A SELF DRIVING DELIVERY BOT AIDING SOCIAL DISTANCING

BY

WEERADAWAN SEESUTIPAN

WIPADA KAEWPILUEK

A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF ENGINEERING IN BIOMEDICAL ENGINEERING

KING MONGKUT'S INSTITUTE OF TECHNOLOGY

LADKRABANG

ACADEMIC YEAR 2020

FACULTY OF ENGINEERING

KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG

PROJECT CERTIFICATE

Project Title	A Self-driving Delivery Bot Aid Social Distancing		
Student Name	Miss Weeradawan Seesutipan	Student ID	60011286
	Miss Wipada Kaewpiluek	Student ID	60011287
Degree	Bachelor of Engineering		
Major	Biomedical Engineering		
Year	2020		

Project Advisor **Signed:** _____

(Dr.Wibool Piyawattanametha)

Committee **Signed:** _____

(Asst. Prof. Dr. Suradej Tretriluxana)

Committee **Signed:** _____

(Dr. Wibool Piyawattanametha)

Committee **Signed:** _____

(Dr. Kasama Srirussamee)

Head of Department **Signed:** _____

(Asst. Prof. Dr. Sarinporn Visitsattapongse)

Title	A Self-driving Delivery Bot Aid Social Distancing		
Student	Miss Weeradawan Seesutipan	Student ID	60011286
	Miss Wipada Kaewpiluek	Student ID	60011287
Degree	Bachelor of Engineering		
Major	Biomedical Engineering		
Year	2020		
Project Advisor	Dr.Wibool Piyawattanametha		

ABSTRACT

The drug and medical management system are one of the most important systems in the hospital which can demonstrate the potential of communication management and coordination of various departments related to medicine and medical supplies in the hospital. To achieve maximum efficiency, accuracy, completeness, and timeless on time which these activities show the performance, safety, reliability of medical services in the hospital. Because the delivery system needs to be done through the medical personnel of different departments, which means it may cause delays and errors from the steps, wastes the time and human resources, as well as increasing unnecessary workloads for hospital staff. For this reason, the automation system began to support the increasing number of patients and to ensure the smooth operation of medical units.

At present, there is an outbreak of Covid-19 situation which affects the symptoms of work of medical personnel that causes work more delay because more cleanliness measures need to be in place to reduce infection between personnel and patients. Furthermore, various automatic robots are used in hospitals. With the

expectation that the robots will replace the hospital personnel in complicated, redundant tasks, requiring high accuracy, additionally reduce the social distance between medical personnel.

These are advantages in reducing the cost of hiring non-essential personnel. The shorten the working time to reduce errors and increase the efficiency of work. Including in the field of treatment to increase the ability to support patients who need treatment which is likely to increase from the number of elderlies in the future.

The purpose of a self-driving delivery robot aiding social distancing is to reduce the unnecessary workload of hospital personnel. The robot allows the person to focus on working with patient care to their full potential. The use of robots will help increase patients' security, reduce the risk of errors, reduce time and costs in terms of hiring personnel for unnecessary long-term workloads. Furthermore, it can help in reducing the amount of waste generated by the tracking system, forwarding, and reporting in the old document formats including more efficiency in following up and traceable medicines and medical supplies in case that the medical product has a problem or needs to recall. There, we aimed to develop a delivery robot that can achieve the aforementioned tasks at an affordable price point with great versatility and utility.

ACKNOWLEDGEMENTS

We would like to express the deepest appreciation to my advisor, Dr. Wibool Piyawattanametha, who always gives us the best guidance throughout the completion of the project.

We also appreciate Dr. Poom Konghuayrob, the researcher of Power Electronics and Robust Control department, for his suggestion.

We would also like to thank Mr. Nutthanan Wanluk, the graduated student of the Biomedical Engineering Department, for all of his support, not only knowledge, but also project components.

We would also like to thank Mr. Theerapat Antachai, Mr. Tanutpong Ramkaow, and Mr. Suphom Achanapornkul, the students of the Electronics Engineering Department. They have all provided a huge amount of their precious time and effort for us.

We would also like to thank Mr. Thanaphat Jiamcharoendet, the student of Robotics and AI Engineering Department. He provided the knowledge about robotics and advised us to make the efficient project.

Last but not the last, we would like to thank all of our family and friends, for their careful and precious guidance which was extremely valuable for our project.

Weeradawan Seesutipan

Wipada Kaewpiluek

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS/ABBREVIATIONS

Symbols/Abbreviations	Terms
1D	One Dimension
2D	Two Dimension
3D	Three Dimension
AC	Alternating Current
AGV	Automatic Guided Vehicle
AI	Artificial Intelligence
ASCII	American Standard Code for Information Interchange
AVR	Advanced Virtual RISC
CAN	Controller Area Network
CLI	Command Line Applications
COVID-19	Coronavirus disease 2019
DACs	Digital Access and Cross-connect
DC	Direct Current
EAN	International Article Number
GPIO	General Purpose Input/Output

LIST OF SYMBOLS/ABBREVIATIONS(CONTINUED)

Symbols/Abbreviations	Terms
GUI	Graphic User Interface
IBM	International Business Machines
I/O	Input and Output
ISBN	International Standard Book Number
PCB	Print Circuit Board
PDF417	Portable Data File-417
PyQt	Python bindings for Cross-platform application
QRcode	Quick Response Code
RAM	Random Access Memory
ROS	Robot Operating System
RPLIDAR	Low-cost Light Detection and Ranging
RPM	Rate Per Minute
SLAM	Simultaneous Localisation and Mapping
SQL	Structure Query Language
UARTs	Universal Asynchronous Receiver-Transmitters
UPC	Universal Product Codes

LIST OF SYMBOLS/ABBREVIATIONS(CONTINUED)

Symbols/Abbreviations	Terms
USB	Universal Serial Bus

CHAPTER 1

INTRODUCTION

1.1 Statement of the problems

Today, the coronavirus disease 2019 (COVID-19) has widespread outbreaks worldwide, including Thailand, which significantly impacts people's work and life. This situation is especially true in hospital-related work, such as medical equipment delivery, medicine, medical supplies, and food delivery for patients. The medical personnel is at high risk of getting viruses from breathing, bringing pathogens into the body, or touching their hands on surfaces with pathogens.

Because the COVID-19 can spread from person to person through a nebulizer from the nose or mouth, which is excreted when the patient is present, one in public health measures to reduce the infection risk with the COVID-19 is spaced, meaning being away from each other. The World Health Organization recommends spacing at least one meter from others to avoid breathing in the aerosol from people with the infection. As a result, the operation of the hospital delivery system is even more difficult. Medical personnel may be infected during the delivery of medical supplies to the hospital during the procedure.

Delivery bot aiding social distancing is an innovation that has been developed to address these problems. Robots will be used as a tool—food, drug, and drug institutions or between institutions, even computer software control. The software simulates the user'sactivity map by using the technology of an intelligent coordinate system. The robot can move to a designated area by determining the required positioning technology. The intelligent coordinate system of the robot is applied to the depth detection of the motion sensor. Robots can identify objects or people, including the environment, improve the efficiency of moving, and avoid obstacles. Automatically complete tasks, delivery, and product objectives according to user requirements. Accurate, complete, and error-free.

It is essential to develop system software that is easy to use. This affects the speed of operation and accuracy of the operation. The software system used is called Python bindings

for the cross-platform application (PyQt5), which is a development framework for graphic user interface (GUI). Structured Query Language (SQL) is also used to develop system database management systems such as access to medical information, medical information, and patient food information.

The robot delivers medicine and food in the hospital with this automated navigation system. The aim is to reduce the unnecessary workload of hospital personnel. The staff has focused on the full range of patient care. It also increases security. Reduce the risk of direct contact with the patient. So that of the COVID-19 outbreak. Errors, time reductions, and long-term outsourcing costs may reduce the amount of waste generated by the tracking system, forward, and report results in the old document format. It also helps to manage the pharmaceutical system more efficiently. Easy to follow up and traceback medicines and medical supplies if the medical product crashes or needs to be restored. Intelligent coordinate navigation technology for pharmaceutical and pharmaceutical delivery robots can also be applied to parcels, medical equipment, or other medical supplies. It can be further developed into a patient or elderly monitoring system at home by identifying the robot's coordinates.

1.2 Objectives

1.2.1 To study and develop drug and food delivery robots in hospitals that can be moved using navigation technology with an intelligent coordinate system. Both can automatically avoid obstacles by recognizing and recognizing their surroundings in real-time.

1.2.2 To study and develop software or programs for operating or controlling robots displayed through the GUI application.

1.2.3 To develop drug and medical supplies management systems, including food in the hospital to be efficient.

1.2.4 To apply electronic knowledge and computer programming, as well as to develop knowledge in new technologies.

1.3 Scope of study

This project aims to design an automated and manual user interface to command or control automated drug and food delivery robots for patient care management and hospital logistics management. Invention consists of

1.3.1 Software or program for operating orders or controlling robots by displaying results through the GUI application.

1.3.2 Joystick manual robot control.

1.4 Expected result

1.4.1 Develop software or program systems for working robots through the website.

1.4.2 Develop an efficient delivery system for drugs and food within the hospital. Reduce mistakes time and cost of work, including reducing the workload of medical personnel.

1.4.3 Develop and practice electronic working skills, structural design, operating the device, and various programming tools, including applying relevant knowledge and skills in the workplace.

1.4.4 To be a way to extend the technology to a patient monitoring system. The home elderly from the robot body coordinate system develops technology and other relevant innovations in the future.

1.5 Timeline

No.	Operation	Operation Duration (2020-2021)									
		Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1	Study and research related information. Including robot design and interface.										
2	Improvement and programming of robot interface.										
3	Develop software system and application.										
4	Software and interface testing of robot motion control.										
5	Develop software systems and applications.										

6	Use the results to enhance the system.										
7	Conclusion of the project.										
8	Prepare the report.										

Table 1: Operation Duration.

CHAPTER 2

RELATED THEORIES

At present, there is an outbreak of COVID-19 situation that affects the symptoms of medical personnel work that have to work more delay because of more cleanliness measures that need to be in place to reduce infection between personnel and patients. Furthermore, various automatic robots are used in hospitals. Moreover, the robots will replace the hospital personnel in complicated, redundant tasks, require high accuracy, and reduce the social distance between medical personnel.

These are advantages in reducing the cost of hiring non-essential personnel. They are shortening the working time to reduce errors and increase work efficiency, including in the field of treatment, to increase the ability to support patients who need treatment, which is likely to increase from the number of elderlies in the future.

2.1 COVID-19 live on the surface

The coronavirus that causes COVID-19 chiefly spreads from person to person. Transmission from person to person will happen through larger droplets from sneezes and coughs. However, there is growing proof that smaller particles known as aerosols will bear on the air longer and travel farther. These aerosols may play a locality in transmission[1].

A variety of studies area unit observing, however long the virus stays alive on a range of surfaces. It is still unclear when this will increase the possibility of transmission. For now, transmission from surfaces is way lower than person to person.

2.1.1 Different Kinds of Surfaces that COVID-19 live on the surface[2].

Type	Duration	Examples
Metal	5 days	Doorknobs, jewellery, silverware
Wood	4 days	Furniture, decking

Plastics	2 to 3 days	Milk containers and detergent bottles, subway and bus seats, backpacks, elevator buttons
Stainless steel	2 to 3 days	Refrigerators, pots and pans, sinks, some water bottles
Cardboard	24 hours	Shipping boxes
Copper	4 hours	Pennies, teakettles, cookware
Aluminium	2 to 8 hours	Soda cans, tin foil, water bottles
Glass	Up to 5 days	Drinking glasses, measuring cups, mirrors, windows
Ceramics	5 days	Dishes, pottery, mugs
Paper	The length of time varies. Some coronavirus strains live for only a few minutes on paper, while others live for up to 5 days.	Mail, newspaper

Table 2: Different Kinds of Surfaces.

2.2 Logistics system within the hospital

Patient Safety is an essential medical concern, with each treatment process posing a risk of errors. A hospital is an organisation that provides medical products such as drugs and medical supplies, medical equipment, which are essential resources and impact the lives of the patients. However, the flow of material people and the information in the hospital is complex. As a result, each department in the hospital cannot connect to the information between each other virtually. As a result, the system does not have information to track and trace drugs and pharmaceuticals in the event of a medical problem or need to be recalled [3].

Logistics is the science involved in inflow, which Stock and Lambert define. This flow is provided in 3 looks:

1) Product / Service (Material Flow) is a flow in the form of Physical Movement.

2) Information (Information Flow) is the flow of information for communication such as what products, how much, price, how many baht.

3) Money or other returns (Financial Flow) such as the cost of goods or services that must be paid in exchange for goods or services received. This flow is mainly focused on the product or service. With the goal of how to flow to be the most efficient, to meet this efficiency problem, the logistics system was built based on 13 activities, as shown in Figure 1.

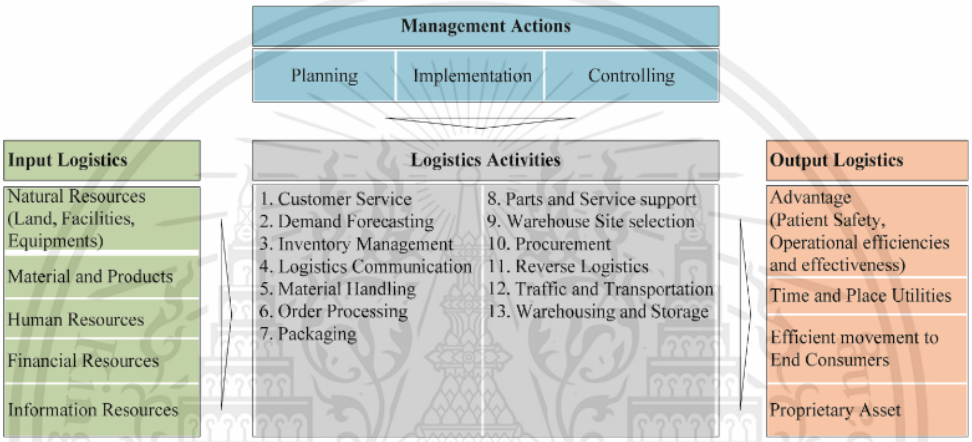

Figure 1: 13 basic activities on logistics [3].

2.3 Application of automation

Never-ending advances in technology have fueled the development of automated robots. To be applied in various tasks, especially in the manufacturing sector, robots are introduced in various forms and widely applied to increase efficiency in the production process.

Also, the advancement of the ageing society of many countries worldwide makes robot technology in the service sector increasingly important. Especially AI (Artificial Intelligence) technology, which is a form of intelligent robots. Furthermore, it is considered a state-of-the-art robot technology that can meet the closest and clearest coexistence between robots and humans in the future. The use of technology to play a role in helping the elderly to care for the sick is essential. Robot technology applications are another way for robot manufacturers to solve problems and facilitate their lives [4].

The robots used to solve logistics problems in hospitals will reduce resource and labour use, such as nursing the job of pushing a wheelchair or pushing heavy loads. Hospitals hire a courier service to deliver items such as medication and linens, food kits, medicines, and supplies. Alternatively, even waste from one hospital location to another. And for a wide range of applications in material transportation. The system will contribute to the increased transport of materials and the less time spent on work. The robots can have a working schedule, and the user can control the system individually. It is used in hospitals with a constant exchange of schedules [4].

2.4 Jetson Nano

Jetson Nano is a small artificial intelligent computer for makers, learners, and developers. NVIDIA has been at the tip of the spear in developing hardware for artificial intelligence (AI) and artificial neural networks. They have scaled down a number of that technical school onto a bit of a piece of kit. The Nano itself is simply the module below that appears sort of a superior version of a portable computer or random access memory (RAM). The opposite piece of a print circuit board (PCB), the layer with ports and headers soldered on, is simply the event board that exists to show all of the Nano's inputs and outputs for testing and prototyping [5].

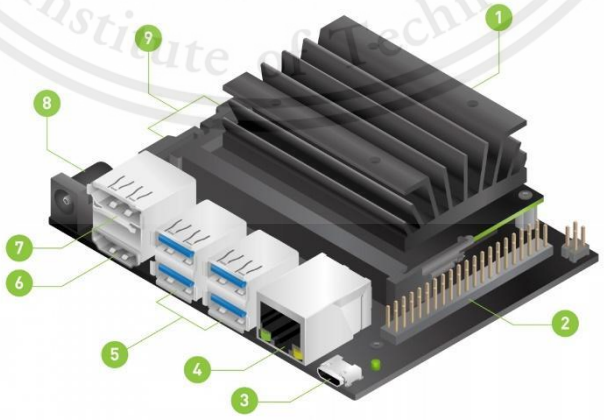

Figure 2: Jetson Nano.

1. microSD card slot for central storage
2. 40-pin expansion header
3. Micro-USB port for 5V power input, for Device Mode
4. Gigabit Ethernet port
5. USB 3.0 ports (x4)
6. HDMI output port
7. DisplayPort connector
8. DC Barrel jack for 5V power input
9. MIPI CSI-2 camera connector

As mentioned above, the Jetson Nano was used for this work as a computer prototype for controlling various robot functions. A processor receives values from external devices and executes commands such as receiving motor speed and direction from Arduino coding, then directing the robot to a controlled direction.

2.5 Arduino Due

Arduino Due is a board based on the Atmel AT91SAM3X8E chip belonging to the ARM Cortex-M3 family. Dissimilar to other Arduino boards that use Microcontrollers (chips), the Advanced Virtual RISC (AVR) family makes Arduino Due processing fast but still formatted.

Arduino Due programming code is the first Arduino microcontroller board to use a 32-bit microcontroller, a controller area network module (CAN), and a clock signal with a frequency of 84 MHz. It has 54 pins of digital input and output (I / O), 12 analogue inputs, four universal asynchronous receiver-transmitters (UARTs), several digital access and cross-connect systems (DACs). 2 channels, 2 TWI channels.

Universal serial bus devices (USB) are supported for connecting external devices. Arduino Due requires Arduino IDE software version 1.5 or higher.

The advantages are fast processing speed. It is ideal for demanding workloads and demanding processing speeds, with long I / O pins, making them ideal for moulded modules or demanding applications with large pins.

The disadvantage is the high price compared to the board that does not have built-in Wi-Fi. The library may not have much variety. Due to the chip used for processing No, the panels like the ATmega328P are not suitable for small applications where the board or controller is hidden [6].

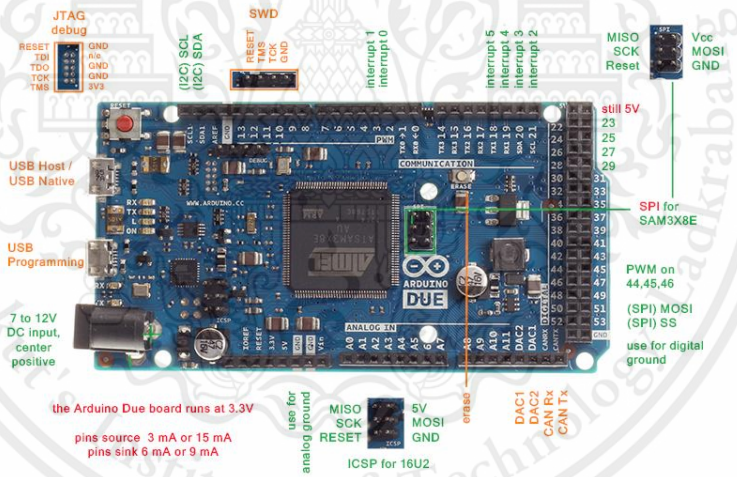

Figure 3: Component of Arduino DUE.

2.6 Motor Encoder

An encoder is an electromechanical device with an associate degree electrical signal used for speed and position management. Encoders provide mechanical motion into associate degree electrical signals utilised by the system to observe specific appliance parameters and create changes if necessary to take care of the machine operates as desired.

The parameters monitored area unit determined by the application and may contain the speed, distance, rate per minute (RPM), and position. Applications utilise encoders or different sensors specific parameters area units usually stated as closed-loop feedback or closed-loop control systems.

2.6.1 Alternating current (AC) Motor Encoders

AC induction motors square measure obtainable choices for general automation machine management systems as they are economical and robust. Motor encoders square measure used for direct speed management in applications mistreatment AC motors and infrequently would like a lot of intense information processing, shock, and vibration parameters [7].

Figure 4: AC Motor Encoders.

2.6.2 Servo Motor Encoders

Servo motors encoders (permanent magnet motor encoders) supply closed-loop system feedback management systems to applications that need higher precision and accuracy and are not as strong as AC induction motors. The motor encoder used on servo motors is standard, progressive, or absolute, depending on the amount of resolution and accuracy needed [7].

Figure 5: Servo Motor Encoders.

2.6.3 Stepper Motor Encoders

Stepper motors are price effective, precise, and generally employed in open-loop systems. In systems victimisation stepper motors, the associate progressive motor encoder is usually mounted to the present motor wherever speed management is needed. It can enable the stepper motor system to attain control system feedback. Stepper motor encoders can even be employed in some applications to permit improved management of stepper motors by providing precise feedback of the step angle of the motor shaft situation [7].

Figure 6: Stepper Motor Encoders.

2.6.4 Direct current (DC) Motor Encoders

DC motor encoders square measure used for speed management feedback in DC motors wherever associate coil or rotor with wire-wound rotate within a force field created by a stator coil. The DC motor encoder provides a mechanism to live the speed of the rotor and supply control system feedback to the drive for precision speed management [7].

Figure 7: DC Motor Encoders.

2.7 Simultaneous Localisation and Mapping (SLAM)

Mapping is a process that uses environmental measurement data from sensors to create a data structure for explaining the environment in the area. Localisation and mapping are an essential task for robots, as robots need to know the location of the map, together with the location data of the robot in planning, to perform activities that respond to the environment, such as the movement for automated survey robots, rescue robots, robot maids, or even capturing objects. The location of the critical points, the explanation of the environment with a large group of points, the description of the environment with the location of objects interested in the robot, or the environmental structure of the environmental relationship. Robots create a map of the environment while moving and identify their location simultaneously. The robot has no environmental information before, which SLAM is very important for robots requiring instant interaction [8].

2.7.1 Low-cost Light Detection and Ranging (RPLIDAR)

RPLIDAR is a sensor for indoor robotic applications. It provides a 360-degree scan field, 5.5 Hz/10 Hz rotating frequency with assurance 8-meter distance ranger [9].

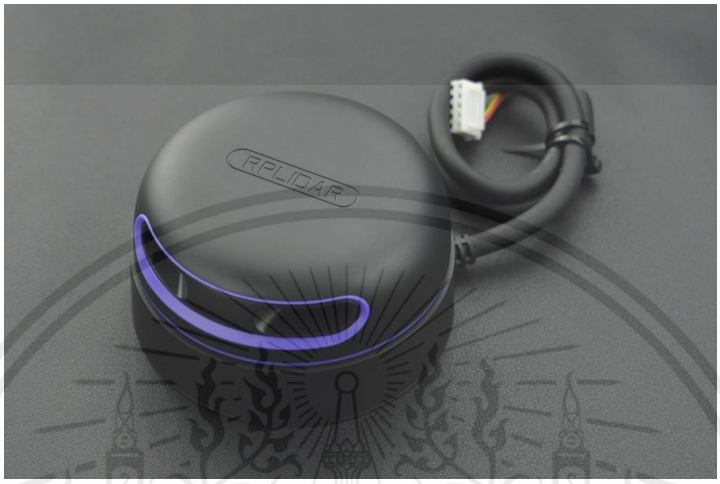

Figure 8: RPLIDAR.

As mentioned above, RPLIDAR is a device that is used for scanning and generating the map quickly and accurately for the autonomous robot.

2.8 Intel RealSense 3 Dimension (3D) Camera

Intel RealSense 3D is a depth-sensing technology that can help computers look at an object. The camera detects movement and processes it in 3D. It can control the computer with a signal. It is also possible to recognise gestures and faces. The camera body is small, portable, and not too cost-per-piece, ideal for further development with other technologies.

Lenses are conducive to infrared lighting and infrared laser projection lenses. It detects infrared light emitted by objects (all objects already emit this wave). The motion tracking software running on the robot operating system (ROS) enables tracking and identifying surrounding environmental conditions, which has led to the application of screen interface control.

2.8.1 Performance characteristics [10]

The RealSense camera is a 3D depth detection technology because the camera can calculate the distance between objects, and it can also separate exciting objects from the background. This camera enables clear recognition of the object's position, including facial recognition, posture, and precise user action.

2.8.1.1 Mapping and Navigation

The camera has SLAM technology, which uses a fisheye camera, accelerometer, gyroscope, and depth camera for motion-based use. Also, the system recognises the map location earlier. When it is used, repeated retrieval will translate the current position and other locations in the surrounding environment at the moment.

2.8.1.2 Facial Recognition/Person Tracking

RealSense recognises a total of 78 landmarks to increase the accuracy of 3D face detection, even if the camera can be detecting the face rotation or twisting. It recognises up to 4 faces in a range of up to 1.2 meters.

2.8.1.3 Obstacle avoidance

Whether it is an airborne drone or a real sense camera-based robot in a typical home system, the camera allows the robot to pinpoint its location and control the movement, evading real-time detected obstacles by calculating the distance between the subject and the background.

Figure 9: Intel RealSense 3D Camera.

2.9 Relay Module

A relay module is a result that an electromagnet operates an electrical switch. A separate low-power signal from a microcontroller activates the electromagnet. When activated, the magnet pulls to either open or close the associate in the treating electric circuit.

A relay will consist of a wire coil that wraps around a soft iron softcore or solenoid. An iron yoke delivers an occasional reluctance path for magnetic flux, a movable iron coil, and one or a lot of sets of the contacts. The yoke hinges the movable armature, and one or more sets of moving contacts link to a movable armature. Held in place by a spring, the armature leaves a gap in the magnetic circuit when the relay is de-energised. While in this position, one of the two sets of contacts is closed while the other set remains open.

When electrical current is passed through a coil, it will generate a magnetic field that activates the armature. The movement of the movable contacts makes or breaks a connection with the fixed contact. When the relay is de-energised, the closed sets opened and broke the connection and inversion if the contacts were opened. When switching off the current pass to the coil, the force returns the armature to its relaxed

position. The spring usually provides a force, but gravity can also be used in specific applications [11].

Figure 10: Relay module 4 channels.

The relay module controls the tower light by connecting to the general purpose input/output (GPIO) of Jetson Nano and 12 volts and ground of the battery.

2.10 Emergency Switch

When an emergency is occurring, the emergency switch will shut off the machine. It is different from a normal shut down switch, which shuts down all systems and machines without damage. The control circuit of machinery equipment wires in series with the emergency switch and battery or power source [12].

2.11 Joystick

There are many alternative kinds of game controllers employed in the history of laptop games. The foremost fashionable controller has been the joystick, which is just a box with a button and sticks to manage the game's motion. However, there are many sorts of joysticks [13].

2.11.1 Different joystick types

2.11.1.1 Digital Joysticks

The most common joystick kind in home computers is Atari-style digital joysticks. Those joysticks square measure referred to as once Atari, due to this joystick kind, was first introduced in Atari 2600 video game and adopted to house computers. The joystick itself consisted of five square measures organised to that four of them were concerning the joystick direction (UP, DOWN, LEFT, RIGHT), and one was for the hearth button.

The most prime factor is that joysticks were customary, and there have been joysticks accessible from several makers.

2.11.1.2 Paddle Controller

A paddle controller may be a straightforward controller consisting of a knob employed to regulate the sport. Paddle controllers were used in video games since the primary television games regulate the racket on the screen.

Paddle management uses analogue principles for control, and that they merely carry with it one potentiometer and button in one controller. The analogue data of the potentiometer should be regenerated to digital so as the personal computer to use that data.

Figure 11: Paddle Controller.

2.11.1.3 Analog Joystick

Analogue joysticks were a combination of ideas of each joystick and paddle. The thought was that potentiometers were gone to live the tick movement (instead of switches like in digital joystick). Digital joystick created is feasible to possess additional correct management that was required on the wing machine programs.

Analogue joysticks are utilised in Apple, Amiga, and International Business Machines computers (IBM) that solely had analogue joystick inputs.

Figure 12: Analog Joystick.

2.11.1.4 PC Analog Joystick

The joystick is simply a basic analogue joystick with two buttons. Later, some makers placed two connectors to their interface card, and a few card makers enforced just one joystick input. The joystick interface card was designed to be as straightforward and low cost as achievable.

Nowadays, their area unit is thus known as laptop digital joysticks. Those sticks have enforced another means than through laptop joystick card interface to avoid several the typical laptop joystick issues and providing quicker access of a joystick for game programs. However, those digital laptop joysticks that

communicate with laptops are not standardised and achievable ways for the unit keyboard connective, interface, or proprietary serial protocol through a previous joystick interface.

Figure 13: PC Analog Joystick.

2.11.1.5 Bluetooth Gaming Controllers

Whether a laptop or a mobile gamer, some games play higher on a controller. A mouse and keyboard may be additional corrections. However, square measure slows to use with restricted area or on a settee. Touchscreen controls do not need any peripherals. However, they are not correct or pleasant to use.

Nevertheless, not all Bluetooth game controllers square measure created equal. Some square measure explicitly designed for golem devices, accurate console controllers that job across all platforms. To help create the choice, that has placed a listing of the simplest Bluetooth controllers for golem and laptop gambling.

Figure 14: Bluetooth Gaming Controller.

2.12 Python

The Python programming language is a high-level computer programming language. It is designed as an easy-to-read scripting language. By eliminating the complexity of the structure and grammar of the language. In the part of converting, the instruction is set to the machine. Python programming language has a function interpreter that is a line-by-line translation of the instruction set. To enter the processor for the computer to work. In addition to that, the Python programming language can be used for many different types of programming. Without being limited to a particular job (General-purpose language), it is widely used in many large global organisations such as Google, YouTube, Instagram, Dropbox, and NASA. [14]

As mentioned above, Python is used for connecting the GUI from PyQt5.

2.13 PyQt5

PyQt comes from a set of Python bindings for the cross-platform application development framework for desktop, embedded, and mobile, usually used as a graphical toolkit. However, it is also beneficial in treating command line applications (CLI). The platforms supported by Qt include Windows, macOS, Linux, iOS, and Android. The number after PyQt means the version of PyQt.

Qt in this project has several collections of modules, including, QtCore is a base library that provides containers, thread management, event management, QtGui and QtWidgets are a GUI toolkit for Desktop, which provides many graphical components to design applications, QtSQL is a full-featured SQL RDBM abstraction layer extensible with its drivers, support for ODBC, SQLite, MySQL, and PostgreSQL [15].

2.14 Barcode

Barcode is a bar code composed of dark lines and bright lines arranged vertically. Used instead of numbers and letters to facilitate the computer to take data into processing more efficiently, faster, more accurately, and precisely. They are using a barcode reader (Barcode Scanner) as a transmission data to the computer system by separating the width between dark and light areas into numeric codes when the light from the bar code reader hits the bar code a horizontal position. The reflected light from the dark line is less than the light reflected from the bright area. The barcode reader converts the light reflected into a code to send to the computer. Barcodes can reduce critical errors a lot. In addition to that, barcodes save time, reduce costs and useless human resources [16].

2.14.1 One-dimension (1D) barcodes

It looks like a black and white line with some thickness alternating. Suitable for general use that does not want to use a lot of storage space, such as product code, product name, identification number, membership number, Serial number, and a lot of the product. The white line is used in place of a number or letter code. It can contain information about 20 characters. Barcode applications are often used in conjunction with a database when reading the barcode and decoding, then using the code that can be used to retrieve the data from the database [16].

2.14.1.1 International Standard Book Number (ISBN)

An abbreviation is a code set to be used in general book publications. The aim is to be unique to each book, but the latter is applied to various products. It can be used in more variety of applications.

2.14.1.1.1 The components of ISBN

ISBN is 10 or 13 digits, divided into 4-5 parts. Each number is divided by a sign (-) or space.

Part 1: If it is 13 digits, it will begin with the code of European Article Numbering-Uniform Code Council is 978 or 979 (10-digit code will not have this part)

Part 2: Country Codes for Thailand Use 974

Part 3: Publisher Code such as Nanmeebooks publishing use 472

Part 4: Title code is the order of the publications produced by that publisher

Part 5: Checking number, used to check in the computer system from the calculation number 9, the position of Part 2-4

Example: ISBN 974-472-362-9 is the international standard number of the book of Harry Potter and the Philosopher's Stone of Nanmeebooks publishing. The way to check it is to take the first ten digits with ten digits, the second with nine digits, the third with 8 to the ninth digit, multiply by 2, add the 9-sum product, and divide it by 11, remove the fraction from the division from 11 again. Then, get the 10th digit or the verification code.

2.14.1.2 The type of barcode one dimension [16]

2.14.1.2.1 Code 39

This barcode is found in electronics, healthcare, and government. It can include the entire 128 ASCII (American Standard Code for Information Interchange) character set and stretch to any length, and is limited by the size of the label.

Figure 15: Code 39.

2.14.1.2.2 Code 128

This barcode is created from the ASCII 128-character set. It is used widely in packaging and shipping applications. It can automatically switch settings that allows users to optimise it for barcode length.

Figure 16: Code 128.

2.14.1.2.3 Interleaved 2 of 5

Interleaved 2 of 5 is usually found in the depository, product distribution, and manufacturing. It is used to encode pairs of a number. Two digits are paired to create a symbol.

Figure 17: Interleaved 2 of 5.

2.14.1.2.4 Universal Product Codes (UPC**)**

It is found on retail products. These barcodes are created for grocery stores to provide quick receipt printing and inventory tracking. After securing a UPC number, a manufacturer will receive a unique company number to combine with their product numbers.

Figure 18: Universal Product Codes.

2.14.1.2.5 International Article Number (EAN**)**

These barcodes are used in booksellers, libraries, universities, and book traceability. 13-digit codes are created from the ISBN for each specific book tracked.

Figure 19: International Article Number.

2.14.2 Two-dimensional barcodes (2D)

It is a technology developed from 1D barcodes designed to contain data both vertically and horizontally. It is possible to contain information up to approximately 4,000 or 200 times the size of a 1D barcode in equal or smaller areas. It can contain information in many languages, English and Thai, Japanese, Chinese, or Korean. 2D barcodes can be decoded even if some barcodes are damaged.

2.14.2.1 Portable data file-417 (PDF417)

It can be found in many types of recognition, such as a driver's license, and extensive in size - 4 times larger than other 2D barcodes.

Figure 20: PDF417.

2.14.2.2 Data Matrix

The data matrix is the most common 2D barcode. It is a square shape code and can amount to information in a small space. It is popular in electronics manufacturing and healthcare for that reason.

Figure 21: Data matrix.

2.14.2.3 Quick Response Codes (QRcode)

With the latest trend in barcoding, QR Codes are gaining popularity as marketing tools to link to web-based information. QR Codes are usually used in advertising or linking to webpage or details about a particular product.

Figure 22: Quick response codes.

2.14.3 Barcode reader for hospital business

The Barcode system helps business management information as a tangible product, and service businesses such as hospitals and nursing homes can use this barcode system to help manage patient information. Nowadays, large private hospitals are increasingly turning to use the barcode system with patient information.

When a patient gets sick and must travel to see a doctor for treatment at the hospital, especially in the case of inpatients must be admitted to stay in the hospital for treatment. The hospital personnel may have seen a case of named wristbands. Patient surname and details are added in a small barcode bar on the wristband. When a patient needs to be serviced at which department, the department receives the patient information using a barcode reader to scan the barcode on the wristband. The information is connected to the computer to store a history of the patient medical treatment. Such information will also link to the dispensary or financial room. When the treatment is complete, and the patient has to take medication or go to pay before they go home.

In addition to the hospital stay in case of illness or accident. Hospital visits for annual health check-ups are also used with this barcode to provide convenience in terms of information. It is directly connected to the computer. The hospital personnel does not have to wait for type information or check information every time the health examination recipient comes in to get a service at the department. Every hospital department has a barcode reader to scan the wristbands of the patient. The probability of a mistake resulting from keying is much less.

Patients or nursing guests from the hospital will be able to provide quick and easy service. If a hospital has a barcode reader and a barcode system used in terms of the hospital itself, it will serve patients more quickly and efficiently. If there are many patients or visitors, there will not need much staff. Hospitals also focus on healthcare or other services that require personnel. As for data management, it is a matter of bar code readers and computer systems.

This barcode system will help to organise data collection of patients and hospital visitors. When the old patient or new patient comes in to receive nursing services, the historical data of the old service will be kept for reference at any time.

2.15 Color Coding for pushbuttons, indicator (pilot) lights, and illuminated pushbuttons (NFPA 79 Industrial Machinery) [17]

Colour	Device Type	Typical Function	Examples
RED			
	Pushbutton	Emergency Stop, Stop, Off	An emergency Stop button, Master Stop button, Stop of one or more motors.
	Pilot Light	Danger or alarm, an abnormal condition requiring immediate attention.	An indication that a protective device has stopped the machine, e.g. overload.
	Illuminated Pushbutton		Machine stalled because of overload (the colour RED for the emergency stop actuator shall not depend on the illumination of its light).
YELLOW			

	Pushbutton	Return, Emergency Return, Intervention - suppress abnormal conditions.	Return of machine elements to a safe position, override other functions previously selected. Avoid unwanted changes.
	Pilot Light	Attention, caution/marginal condition. Change or impending change of conditions.	Automatic cycle or motors running; some value (pressure, temperature) is approaching its permissible limit. Ground fault indication. Overload that is permitted for a limited time.
	Illuminated Pushbutton	Attention or caution/Start of an operation intended to avoid dangerous conditions.	Some value (pressure, temperature) is approaching its permissible limit, pressing a button to override other functions previously selected.
GREEN			
	Pushbutton	Start-On	General or machine start; start of a cycle of partial sequence
	Pilot Light	Machine Ready; Safety	Indication of safe condition or authorisation to proceed. Machine ready for operation with all conditions normal or cycle complete and machine ready to be restarted.
	Illuminated Pushbutton	Machine or unit ready for operation/Start or On.	Start or On after authorisation by lights; start or more motors for auxiliary functions; start or energise machine elements.

Table 3: Color Coding for pushbuttons, indicator (pilot) lights, and illuminated pushbuttons.

2.16 Cooling Fan

The instrumentality will unleash heat that will cause several issues and failure, shorter product life, early deterioration of elements, malfunction, and alternative safety risks. Cooling fans area units essential to applications within the presence of warmth. For avoiding these issues, the suitable cooling unit for these systems should be hand-picked [18].

2.16.1 Axial Fan

The propellers settled within the circular flow path between the cylindrical hub and casing. There is accustomed feed air to come up with airflow within the direction of the axis of rotation. When air flows on the axis of rotation, the structure

is unbroken compact. Capable of generating an outsized air flow, axial fans are suited to applications requiring ventilation cooling wherever the whole house within the instrumentation should be cooled [18].

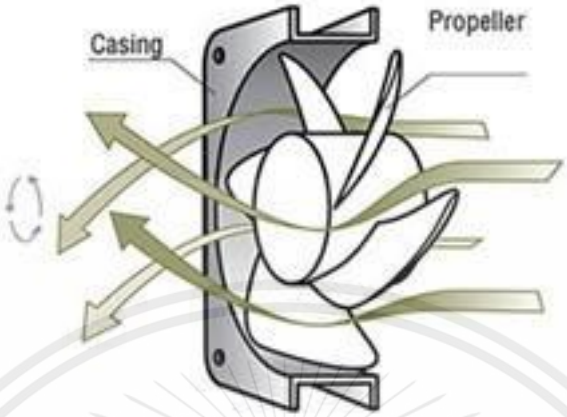

Figure 23: Structure and airflow mechanism of axial fan.

2.16.2 Pressure Loss

When air flows along a specific path, airflow resistance is produced by anything in the path that inhibits the flow. Comparing the cases illustrated in figure 24 and figure 25, the device shown in figure 24 is almost empty, so there is almost no airflow resistance in the device and a minor decline in the airflow. By contrast, there are many obstructions of the airflow in the device shown in figure 25, increasing airflow resistance and decreasing airflow [18].

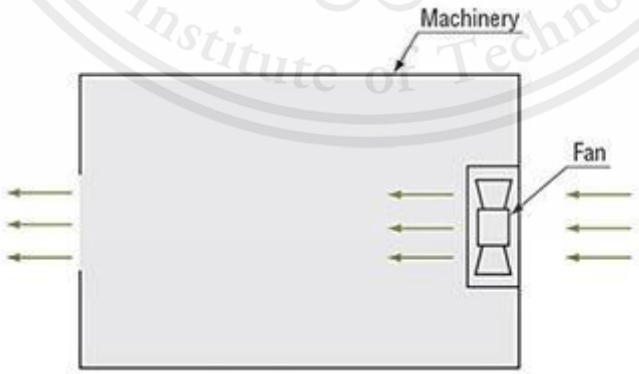

Figure 24: Flow path with low airflow resistance.

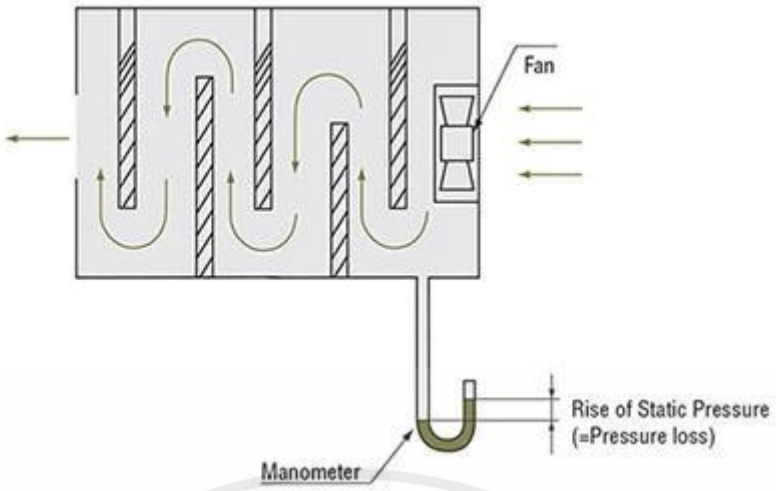

Figure 25: Flow path with high air flow resistance.

When the impedance is low, the air flow is large, and when the impedance is high, the air flow is low. The air flow resistance becomes the pressure energy that will increase the static pressure among the device. This is called pressure loss. Pressure loss is determined using the following formula:

$$P = \frac{1}{2}\xi V^2 \rho$$

$$P = \frac{1}{2}\xi \left(\frac{Q}{A}\right)^2 \rho$$

Hence; V = Flow speed [m/s]

ρ = Air density [kg/m^3]

ξ = Resistance coefficient specific to flow path

A = Cross-sectional area of flow path [m^2]

Q = Air flow [m^3/s]

2.17 SQLite

SQLite is an in-process library, embedded SQL database engine, very carefully tested before every release and reputation for being very reliable. SQLite can read and write directly to ordinary disk files, a complete SQL database with multiple tables, files, triggers, and looks. It is contained in a disk file [19].

CHAPTER 3

METHODOLOGY

The research operation has three main parts. There are the hardware part, the software part, and the interface part. The hardware part has the robot's outer structure and electronic hardware. The robot's software includes a Robot Operating System (ROS), mapping, interface control of the robot, automatic obstacle avoidance system, barcode scanner, tower light that shows the robot's operation phase, etc. The interface part has three sections. There are login page, scan product page, and selecting point or destination page.

3.1 Robot model and structure

3.1.1 Robot structure design

In the design of robots has used the Solidworks 2018 program to design the general appearance of the robot is a rectangular shape with a width of 606 mm, a length of 600 mm, an overall height of 850 mm, where the robot will consist of the following parts:

3.1.1.1 The base section

The base section has a width of 606 mm, a length of 600 mm, and 230 mm of height. It consists of four motors that control four wheels, two motor drive boards, and both dual boards to help save space. Inside of the base section is a Microcontroller system (Jetson Nano) for controlling the robot and circuit board. Also, the top part of the base below is drilled into a slot for installing LiDAR, providing laser detection for the mapping process to shine through the outside.

3.1.1.2 The middle section

The center section is a work area where any medicines, foods, or medical supplies are needed. The height is about 300 mm. It will be empty, with space allocated on the shelf. The front door requires a password to access the inside of the robot. If the user does not know the password, they will not be able to

enter the robot's shelf. The robot also has a depth camera that will be installed to measure the path by using the 3D method.

3.1.1.3 The top section

The top section is the plane for placing the display screen that installs at an inclination of approximately 45 degrees to facilitate visibility. The display we use is the Nvidia jetson touch screen, which is the control area and display part. As shown in the design in 3D models in figure 26.

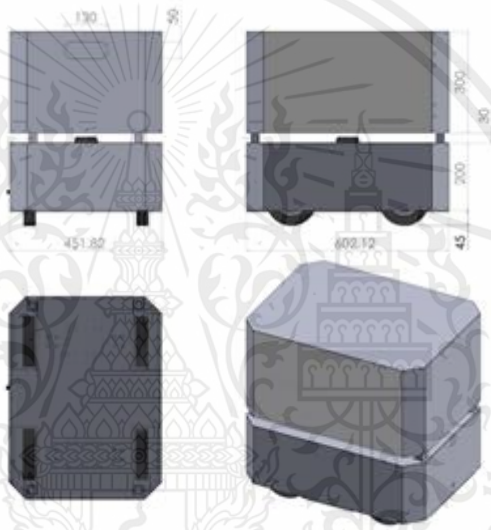

Figure 26: The design in a 3D model of the robot when viewed from the front, side and bottom views.

The 3D model of the robot is molded into an aluminum frame with a thickness of 3 mm. and a total weight of approximately 20 kg.

In addition, the base of the robot has a motor bracket that will attach the motor to the base of the robot which is made from a 3D printer designed with Autodesk Inventor Professional 2020 as shown in figures 27 and 28.

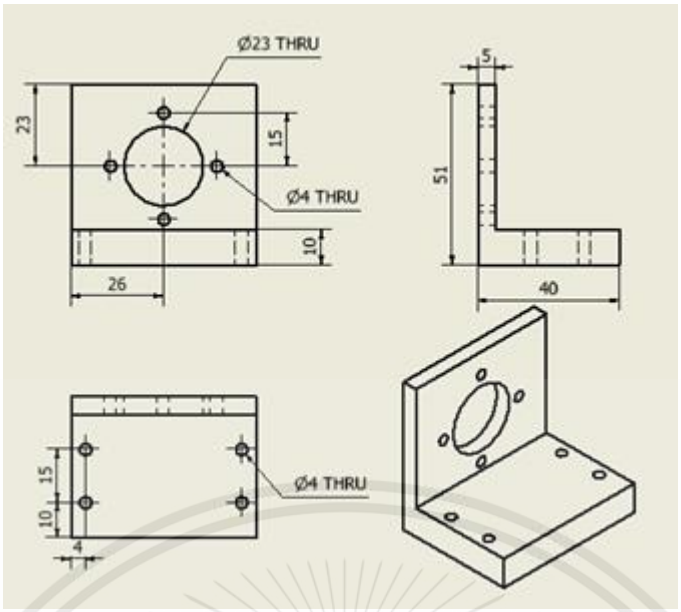

Figure 27: The design of the front motor mount bracket.

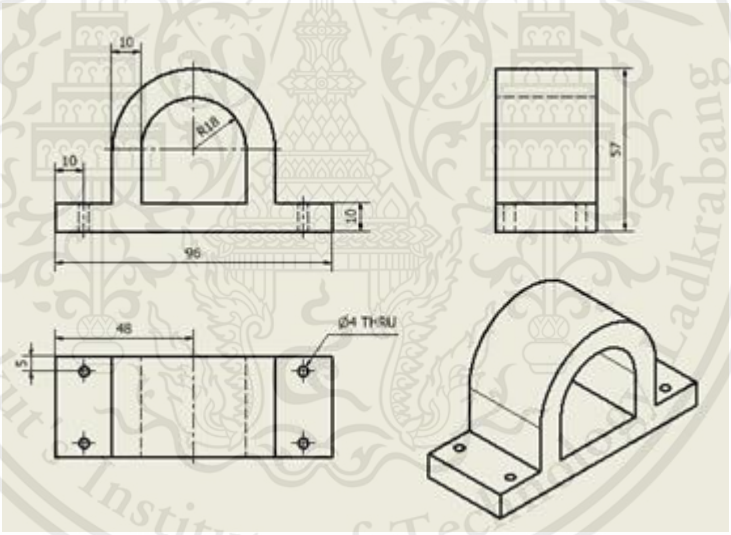

Figure 28: The design of the rear motor mounting bracket.

3.1.2 Electronic Circuit Board Design.

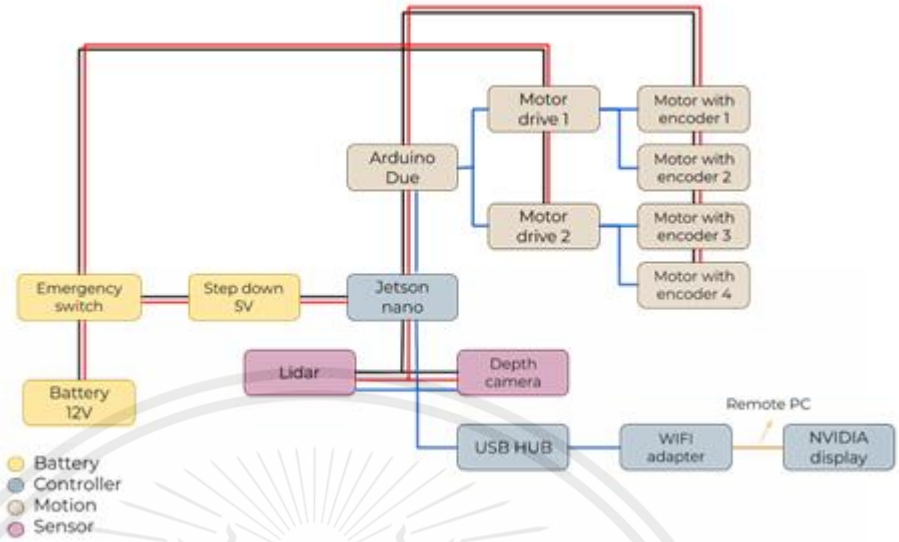

Figure 29: The circuit board inside the robot.

In the movement of the robot, it powered by a 12-volt battery and split into two ways: one is the supplies power to an emergency switch, two motor drives, and through a step-down voltage regulator 5 volts to power the Jetson nano, which will be the processor and control other components for various robot functions via Nvidia jetson touch screen.

3.1.2.1 Battery

This section consists of a 12 volts 30 Ampere Hour battery, a step-down voltage regulator, and an emergency switch. The battery is supported by a team of Khon Kaen University. The battery uses a nano-silicon process from rice husks that use less toxic chemicals. Currently in use on an industrial scale with the production process as in Figure 30.

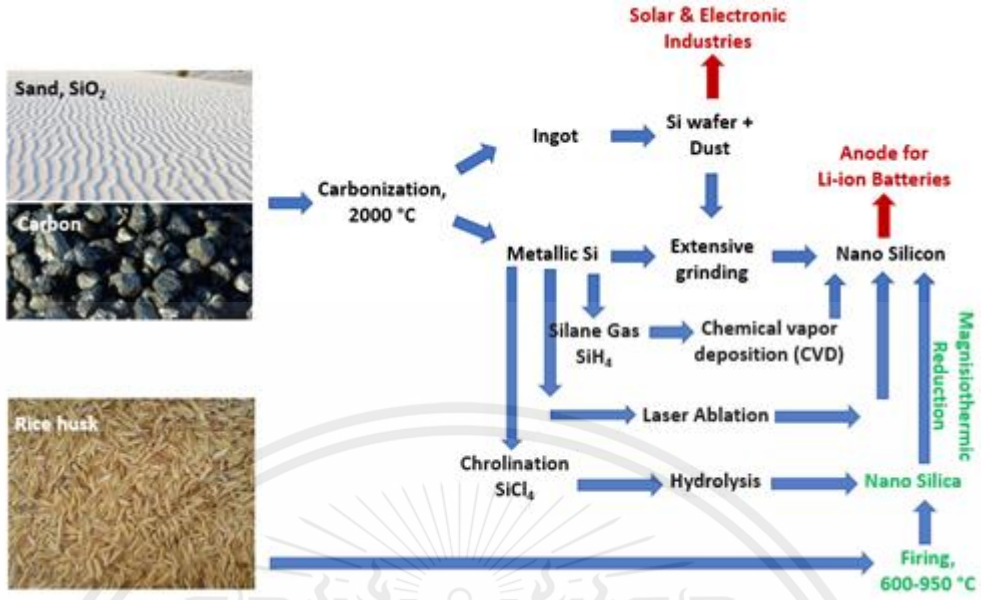

Figure 30: Lithium-Ion Battery Production Process Using Rice Husk Electrodes.

The nano silicon production process from rice husk is base on a chemical process that uses less toxic chemicals than the existing processes on an industrial scale that uses heat as low as 600-950 degrees Celsius, which is lower than the process. Carbonization uses temperatures around 2000 degrees Celsius, allowing the process to use a variety of fuel sources. Do not rely on only the heat from electricity. As a result, the production cost is much lower than that of silicon nanomaterials on the market. The purity is high enough to be used to make the electrodes in lithium-ion batteries. Moreover, the process we use does not rely on technology imports or expensive equipment imported from abroad. So, because the equipment used is a kiln, which Thailand can design and build.

The current lithium-ion battery production process consists of:

1. Mixing is the introduction of early raw materials such as cathode or anode materials, conductive additives, mostly carbon materials, and binders, which hold particle powder together.

2. Coating is the use of the mixture obtained in verse 1 to plaster thinly on the current receiver to achieve a uniform thickness as required, plastering it on both sides of the current receiver.

3. Drying is the film of the electrode material obtained from clause 2 to be dried in a vacuum oven using the required temperature and time.

4. Pressing, rolling the thin film of the composite material firmly to the current receiver and through the slitter to cut it to the width and fit the battery configuration as needed.

5. Stacking thin films of materials from both cathode and anode terminals and step by step with a barrier in the battery.

6. Cutting to a thin film consisting of both cathode terminals. The anode terminals and partitions in the battery are the required length and winding to be cylindrical.

7. Packing thin film rolls into containers and adding electrolyte solutions This procedure must be done in the atmospheric control room and humidity.

8. Sealing and connecting various controlled electronic devices, including anodes and negatives. on the battery.

Lithium-ion batteries are small and lightweight electric power storage. Using this type of battery will cause mobile devices such as mobile phones. Modern electronics, or even mobile medical devices, used to be huge, sloppy. Inconvenient offsite use It's small, lightweight, portable, and lasts a lot longer before recharging. The battery type selected in this robot uses battery cells developed from Khon Kaen University technology.

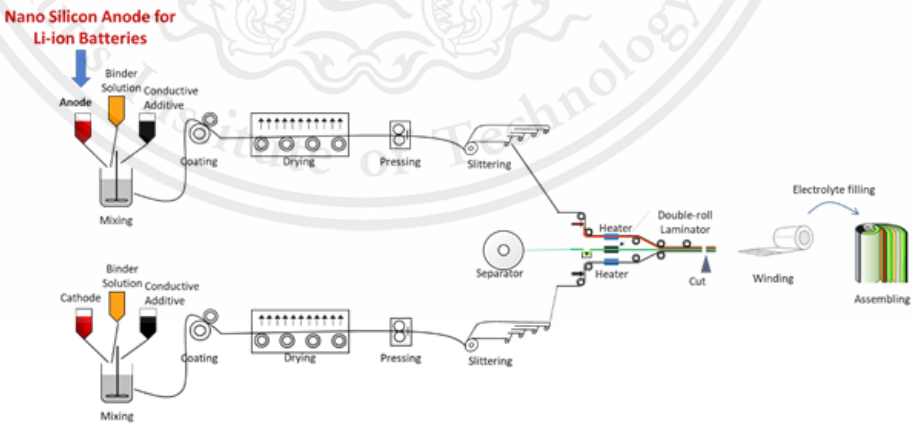

Figure 31: Production process of nano silicon for use as an electrode in lithium-ion batteries.

Khon Kaen University has received government funding to build a prototype factory to produce lithium-ion cell batteries that use Khon Kaen University technology. A chasm and ash are manufactured as high-purity nano-silicons as elements in cell batteries, which gives cell batteries a higher capacity and better support for fast charge. Compared to today's commercial batteries, the goth is used as the default raw material for the production of nano-silicon, a component of the battery terminals. The prototype plant has completed construction, with a capacity of approximately 225,000. This is sufficient and can support the robot for both domestic and international market trials and testing sessions.

Figure 32: Current picture of the model factory at the Northeastern Science Park, Khon Kaen University, Mueang District, Khon Kaen Province.

Figure 33: An example of a lithium-ion battery cell produced by the Battery Research Project of Khon Kaen University.

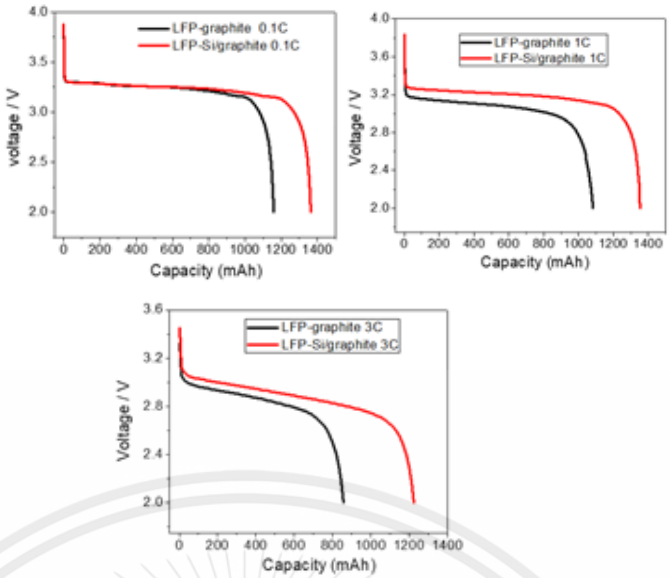

Figure 34: Comparison of Voltage Profile at various C-rates 0.1C (left), 1C (center) and 3C (right) of High Power Cell. The black line shows Commercial and red is the data of the research from Khon Kaen University.

Figure 34 shows the Voltage profile, comparing the performance of a High Power Cell battery using silicon nanomaterial with a commercially available High Power Cell battery at various C-rates. Khon Kaen University's batteries have an energy storage capacity approximately 25% higher at 1C (about 60 minutes of charge-discharge time) and 42% higher at 3C (charge-discharge time). It shows that our battery has better Fast Charge capability than commercially available batteries of the same type.

This prototype plant aims to promote the research and development of cell batteries in Thailand to be more efficient and can be used for commercial use by providing research, development, and production services in conjunction with both government and private sectors. This prototype plant can work with startups that want to experiment with less equipment to the market. However, it requires a high-performance lithium-ion battery that may not be available or may only be expensive and often requires sufficient order. It is a startup that invests less and reduces risk. Also, from production technology that relies on goths and ash, the goth is a precursor raw material. It can also elevate the value and value chain of rice in Thailand because nano-silicon is a high-value material. To make the most of this preparation. Khon Kaen University has a plan to purchase the bean from the farmers' network in Khon Kaen and nearby provinces. To generate higher income for farmers than the normal sale of the goth to make

Thailand move towards a 20-year national development strategy without leaving anyone behind.

The battery is used for automated drug and food delivery robots for patient care and hospital logistics management by artificial intelligence. Developed by the Khon Kaen University team, it can manufacture according to the power requirements and size of the robot. Customers can also choose to use cathode materials with the properties required by the project. To get the most out of tailor and custom-made equipment.

Requirements: A battery device that can support the operation of automated drug and food delivery robots for patient care management and hospital logistics management by artificial intelligence. The 12-volt, 300-watt battery lasts 3 hours and can be fully charged in about 2 hours.

Solutions: Equipment at Khon Kaen University will be responsible for the production of the project, including:

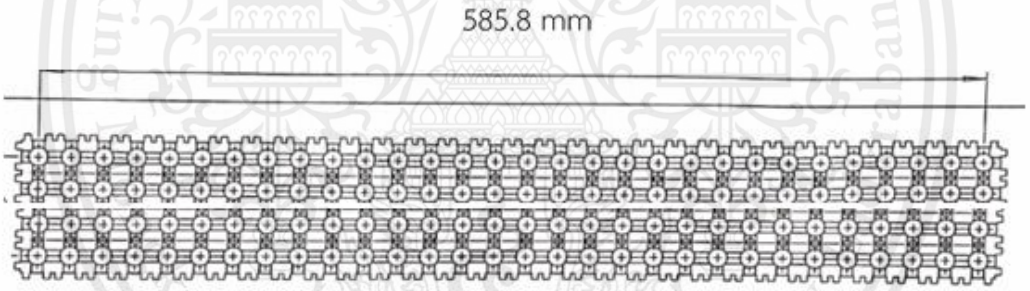

Figure 35: Example of battery size (The actual size may be smaller when robot design is optimized.)

1) Battery pack 12V 4S 30 Ah using cylindrical battery cells developed in the research of Khon Kaen University (the example of the lithium-ion battery that will be produced for the project will be a pack with approximate dimensions 78 mm x 586 mm. x 70 mm (width x length x height), but can customize according to the area provided by the project (Customizable) as shown in Figure 35.

2) PCB with BMS for 12V 30Amps (use 4S). An example of BMS would use a commercially available BMS for 12V batteries and support 30 amps or as required by the project. (Customizable) as shown in Figure 36.

3) Charger (Charger) 300 W for Normal Charge at about 2 hours 1 piece shown as an example. With the charger to be used Must have standard test results and have a minimum CE Mark as shown in Figure 37.

4) 300 W charger for Fast Charge within 1 hour, 1 piece as in Figure 38.

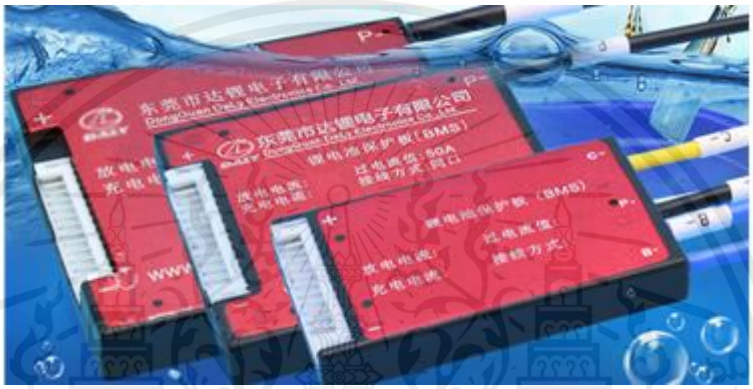

Figure 36: An example of a high-quality Battery Management System (BMS) that can monitor Voltage, Current and Temperature while charging and using the battery for the safety and long life of the battery.

Figure 37: An example of a charger that can charge at a maximum power of 300 W.

Figure 38: An example of a charger that can charge at a maximum power of 600 W.

3.1.2.2 Controller

This section uses the Jetson nano as the core processor to control the robot's operations, the software, and the hardware and using the Nvidia Jetson touch screen to encourage and display the results. Including a connector to various parts of the robot status tracking. The internet connects to Jetson nano by using the same network. Because Jetson nano does not have a WIFI receiver, it requires a WIFI adapter connected via a USB HUB to receive the signal.

3.1.2.3 Motion of robot

This section consists of two motor drives, four motors, and a mechanical wheel, which are programmed through the Arduino Due controller board. Since it must be able to support the motor and encoder (motor with encoder) with 400 rpm, can load 7.9 kg.cm and have a gear ratio of 1 to 14 cycles.

3.1.2.4 Sensor

This is a sensor that assists in automatic walking that uses a gyroscope to locate and use Lidar and depth cameras to process images and help avoid obstacles in real-time.

Lidar and depth camera are 3D sensing elements, where depth cameras will be able to receive 3D images and process them into 3D images with high resolution, but the detecting distance of the sensor is very close, where the Lidar

part will receive it. The images are in a 2D plane and will be processed into a 3D image with a smaller resolution. The lidar and depth camera opted for LDS-01 and intel RealSense D435 for locating and mapping by combining the two 3D sensing elements. The lidar and depth camera use for positioning and mapping. The detailed specifications of each sensor are shown in Tables 4 and 5.

Depth camera Operational Specifications: Intel RealSense D435	
Operating Range (Min-Max)	0.1 m – 10 m
Depth Resolution and FPS	1280 x 720 @ 90fps
Depth Field of View	82.5 x 58

Table 4: The specifications of the Intel RealSense D435.

Name	RPLIDAR A2	RPLIDAR A1	LDS-01
Distance range	0.12-18 m	0.15-12 m	0.12-3.5 m
Angular range	0-360 deg	0-360 deg	0-360 deg
Distance resolution	<1% Dis.range	<1% Dis.range	-
Angular resolution	0.9 deg	≥1 deg	1 deg
Sample duration	0.25 ms	0.5 ms	-
Sample Freq.	2000-4000-8000 Hz	2000-4000-8000 Hz	1800 Hz
Scan rate	10 Hz	5-5.5-10 Hz	5±0.1 Hz
Weight	190 g	170 g	Under 125 g
Height	41 mm	60 mm	39.5 mm
Width	76 mm	98.5x70 mm	95.5x69.5 mm

Table 5: The characteristics of each Lidar.

3.2 Programming and control software of robots

3.2.1 Programming for controlling the movement of the robot

This section is programmed to control the operation of the motor and the upper encoder. The Arduino Due board, which uses PID control to control the speed of the motor, is as follows:

The first process is to read the rotation value from the encoder because the encoder is high resolution, so interrupt readings are required, which is the reading every time the pulse from the encoder changes according to the code.

>> attachInterrupt(encoder1PinA , encoder1read, RISING);

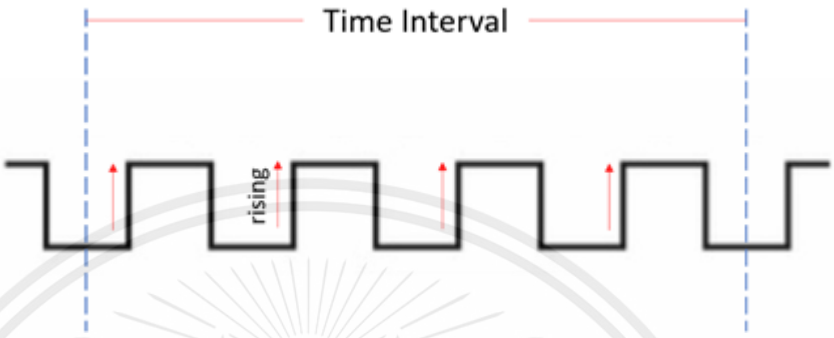

Figure 39: the encoder readings for a given period of time.

After reading for a specified time, it is taken into account the frequency in Hertz (Hz), the number of pulses per second, and converted to the number of pulses rotating the motor. one cycle to control the speed of the motor in meters per second. The gear ratio 1:14, 500 line/revolution is used in the formula.

>> Number of motor cycles per second = frequency/ (14 x 500)

and find out the number of pulses per motor rotation from:

>> number of pulses per 1 motor rotation = (1 x frequency)/number of motor cycles per second

This part of the program receives the speed value from the robot operating system (ROS), which is discussed in the next section. In the robot's motion driver, topic: cmd_vel or speed value in m/s is derived from ROS and converts to frequency to order the motor to rotate according to the PID control system. Maximum P magnification, Ku, until swing begins to bring the Ku value and the Pu swing range value to the remaining variable values as shown in Table 6.

Control Type	K_p	K_i	K_d
P	$0.50K_u$	-	-
PI	$0.45K_u$	$1.2K_p/P_u$	-
PID	$0.60K_u$	$2K_p/P_u$	$K_pP_u/8$

Table 6: Ziegler–Nichols's method

And the values obtained are used to adjust the frequency for further control of the motor speed as shown in the code

```
>>      error = setpoint - HHZ; //determine error

        if (error < 70 && error > -70) {

        error = 0;  }

        integral = +error; //i

        if (integral >= 255) {

        integral = 255;  }

        if (integral <= -255) {

        integral = -255;  }

        derivative = error - previous_error; //d

        Output = (error * Kp) + (integral * Ki) + (derivative * Kd); //output
```

3.2.2 Creating robot drivers in robot operating systems (ROS)

Installing the operating system for Jetson nano must first begin with the preparation of other basic necessary components:

- MicroSD Card The Jetson nano board requires an SD Card for software booting. And as an area to store data (Storage) is important that the SD Card is required space. The minimum recommended capacity is 16GB

- Micro-USB Power Supply for the Jetson nano board requires a minimum of 5V-2A for the Micro-USB port. It also affects the processing performance of some boards. Therefore, the board has a jack port that supports 5V-2A power to enable Jetson nano board to be able to perform at full capacity.

- Wireless Networking Adapter Since the Jetson nano board does not have a built-in WiFi adapter, so internet usage requires a Wireless WiFi adapter to connect.

When preparing various preliminary components, it will go into the process of installing the operating system on the prepared SD card. The first process is to format the SD card with the SD card formatter program as shown in figure 40.

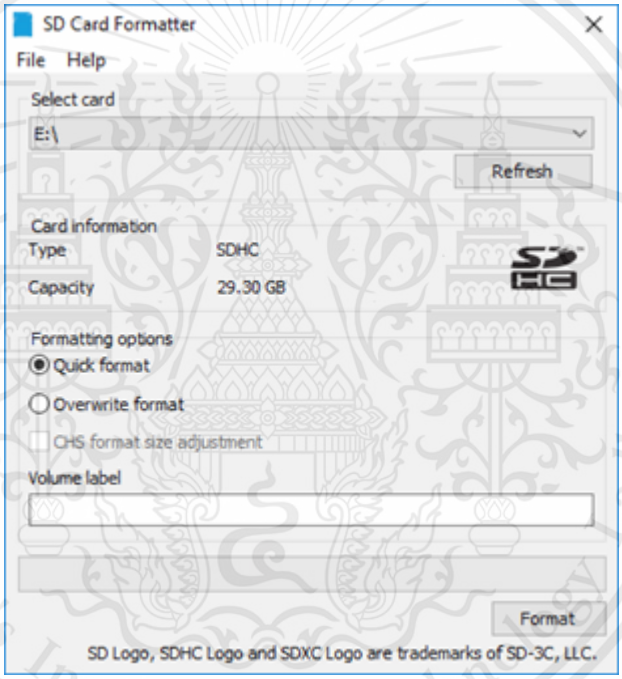

Figure 40: The formatting SD card process window.

Next, download the OS file from https://developer.nvidia.com/jetson-nano-sd-card-image-r322. This OS is Ubuntu 18.04 with some Jetson nano packages included. Installing OS onto SD card requires Etcher to flash OS to SD card.

Select the OS file that we loaded and select the drive address of our SD card, then press flash as shown in figure 41. It will take a while to work, during the operation a pop-up window appears as in figure 42, press cancel.

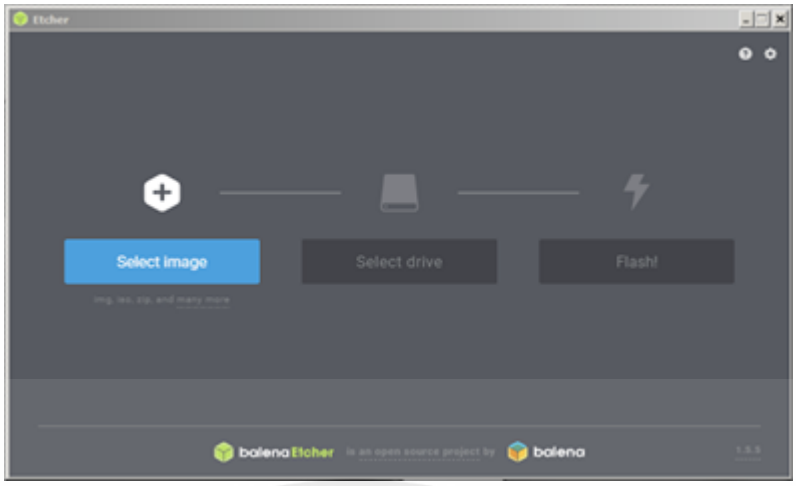

Figure 41: The Etcher program window.

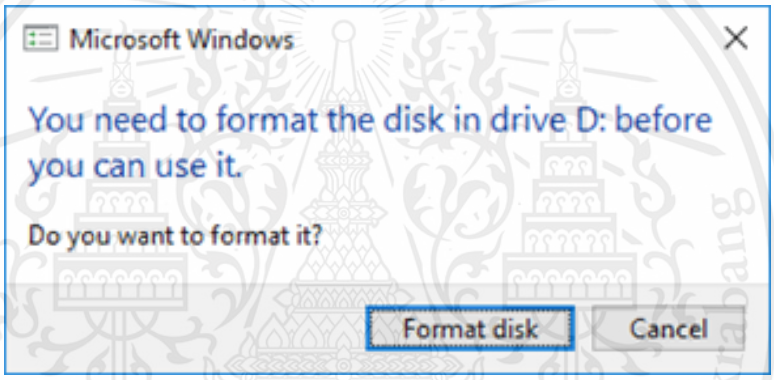

Figure 42: The windows that may come up during operation.

When the program finishes the flash OS process, remove the SD card, insert the Jetson nano, then connect to the HDMI, keyboard, mouse, WiFi adapter, and power supply. After connecting the devices, the Jetson nano board will boot the program automatically. And when setting up the language and the initial password is complete, the Jetson nano board can use to work the operation as shown in figure 43.

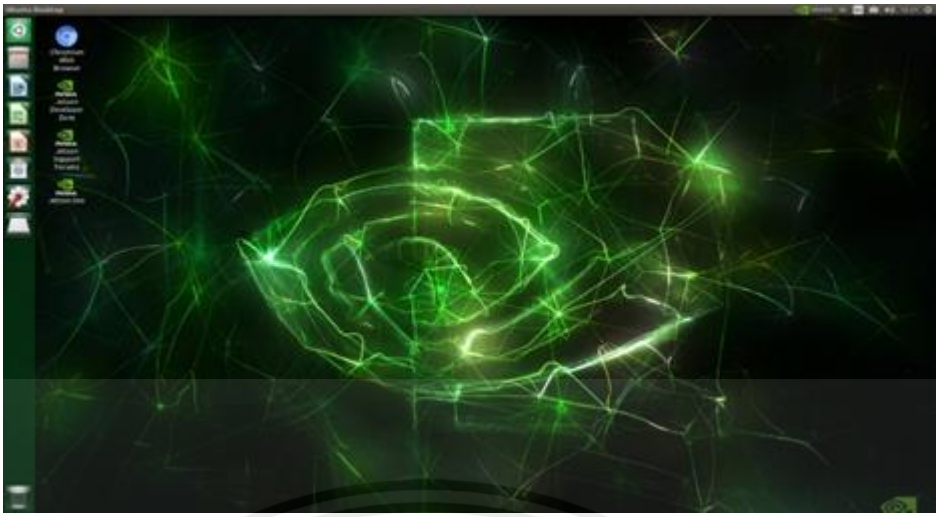

Figure 43: The display screen of the Jetson nano board when the OS is finished and ready to use.

When Jetson nano is ready to use, we will open the terminal and install the ros-melodic-desktop to operate the robot operating system (ROS) and create the workspace that will use as shown in figure 44 that shows the folder within the workspace called Catkin_ws.

Figure 44: Folders within the workspace.

After this, install the package that we want to use within the src of the workspace.

3.2.2.1 My_package1

This package consists of a launch file that is primarily used for map storage and automated walking by using other packages within the workspace together as shown in Figure 45.

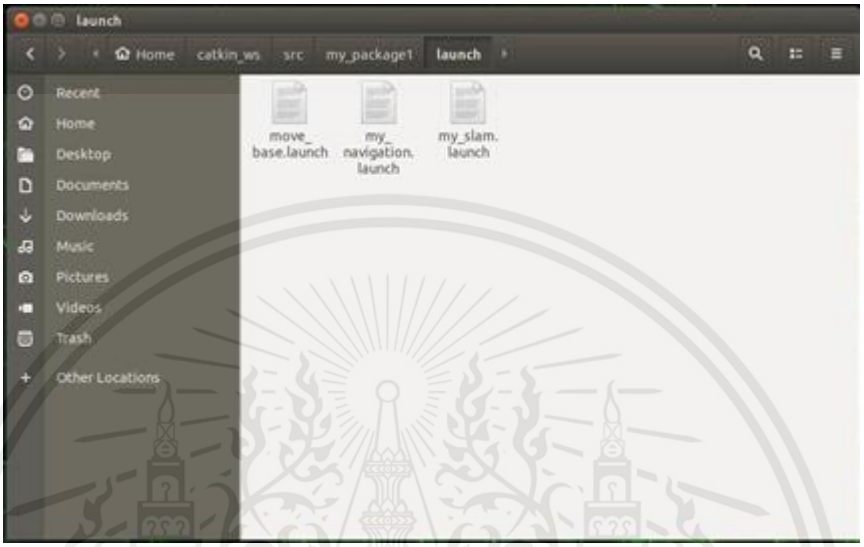

Figure 45: An example of Launch File inside My_package1.

3.2.2.2 Slam_gmapping

This is a package that will use a Lidar sensor, Imu sensor or depth camera and Odometry (the value used to determine the location of the robot based on the motion control or wheels or sensor) to create a 2D map and locate the robot within the map.

3.2.2.3 Rplidar_ros and Realsense-ros

There are packages for Lidar and Depth camera applications, which provide the library required for equipment and parameter adjustments to relevant applications.

3.2.2.4 Navigation

This is a package that relates to the fully automated movement of the robot. This package will save the map values, determine the position of the robot (Amcl), create a cost map, or configure the footprint of the robot and the Move

Base for walking route planning. This part will send the speed value to the robot movement control and activate the wheel to rotate and move, as figure 46 shows the node inside the package navigation.

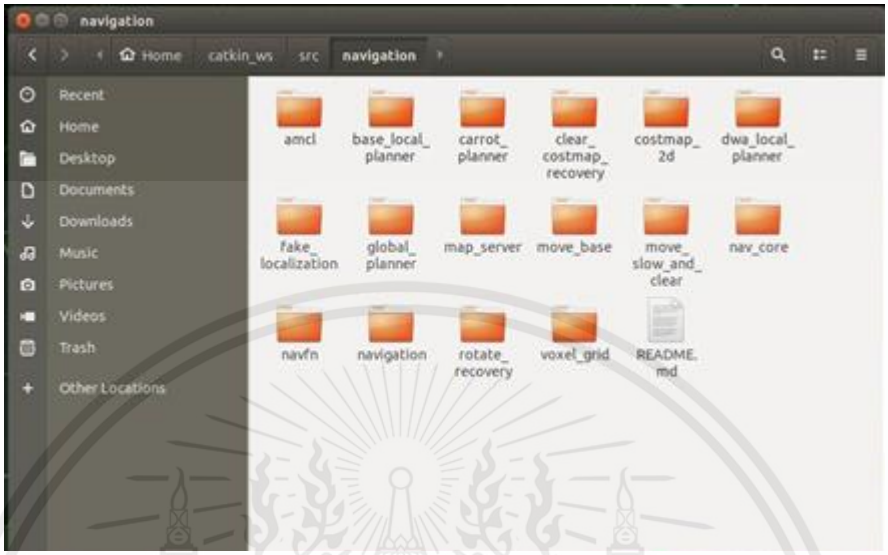

Figure 46: The Node in Package Navigation.

For the robot's automatic movement, it will be shown as the relationship between different packages as shown in Figure 47.

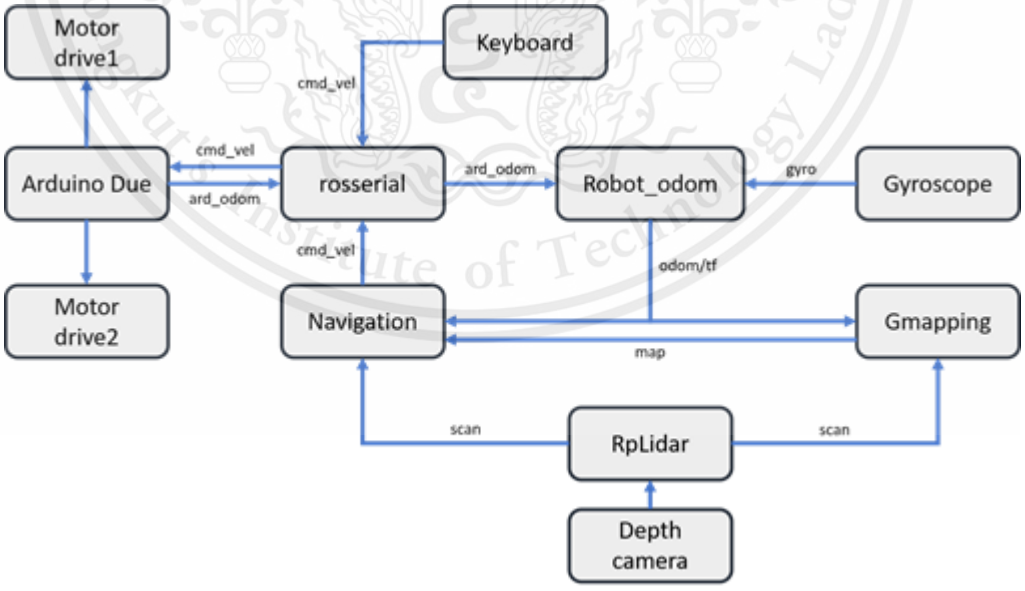

Figure 47: The working of packages on ROS.

From the above schematic, we can control the robot via the joystick which is manual control. For control with an automatic system needs to collect the map with package Gmapping and control it with a joystick, which will take the values from Lidar's sensor and depth camera. While creating the map, we need to locate the robot by receiving Odometry and Transform values from Robot_odom. Which converts the ard_odom obtained from the rotation of the wheel.

After collecting the map, it will send to record in the Navigation section, which will have an automatic walking system, avoiding obstacles and plan a route to the goal that will take the least amount of time to travel which will send cmd_vel to control the movement of the robot as shown in the diagram.

The procedures for installing packages, including the use of parameter adjustments, have been studied in the book On Operating Systems for Robot Development.

Joystick control includes a Joy node that keeps the value from pressing a button and changing the direction of the lever. The vel_cmd receive the value from the Joy node to pass it on to Arduino Due, causing the encoder to rotate at the speed according to the value obtained according to the diagram function of joystick as shown in the figure 48.

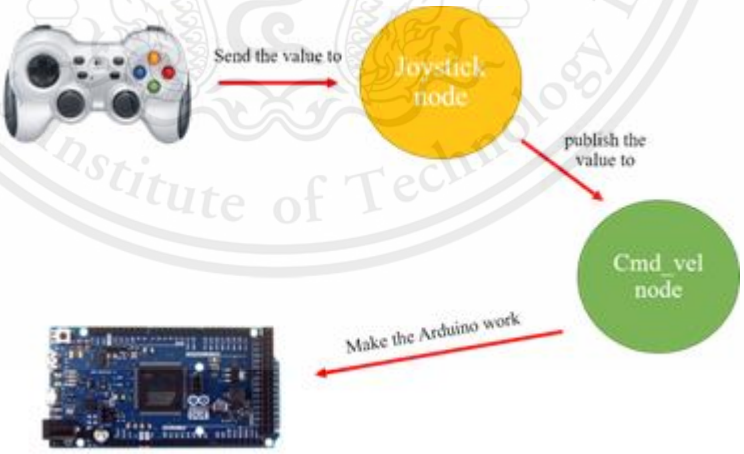

Figure 48: Diagram Joystick working of the robot.

3.3 Programming display screen

For the overall operation of the robot, it starts with the login page as shown in figure 49, user must insert the username and password and unique for identity verification. The example of gui interface shown as figure 50.

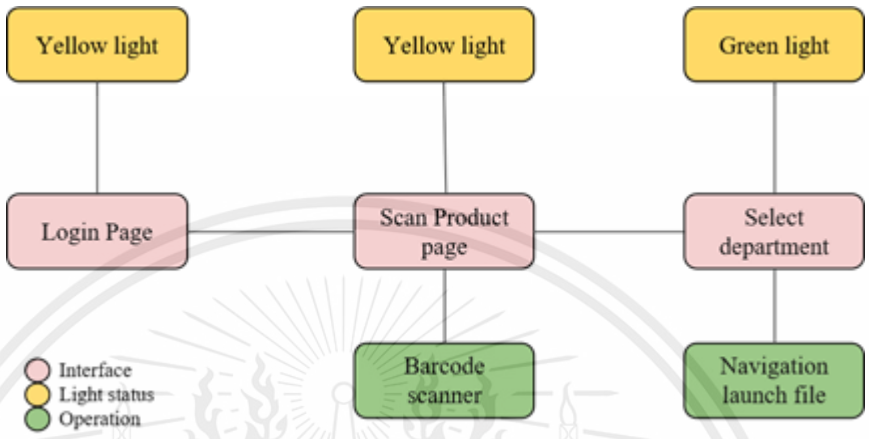

Figure 49: Overall diagram of the robot.

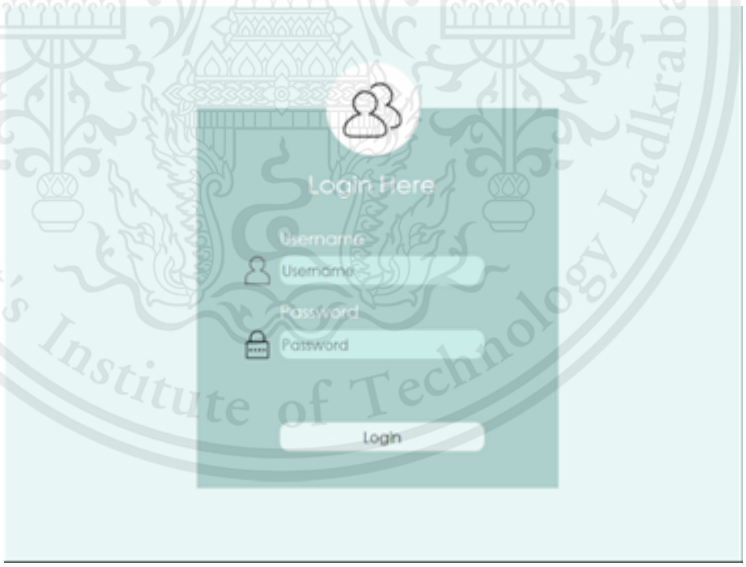

Figure 50: Login Gui interface.

Second page is the scan product page as shown in figure 51, this page uses the barcode scanner to scan the barcode that attaches with the product. After scan, the information of the product will show on the screen as a table and the information will be stored in the SQlite database browser.

Figure 51: Overall diagram of the robot.

For the SQlite database browser we use to store the information of medical supplies, foods and drugs by collecting the product code, product name, brand, model, type and quantity. When the barcode of the product was scanned, it will check the product code if they are the same to each other, it will show on the table of the scan product page. The programming for the SQlite as shown in figure 52.

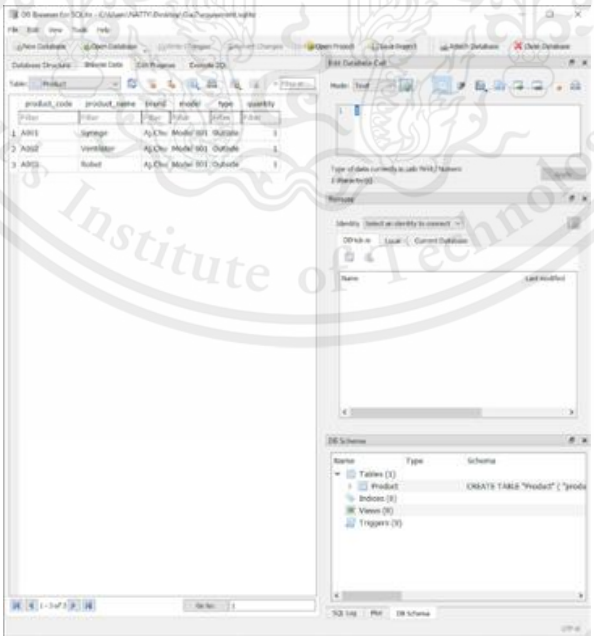

Figure 52: Overall diagram of the robot.

Last page is the destination page. This page user must select the destination or point that they want the robot to go. Then click “OK” then it will start the operation of roslaunch my_navigation.launch to start the navigation. This process will change the light status to be a green light that shows the operation when robots move. As shown in figure 53.

Figure 53: Overall diagram of the robot.

CHAPTER 4

OVERALL OPERATION

4.1 Robot model and frame

The whole robot structure is made of aluminum, forming a square shape with dimensions of width 455 mm, length 650 mm, and overall height 600 mm. The top of a robot is flat for laying the display monitor perpendicular to the robot which can be adjusted according to the user's needs. Display monitor has a width 30 millimeters, length 345 millimeters. The side of the robot has a door with a hinge for storage that has width 500 millimeters, height 300 millimeters. At the back of the robot has a ventilation fan to protect the overheating of the internal circuit. In front of the robot has the on-off switch for start or stop robot processing and has a battery monitor to check the percentage of the battery as shown in figure 53.

A B

C D

Figure 53: The overall appearance of the robot's external structure.

A: Front of the robot **B:** Side of the robot **C:** Back of the robot **D:** Top of the robot.

The base of the robot is the most important part, as it is where the components are placed, including the processor board, the sensor, and the battery. All of the components are stored in the protecting box that protects them from dust and contamination as shown in figure 54.

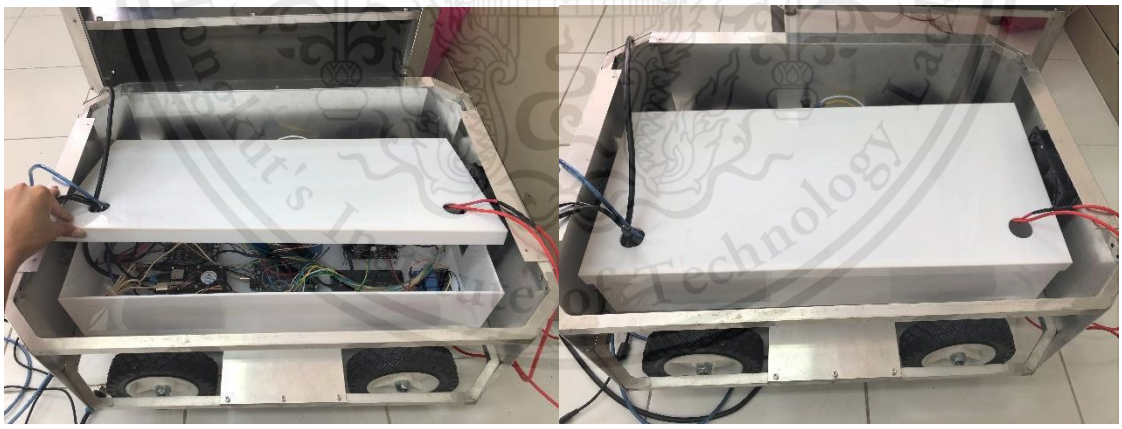

Figure 54: The combination of various elements on the base of the robot.

4.2 Robot movement control (Motor control)

For the robot's motion, it will use four Direct Current motors (DC motor) to connect to all four wheels, two boards of motor drivers will be used to control all the motors as shown in Figure 55.

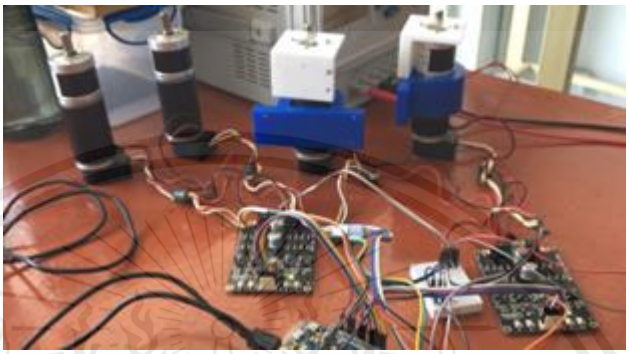

Figure 55: An example of connecting a DC Motor to a Dual motor driver board.

Besides, to attach the motor to the base of the robot chassis, the motor mount was designed through a 3D programming program then printed out using a 3D printer as shown in figure 56 with a total of two designed mounting parts: the front motor mount. And the bracket around the motor as in figure 57.

Figure 56: The process of printing the motor holder with 3D Printer.

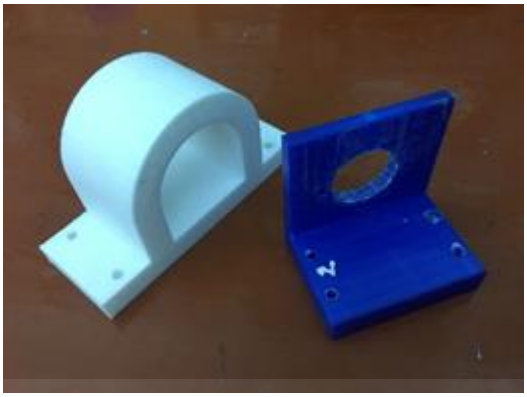

Figure 57: The fasteners around the mounting motor (blue) and the front motor key holder (white).

The operation of the robot motion controller is delivered as a speed value through the ROS (Robot Operating System), so the command code requires code to be sent from the .cpp main processor and the code to receive them for use. The code for receiving commands is the code used for the Arduino board, as shown in Figure 58. The program tries to stabilize the rotation of the wheels as needed to ensure the greatest stability in moving towards the target, preventing the robot from jerking from sending excessive frequencies at the start of operation as shown in Figure 59 shows the frequency curve for controlling motor motion via Serial plot in the Arduino program.

Figure 58: An example code for receiving commands in the Arduino program.

Figure 59: The frequency curve for controlling motor motion via Serial plot in Arduino program.

4.3 Depth camera display : Intel RealSense D435

The RealSense D435 is connected to ubuntu via USB (Universal Serial Bus) and can be processed on RealSense Viewer, showing three different video streams: RGB video stream, IR video stream, and depth video stream through the compatibility of the left camera, the right camera, and infrared camera. In conjunction with the calculation using the relationship between the left camera and the right camera, as shown in Figure 60.

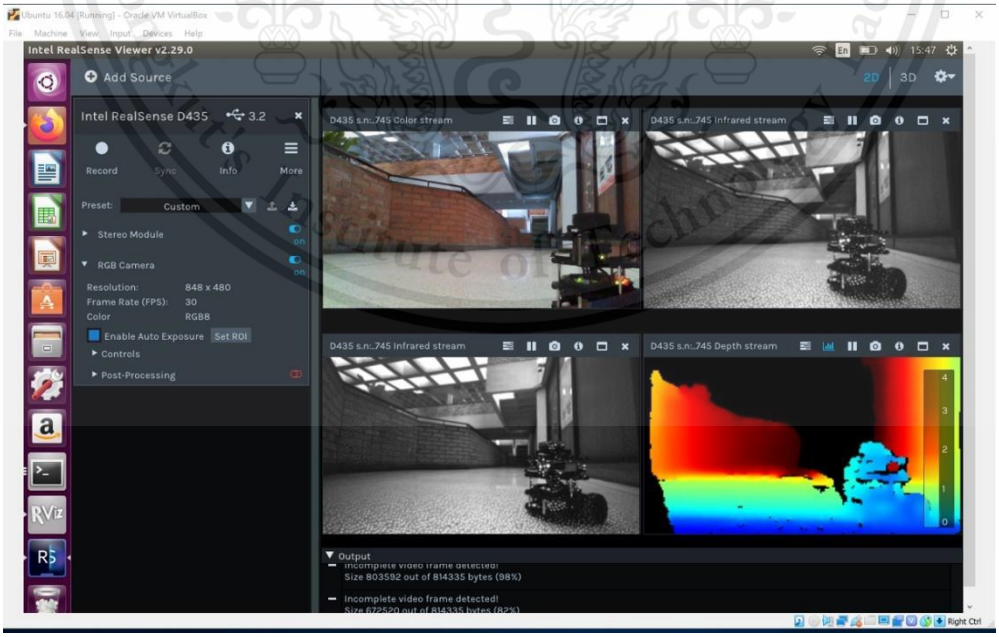

Figure 60: The video stream display of the RealSense D435, including RGB (top left), IR (top right and bottom left), Depth (bottom right).

4.4 Mapping

Mapping is the use of the gmapping package, which is one of the nodes in ROS that is the most important for creating a simulated map which will be displayed on the Rviz window as shown in figure 61, The map is continuously overlayed from the barrier data that the robot can detect while moving. It is the distance data received from the Lidar sensor, the gmapping package must work with the movement control node or the Teleoperation node to control the robot to move around and use the Lidar to detect different environments or areas then keep this map will be used as data for the navigation system in the future.

For gmapping to work effectively, the parameters need to be adjusted, such as sensor distance, transmission frequency duration of map creation speed of detecting the environment, etc. Adjusting these parameters can be done by setting them in the node of gmapping within the launch file to run the package as in the example code in Figure 62.

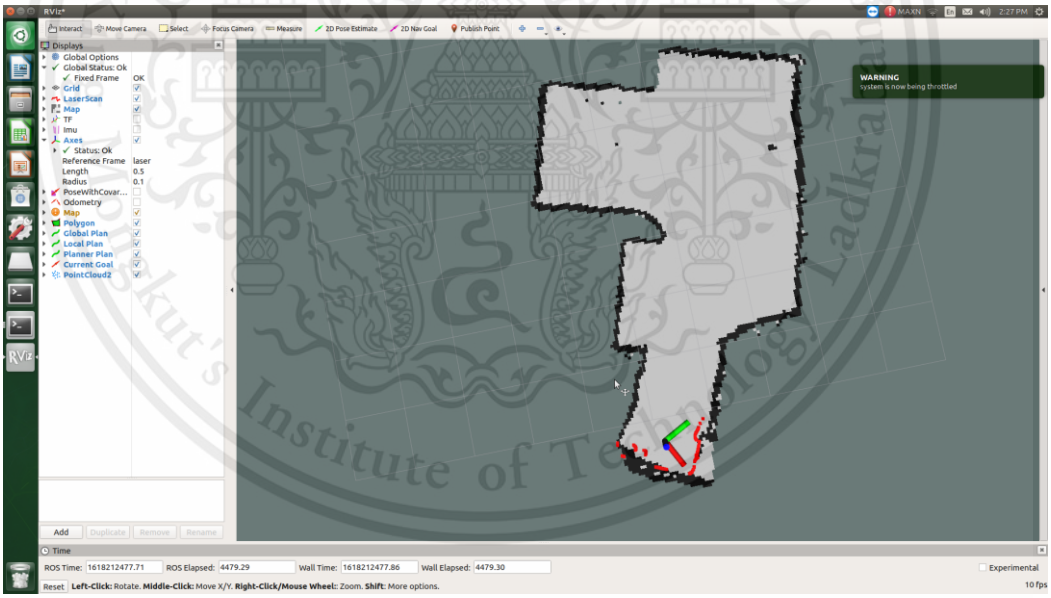

Figure 61: The map on the rviz program window of Wipada's house.

Figure 62: An example of the code within the gmapping launch file.

In addition, the operation of the gmapping node must refer to the information in identifying the location of the robot as well as the location of the sensors from the TF node package. As shown in the frame conversion stage in Figure 63.

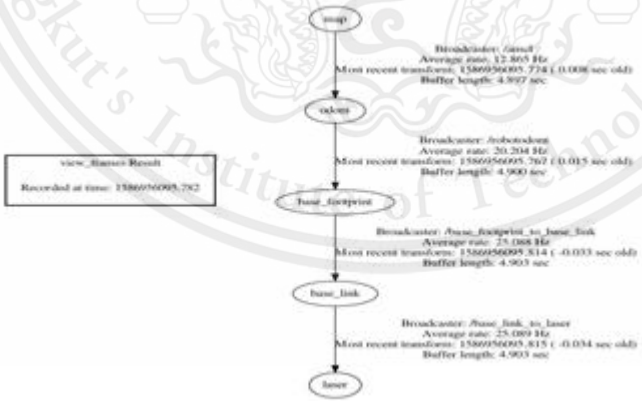

Figure 63: The different frame conversion stages, including the frequency, time, and delay of each frame.

4.5 Navigation system

The automated navigation system for navigation robots is an operation that allows the robot to move from one position to another that we want on the map, where the robot uses the map to create a path to walk to the destination. And can automatically avoid obstacles with the function of the Lidar sensor.

The navigation node processed on Rviz that is a ROS tool connects to a real robot with visualization, where it must run the saved maps and align the position of the robot with its position on the map then set a goal for the robot. The robot will be able to build the path nearest and walk to the destination automatically.

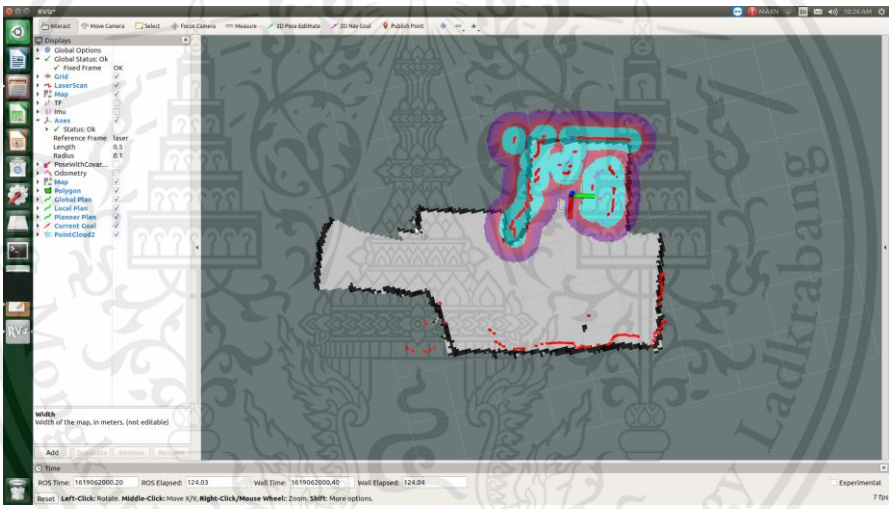

Figure 64: The robot environment map while collecting map data.

Figure 64 shows an automated robot motion action window on Rviz, where the robot calculates the path for movement to the target (Green line) if the sensor detects an obstacle to the path in front of the robot, will calculate a new path as in the figure. While the blue area Is the area that has been calculated prone to collisions and the robots will try to evade the area.

The functionality of a navigation system relies on other tools or packages in the ROS for its functionality. The main packages needed are the coast map package, the command area, and the coast map package, movebase package that make the robot move automatically,

and the part to convert the position information (TF package) by example code to run the command and these parameter settings are shown in the launch file as in Figure 65. All package functions and calls for the navigation system show the links in the graph as in Figure 66.

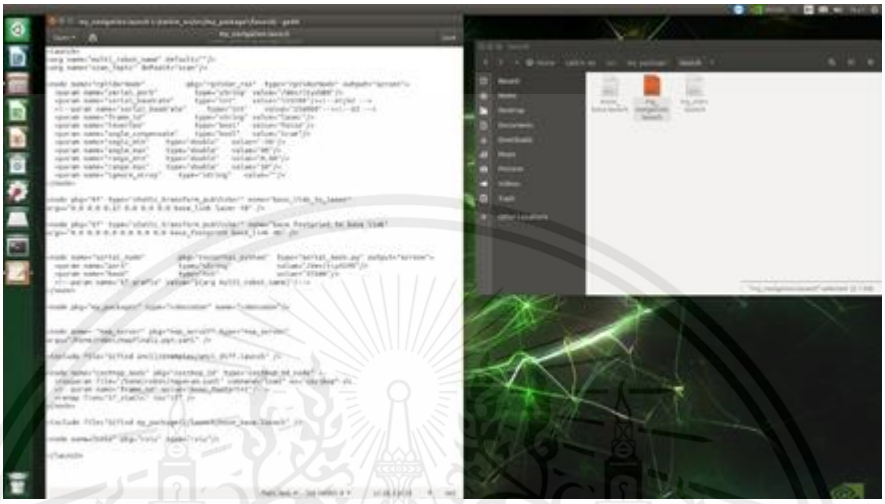

Figure 65: An example of the code within the navigation launch file.

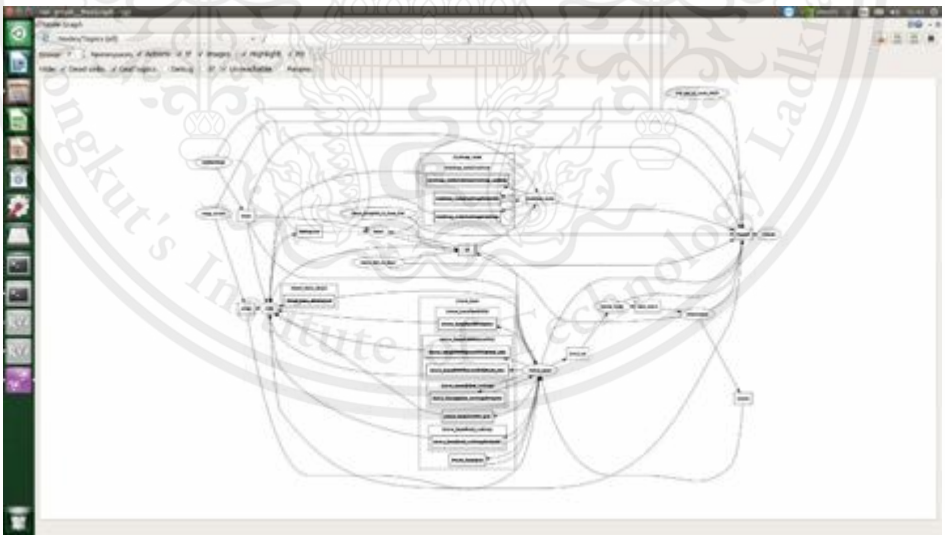

Figure 66: The operation and connection of each node in the navigation system.

4.6 The operation of the interface of robot

The operation of the robot's interface starts with the robot login page, where the user enters the username and password that is set only to the robot to identify the user before accessing the robot. As shown in Figure 67.

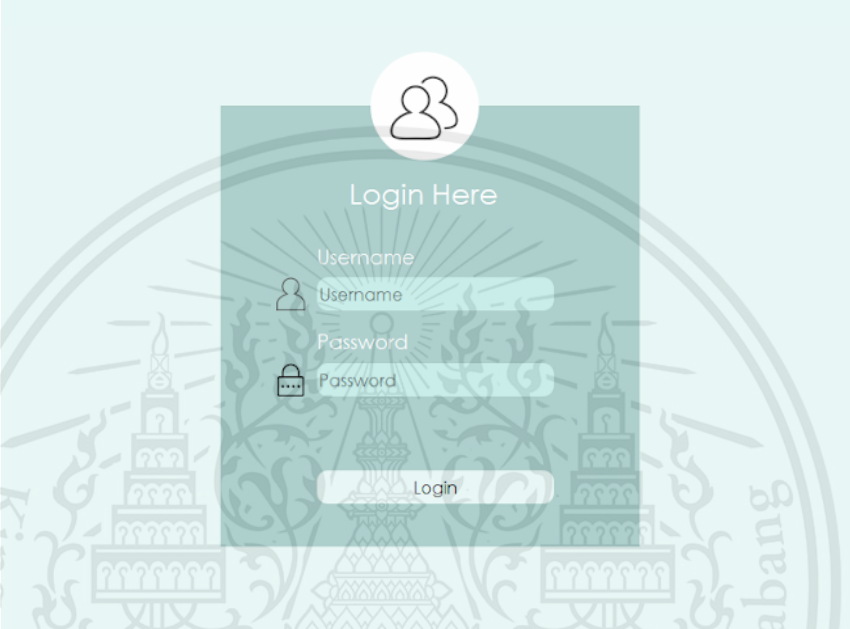

Figure 67: Login page of robot.

Then, by pressing the "next" button, enter the scan product page, so users need to scan the barcode of the devices, medicines, or foods that need to be brought into the robot for further transportation. The data after the scan will form a data table, as shown in Figure 68, and these data will be saved to a database using the SQLite program to store the data as shown in Figure 69.

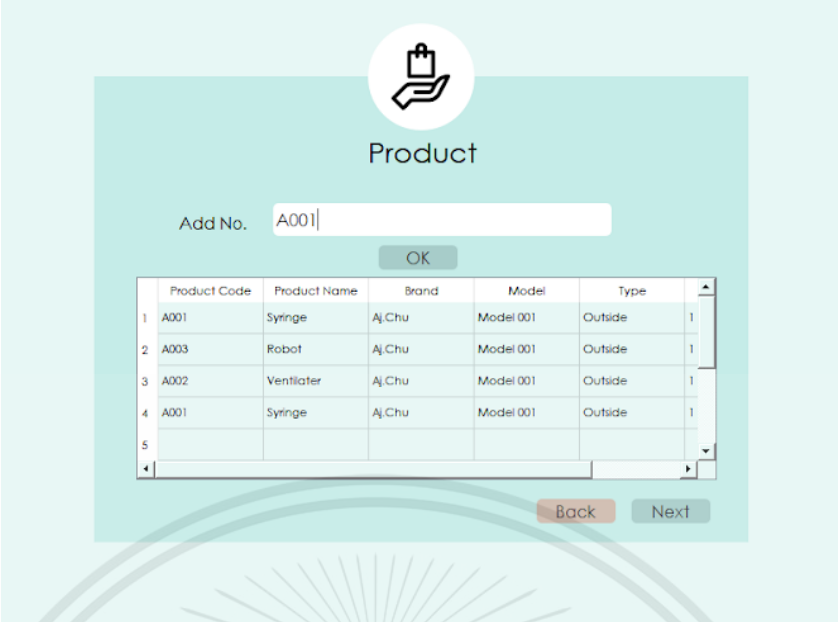

Figure 68: Scan barcode of product page.

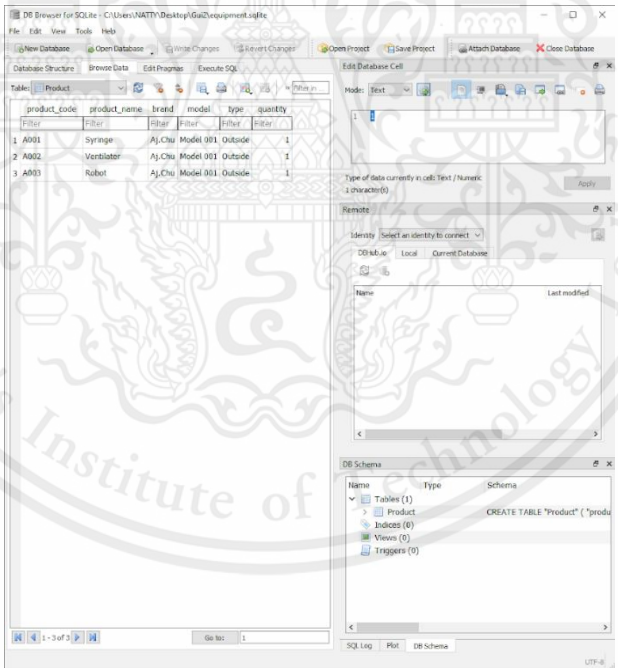

Figure 69: SQLite database that stores the information of product after scan.

After checking the data and pressing the "next" button, it will enter the last page, that is selecting the point at the place where the robot wants to deliver the products. The user must select the location name according to the specified option and press "OK" to enter the command

for the robot to continue delivering the device. As shown in Figure 70. Pressing the "OK" button is the way to run the PyQt5 QProcess command for running a launch file called “my_navigation.launch” and allows the robot to move to the desired point.

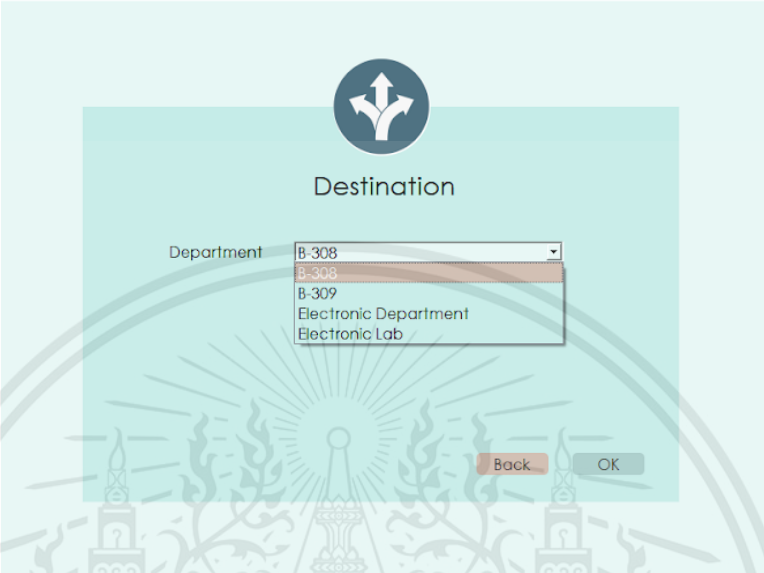

Figure 70: The select point or destination page to make the robot move as navigation.

CHAPTER 5

DISCUSSION AND SUGGESTION, CONCLUSION, AND RESEARCH DEVELOPMENT

5.1 Discussion and suggestion

The problems encountered in the design and construction of the automatic robot system are as follows:

5.1.1 Ubuntu wifi connection requires an external wifi adapter because the jetson nano does not have a wifi receiver. A built-in wifi adapter is required to connect to receive internet signals for the robot's system.

5.1.2 Work order control and display the robot through the RVIZ tool needs to be connected to the same network in the robot system. If the system is not connected to the same network, the robot will not be able to work as needed.

5.1.3 The development of the robot is equipped with a tower light, a battery monitor, and a cooling fan. As a result, the current is drawn from the battery to many devices. Sometimes the core processor or Jetson nano can not work at full capacity. Therefore, the electrical current to be used with other devices, should not be used in conjunction with a core processor or jetson nano. It should use separate electrical sources to make processing more efficient and less likely to cause problems later.

5.1.4 Wheel load cannot support high weight, sometimes it is difficult to drive a robot. The robot has to draw electricity to the motor to enable the wheels to rotate. At the same time, the electric current is drawn to the motor too. As a result, there is not enough electric current to the jetson nano. So, the robot stops working while the robot is collecting maps or doing navigation. Therefore, take into account the upper weight of the base part, and take into account the wheels of the robot. Choosing the type of wheel that can support high weight to reduce problems.

5.1.5 By showing performance on the GUI all the time, the slam system will slow down as it cooperates between the GUI and the navigation.

5.1.6 Due to the range of frequency of PWM pins on Arduino Due by default is in the human hearing frequency. Thus, making a loud noise when the motor is running. To reduce noise problems, the frequency of PWM should be adjusted to higher or exceed the frequency heard by humans.

5.1.7 Keyboard response is a delay in controlling the robot's motor, causing mapping or manual manipulation to be inaccurate. Therefore, change from keyboard to joystick for ease of use. As well as reducing delays and errors caused by keyboard controls.

5.2 Conclusion

This study is to design a robot and a graphical user interface, in which the robot can automatically run data from the database system. Then, the data is applied to the SLAM system to determine the position and environment of the robot, which is controlled by a sensor called RPLidar, it scans the area around the robots and obstacles, then displays them on the RVIZ tool, which can save the map for future work.

The GUI of this study has three main pages, including a login page, the user information is stored in the database, it requires a valid username and password. The next page is a page of product information before delivering the product receiver. The product data is stored in SQLite database browser. The last page is to define the destination to send the product. This page contains information from the ROS system.

5.3 Research development

5.3.1 Automatic recharging

To make the robot work more complete in the future, the automatic recognition function of the robot is enhanced. By applying the wireless charging battery of the AGV robot to reduce the workload of robots.

5.3.2 Implementing a depth camera

Currently, robots that deliver medicines and food, use the SLAM, which is a 2D image. Applying a depth camera is an interesting option. It can be used to create maps of the environment in 3D, which can make the result more accurate and efficient storage of maps and automation of robots.

REFERENCES

[1] R. C. Hale, B. S., Single-Use Plastics and COVID-19: Scientific Evidence and Environmental Regulations, America: ACS Publications, 2020. [E-book] Available: Safari e-book: Environmental Science & Technology. [Accessed Dec. 2, 2020]

[2] Neha Pathak, MD , "Surface Cleaning and COVID-19: What You Should Know",2021. [Online serial], Available: https://www.webmd.com/lung/how-long-covid-19-lives-on-surfaces. [Accessed Feb. 16, 2021]

[3] Duangphan Kritchanchai and others, "Logistics in hospital", 2014. [Online serial], Available: http://www.loghealth.mahidol.ac.th/file/file-11-22-2016-10-47-16-AM.pdf. [Accessed Dec. 2, 2020]

[4] Modern Manufacturing, "AI ROBOT in Aging Society", 2017. [Online serial], Available: https://www.mmthailand.com/ai-robot-in-aging-society/. [Accessed Dec. 2, 2020]

[5] DEVELOPER, N, "Getting Started with Jetson Nano Developer Kit. Retrieved from NVIDIA DEVELOPER", 2020. [Online serial], Available: https://developer.nvidia.com/embedded/learn/get-started-jetson-nano-devkit. [Accessed Dec. 2, 2020]

[6] Store.arduino, "ARDUINO DUE", 2020. [Online serial], Available: https://store.arduino.cc/usa/due. [Accessed Dec. 2, 2020]

[7] DYNAPAR, "Motor Encoder. Retrieved from DYNAPAR",2020. [Online serial], Available: https://www.dynapar.com/technology/encoder_basics/motor_encoders/. [Accessed Dec. 2, 2020]

[8] Yuttana Sutthasupha, Chulalongkorn University, "Positioning along with creating a large map with a wide-angle video camera.", 2014. [Online serial], Available : http://cuir.car.chula.ac.th/handle/123456789/45367. [Accessed Dec. 2, 2020]

[9] Slamtec, "RPLIDAR A2", 2020. [Online serial], Available: https://www.slamtec.com/en/Lidar/A2. [Accessed Dec. 2, 2020]

[10] Robotics business review, "Intel RealSense Brings 3D Vision to Robots",2017. [Online serial], Available: https://www.roboticsbusinessreview.com/wp-content/uploads/2017/09/Robo_Intel_Realsense _ WP.pdf. [Accessed Dec. 2, 2020]

[11] RANDOM NERD TUTORIALS, “Guide for Relay Module with Arduino”, 2019. [Online serial], Available: https://randomnerdtutorials.com/guide-for-relay-module-with-arduino/. [Accessed Dec. 2, 2020]

[12] Wikipedia, “Kill switch”, 2021. [Online serial], Available: https://en.wikipedia.org/wiki/Kill_switch. [Accessed Feb. 16, 2021]

[13] CardoO, “The types of Joystick. Retrieved from CardoO”, 2020. [Online serial], Available: https://cardoo.co/technology-news/the-types-of-joystick/. [Accessed Dec. 2, 2020]

[14] PhoenixNAP Global IT Services, “How to install Python 3 on Ubuntu 18.04 or 20.04”, 2019. [Online serial], Available: https://phoenixnap.com/kb/how-to-install-python-3-ubuntu. [Accessed Dec. 2, 2020]

[15] Stack overflow, “Install PyQt5 and QtDesigner on Raspberry Pi”,2020. [Online serial], Available: https://stackoverflow.com/questions/62802520/install-pyqt5-and-qtdesigner-on-raspberry-pi. [Accessed Dec. 2, 2020]

[16] ID Automation, “How to identify a Barcode”,2019. [Online serial], Available: https://www.barcodefaq.com/barcode-match/. [Accessed Dec. 2, 2020]

[17] iProcesSmart. (n.d.), “Color Coding for pushbuttons, indicator (pilot) lights, and illuminated pushbuttons”, 2019. [Online serial], Available: http://www.iprocessmart.com/techsmart/lightcodes.htm. [Accessed Dec. 2, 2020]

[18] Orienral motor, “Cooling Fans Structure, Air Flow Static Pressure Characteristics, and Heat Protection”, 2020. [Online serial], Available: https://www.orientalmotor.com/cooling-fans/technology/cooling-fan-structure-overview.html. [Accessed Dec. 2, 2020]

[19] Shahriar Shovon, “Install SQLite and SQLite Browser on Ubuntu 18.04 LTS”, 2018. [Online serial], Available: https://linuxhint.com/install_sqlite_browser_ubuntu_1804/. [Accessed Dec. 2, 2020]