The robot that was utilised to deliver packages is depicted in Figure 2.2.

Figure 2.2: Proposed robot system in real-world service [5]

2.3.1.3 Low-Cost Food Delivery Robot

The application of technology has significantly expanded across variety of fields in contemporary society. As a direct result of this, there has been a swift expansion in the market for automated machinery. The vast majority of small and medium-sized organisations are making efforts to incorporate this technology to improve their reliability and speed. Robotics is an emerging field of technology that can provide numerous benefits to commercial enterprises. This work presented the process of designing, simulating, modelling, testing, and deploying a low-cost food delivery robot that may be used in hotels, restaurants, and other food service firms. The robot was intended to bring meals to customers. These automated meal delivery systems improved the restaurant's bottom line by improving customer satisfaction and fostering favourable

public relations. The restaurant business was also suffering as a result of the COVID-19 outbreak [6]. With this technology, it might be possible to meet all of the sanitary criteria while delivering food directly from the kitchen to the customer's table. The microcontroller of the robot was modified so that it could operate the DC motors. As shown in Figure 2.3, ultrasonic and infrared sensors are used in the operation of the motor drivers, mapping and localisation of destination tables, identifying obstacles, avoiding collisions, and detecting the path. The robot was successful in the test and delivered the desired result.

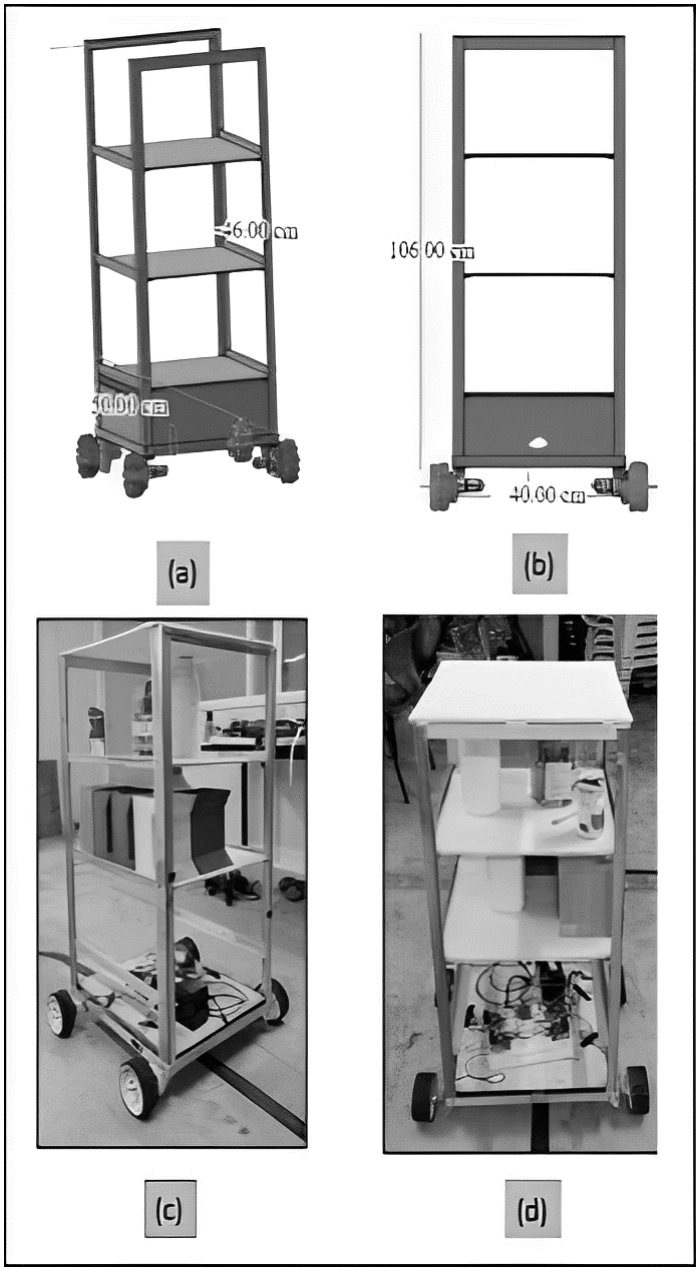

Figure 2.3: 3-D model and fabricated robot [7]