VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi – 590018

A Project Work on

"SMART MEDICINE DISPENSING SYSTEM WITH APP INTEGRATED"

A Dissertation work submitted in partial fulfilment of the requirement for the award of the degree

BACHELOR OF ENGINEERING
IN
ELECTRICAL & ELECTRONICS ENGINEERING

Submitted by:

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CERTIFICATE

This is to certify that the project work entitled **"SMART MEDICINE DISPENSING SYSTEM WITH APP INTEGRATED"** is carried out by **BHARGAV N(1AY20EE011), HARSHA G (1AY20EE013), RAGHAVENDRA D (1AY20EE023), SOURABH P KULKARNI (1AY20EE026),** bonafide students of **ACHARYA INSTITUTE OF TECHNOLOGY** in partial fulfilment for the award of **Bachelor of Engineering in Electrical and Electronics Engineering** of the **Visvesvaraya Technological University, Belagavi** during the academic year **2023-2024.** The project report has beenapproved, as it satisfies the academic requirements in respect of project work prescribedfor **Bachelor of Engineering Degree.**

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DECLARATION

We, **BHARGAV N, HARSHA G, RAGHAVENDRA D AND SOURABH P KULKARNI** students of VIII Semester B.E in the **Department of Electrical and Electronics Engineering, AIT, Bengaluru** hereby declare that the Project entitled **"SMART MEDICINE DISPENSING SYSTEM WITH APP INTEGRTAED"** has been carried out under the supervision of **Mr. DEVENDRA GOWDA,** Assistant Professor, Dept. of EEE, AIT, and submitted in partial fulfilment of the requirements for the award of degree in **Bachelor of Engineering in Electrical and Electronics Engineering** of **Visvesvaraya Technological University**, **Belagavi** during academic year **2023– 2024**.

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ABSTRACT

The development of an automated vending machine for the application of dispensing medicines is an innovative solution that aims to improve the accessibility and efficiency of medication dispensing. This project involves the use of microcontrollers, sensors, and communication protocols to develop a reliable and effective system that can securely dispense medications to patients.

The automated vending machine for dispensing medicines is designed to provide an alternative means of accessing medication, especially in remote or underserved areas where access to pharmacies or medical facilities may be limited. The system can also potentially reduce waiting times, minimize errors, and increase the speed of transactions, which can improve patient satisfaction and outcomes.

The implementation of an automated vending machine for dispensing medicines could lead to significant improvements in the healthcare industry by providing patients with increased access to vital medications, while also helping healthcare providers to streamline their processes and reduce costs.

An automatic vending machine is a technology-driven solution that enables people to get medical supplies and over-the-counter medications with minimal human intervention. It operates by utilizing cutting-edge technologies such as artificial intelligence, machine learning, and the internet of things to enable automated inventory management, real-time transaction processing, and predictive maintenance. The machine offers a range of medical supplies, including prescription medications, first-aid kits, and hygiene products, among others. It provides patients with the convenience of obtaining their medical supplies at anytime of the day, reducing the need for physical visits to a pharmacy or healthcare provider. The use of an automatic medical vending machine offers a cost- effective and efficient approach to healthcare delivery, reducing the burden on healthcare providers and enhancing patient experience and satisfaction.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

A groundbreaking solution in healthcare, the medical vending machine streamlines the process of acquiring essential medical supplies and over-the-counter medications. Resembling conventional vending machines, this innovation swiftly dispenses products upon patient selection and payment. Deployed across hospitals, clinics, and public areas, these machines offer unparalleled convenience, granting patients seamless access to necessary medical provisions.

Traditionally, obtaining medical supplies involved pharmacy visits or requisitions from healthcare providers, processes notorious for their time consumption and inconvenience. Medical vending machines emerge as a time-saving alternative, particularly beneficial for individuals leading hectic lives. Moreover, they alleviate the burden on healthcare professionals, allowing them to allocate more attention to critical responsibilities.

Automated dispensing machines, integral to decentralized medication distribution systems, revolutionize medication management by offering computer-controlled storage, dispensation, and monitoring of medications. Widely adopted in numerous hospitals, these systems prioritize efficiency and patient safety. Additionally, they incorporate secure payment mechanisms, facilitating various payment options including cash, credit/debit cards, and mobile transactions.

What is Automated Vending Machine ?

The emergence of automated vending machines for dispensing medications marks a groundbreaking approach to providing efficient and accessible access to prescription drugs. These machines are engineered to streamline the dispensation process, granting patients convenient and rapid access to their prescriptions sans the necessity of direct interaction with a pharmacy.

Automated medication vending machines offer a myriad of potential advantages, encompassing the reduction of pharmacy wait times, enhancement of medication adherence, and fortification of patient confidentiality. Nevertheless, their development and integration pose various hurdles, such as ensuring precision and safety, compliance with regulatory standards, and addressing apprehensions regarding security and data protection. Despite these obstacles, the advancement of automated vending machines for medication dispensation represents a promising frontier of innovation poised to revolutionize how patients procure and receive their prescription medications.

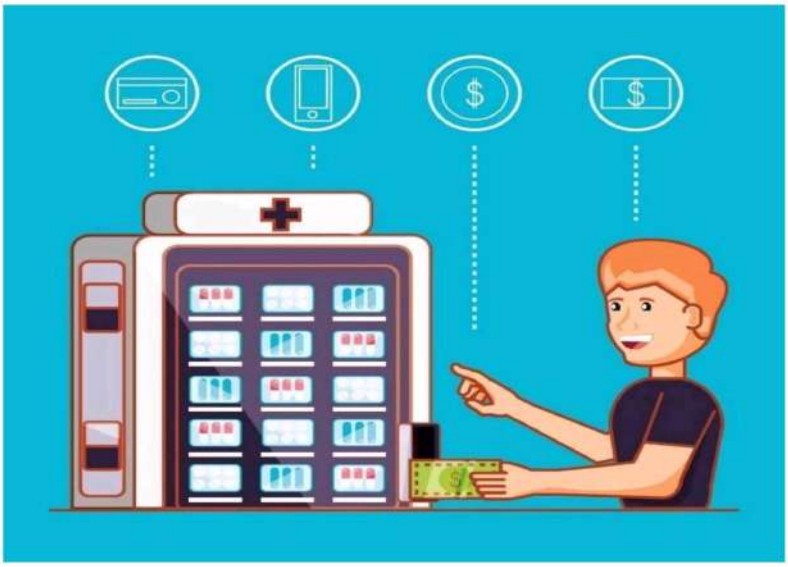

Fig. 1.1 : Basic outlook of medical vending machine

One notable advantage of these machines is their strategic placement in convenient locations such as hospitals, clinics, and pharmacies, enabling patients to effortlessly access their medications, even beyond regular operating hours.

Furthermore, these machines offer the benefit of seamless integration with electronic health records (EHR) and pharmacy management systems. This integration streamlines medication dispensation procedures, curbing errors, and fostering enhanced patient outcomes. By autonomously updating patient records and medication profiles, these machines bolster medication adherence and mitigate the likelihood of adverse drug reactions.

Nonetheless, the development of automated vending machines for medication dispensation is not without its challenges. Regulatory and legal hurdles may need to be navigated, along with concerns pertaining to patient privacy and data security. Moreover, it is imperative to ensure that these machines are accessible to all patient demographics, including those with disabilities or language barriers.

The development process typically entails several phases, commencing with concept development, followed by design, fabrication, and testing. During the concept development phase, the team identifies the core issue to be addressed. Subsequently, in the design phase, meticulous drawings and schematics are crafted, delineating the product's specifications, materials, and manufacturing techniques essential for prototype realization.

Fig. 1.2 : Prototype showing needed access for unlocking machine

The fabrication phase encompasses the tangible creation of the prototype, employing a blend of manual and automated techniques like 3D printing, CNC machining, and injection molding. The team must ensure the prototype aligns with specified criteria, prioritizing safety, reliability, and scalability for mass production while keeping costs reasonable.

Subsequently, rigorous testing is conducted to verify compliance with performance standards, pinpointing and rectifying any detected issues or flaws. This may entail user trials, quality assurance assessments, and adherence to regulatory requirements.

In essence, developing a prototype for an automated medication vending machine demands a proficient and interdisciplinary team comprising engineers, designers, and healthcare experts. Consideration must be given to numerous factors including patient safety, user-friendliness, and regulatory adherence, ensuring the resultant product caters effectively to the requirements of both patients and healthcare providers.

First Aid Medicines :

First aid medicines typically include over-the-counter medications that can help alleviate common symptoms and treat minor injuries. Some examples include pain relievers like acetaminophen or ibuprofen for pain and fever, antihistamines for allergic reactions, antacids for indigestion, and antiseptic solutions for cleaning wounds. It's important to consult healthcare professionals for guidance on proper usage and dosage, especially if you have specific medical conditions or are taking other medications.

CHAPTER 2

LITERATURE SURVEY

2.1 LITERATURE SURVEY

1. **Title :** E - pharm assist : The future Approach for Dispensing Medicines in Smart cities.
   Author : Sophia Rahaman, Shahid Mohammad and Tejasvi Manchanda
   Published in : Institute of Electrical and Electronics Engineers Access [Vol - 8]
   Summary : The purpose of this study is to gain insight into how traditional ways of prescribing medicines are preferred over a prescription to reduce errors in dispensing medication. On the Analysis of data collected surface significant associations where errors made in reading handwritten prescription and trusting online pharmacy relation between E Pharma of medical professional reduce error margin and deliver highest rate of medicine to patients .

2. **Title :** AutoImpilo : Smart Automated Health Machine using IOT to improve Telemedicine and Telehealth.
   Author : Divya Ganesh, Gayathri Seshadri, Sumathi Sokkanarayanan & Panjavarnam Bose.
   Published in : International Journal of Innovative Research in Science, Engineering & Technology. [IJIRSET], 2018
   Summary : The aim of paper is to develop an automated system that can connected doctors healthcare for any resource or especially in rural areas and remote areas . We believe our system can be established not only in hospitals but also in a public settings such as community centers jail , School , retail stores , Mall office building or airport example best in pandemic situation.

3. **Title :** Automatic Chocolate Vending Machine
   Author : Kanagasabapathi V. , Naveenraj K , Neelavarnan V. & Naveen raj S.
   Published in : 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS)
   Summary : This machine can be operated in different ways by using processor or a controller .After the amount is paid, the Product may be available to the user by the machine releasing it. But in previous vending machine based on microcontroller, this may cause problem by using coin recognize unit.

4. **Title :** Design of Smart Unstaffed Retail Shop Based on IoT and Artificial Intelligence.
   Author : JIANQIANG XU, (Member, IEEE), ZHUJIAO HU, ZHUO ZOU, (Member IEEE)
   Published in : 03 August 2020 , Published in: IEEE Access (Volume: 9)
   Summary : This study is based on the verify of feasibility in installed retail shop that is maintenance is to reduce the men work to machine work . Smart vending machines in five convenience shops were installed to operate under the new retail mode, each store has four smart vending machines, aiming to test the impact of smart vending machines on customer flow and customer transactions.

5. **Title :** Medicine Dispensing Machine using Arduino controller
   Author : Vishal Tank, Sushmitha W, Nishanth Jakhiya
   Published in : IEEE Conference on Emerging Devices Smart Systems (ICEDSS 2017)
   Summary : This paper presents a machine designed to provide such healthcare at areas where having a medical store may not be feasible or possible. It allows the user to select a medicine, pay the required amount after which it verifies the amount received and dispenses the medicine. There are number of medicine dispensing machines available in the market today. However, most of these are customized for household use, and cannot be used for outdoor applications.

6. **Title :** Automatic Medicine Vending Machine using PIC micro controller.
   Author : Sarika Oundhakar, K S Prasanna, Naveen Kumar
   Published in : **:** International Journal of Innovative Research in Science, Engineering & Technology. [IJIRSET], 2017
   Summary : Dispenser box is made up of number of drawers which stored the medicine and drawer moves with the help of stepper motor. They used NFC card to store the data. First the user or patient have RFID tag, then person have to put the tag in front of machine RFID reader then it will detect the RFID code of the person. When the code of both the tag matches then it will ask for quantities of the tablet or pills, then user have top number for the pills .this machine is basically offer for quantity of 2 tablets. when person enter the 1 or 2 pills quantity then motor driver will drive the two motors and from the pill box pills will come out.

CHAPTER 3

MOTIVATION AND OBJECTIVES

3.1 MOTIVATION

Ensuring round-the-clock availability of vital medications, particularly in regions with limited pharmacy access or during non-operational hours. Offering a convenient alternative for individuals to procure medications sans the hassle of queuing up at a pharmacy. Enhancing the efficiency of medication distribution processes, trimming down wait times, and mitigating the potential for human errors in dispensation. Introducing intelligent functionalities like inventory tracking, expiration date management, and real-time monitoring to uphold medication availability and optimize overall operational efficacy. Enforcing protocols to authenticate patient identity, validate prescription legitimacy, and verify dosage instructions, fostering the safe and responsible use of medications. Pioneering innovative technological solutions to tackle healthcare obstacles and elevate patient care standards.

3.2 OBJECTIVES

- Procure necessary components and assemble the hardware, including mechanical parts for dispensing, sensors, payment devices, and networking equipment.
- Develop software for user interaction, inventory management, payment processing, and machine operation.
- Conduct extensive testing of the machine to ensure proper functionality of all components.

This includes the housing, slots for products, a display screen, and payment mechanisms. Choose a microcontroller which is good in performance to control the vending machine's operations. Incorporate sensors to detect when a product is dispensed or when a customer interacts with the machine. Use motors or solenoids to dispense the selected product. Include buttons or a touchscreen for users to make selections. Ensure a stable power source to run the electronics reliably. Consider adding a secure enclosure and security features to prevent tampering and theft. Test each component individually to ensure they work correctly.

CHAPTER 4

BLOCK DIAGRAM AND METHODOLOGY

4.1 BLOCK DIAGRAM

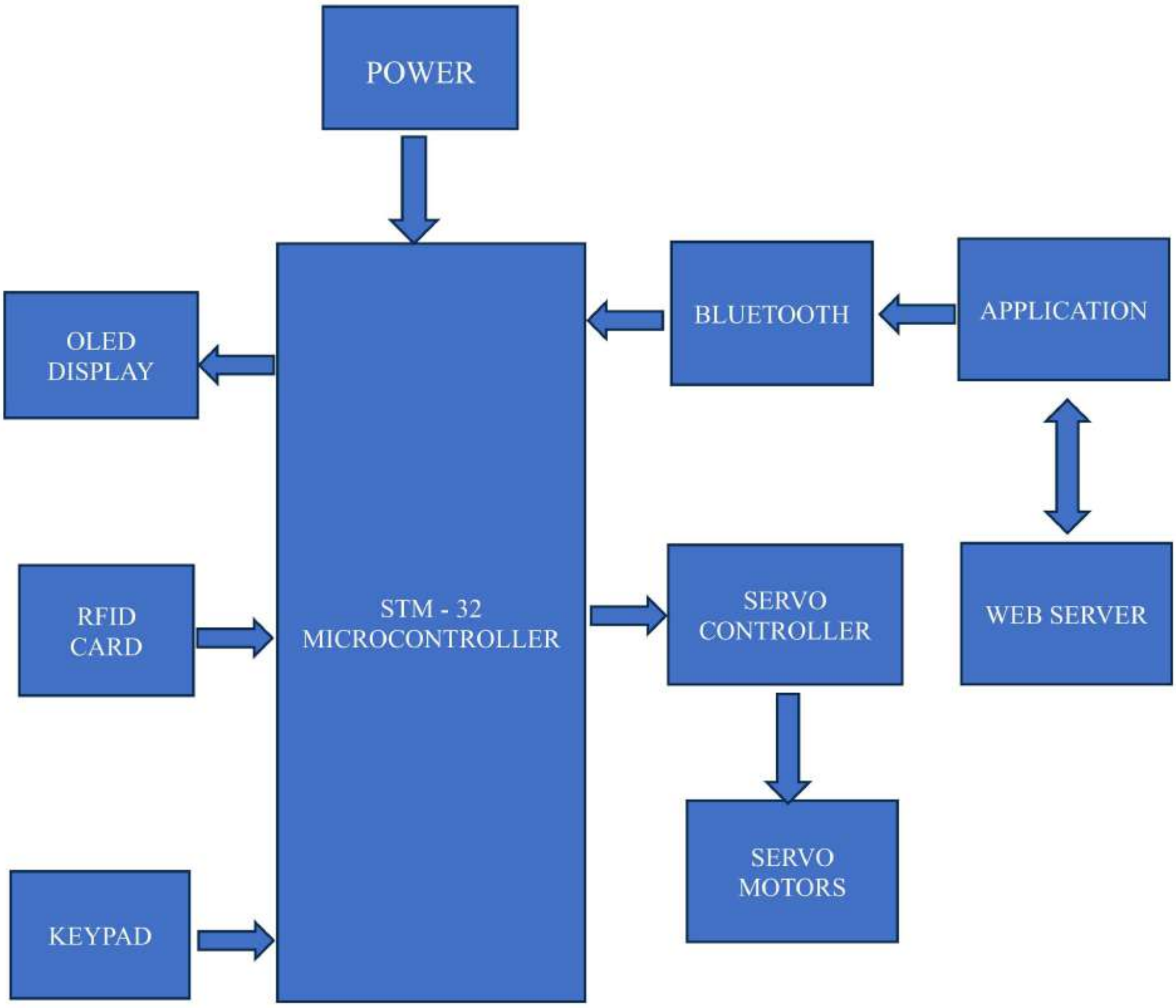

Fig. 4.1: Block Diagram of Smart medicine dispensing system with app integrated

The shown block diagram consists of STM 32 microcontroller which is the main component of the machine. It monitors all the activities both directly and indirectly. The flow of data occurs in bidirectional manner. The power supply is connected to microcontroller and all other devices receives command from the microcontroller to operate. The 4x4 keypad matrix is connected to the microcontroller , the OLED display is connected to the microcontroller and the RFID module is used here to scan RFID cards of customers . Based on the data obtained from RFID module and keypad matrix , the microcontroller controls the dispensing of medicine by rotating respective servo motor which is controlled by the servo controller. The customer could be connect with machine by the help of Bluetooth or App which gives notification of his transactions.

The basic theme of this project involves dispensing of medicines as per the user's requirements. A smart card reader is used as an input sensor. The input provided by the user through the keypad is then forwarded to the Microcontroller for processing and for taking the required decisions in order to proceed forward. The Microcontroller, with the help of the motor drivers, drives the concerned medicine cabinet having the medicine that the user needs. These motor drivers control the rotation of the motor that dispenses medicines from the medicine cabinet. The motor rotates the disk attached to it, which has a cavity. This cavity when coincides with the cavity of the medicine cabinet, the medicine falls and arrives at the outlet. Thus the medicine dispensing function is fully controlled by the motor drivers.

For health workers, village peoples, and in rural areas medical masks are essential personal protective equipment when engaging with patients with suspected, probable or confirmed COVID-19. Respirator masks (such as FFP2, FFP3, N95, N99) should be used in settings where procedures generating aerosols are performed and must be fitted to ensure the right size is worn. The Prototype constructed so far is just for detecting general illnesses like fever, cold, headache, and vend out medicines that does not need doctor prescription. Inventory controller controlling the inventory of drugs is critical to functioning of machine. Not only from inventory levels but also from misuse or theft cases. By keeping in mind covid 19 pandemic we are going to design innovative idea, a module which will perform three different operations all together.

The input provided by the user through the keypad is then forwarded to the Microcontroller for processing and for taking the required decisions in order to proceed forward. The Microcontroller, with the help of the motor drivers, drives the concerned medicine cabinet having the medicine that the user needs. These motor drivers control the rotation of the motor that dispenses medicines from the medicine cabinet. The motor rotates the disk attached to it, which has a cavity. This cavity when coincides with the cavity of the medicine cabinet, the medicine falls and arrives at the outlet .Thus the medicine dispensing function is fully controlled by the motor drivers. The keypad is provided for user interaction ,so based on requirement the end user will press the switch there will be one Lcd display to display the masks and drugs available for what kind of disease. Later the input from this is used to coordinate with dispensing mechanisms. Based on the keypad values the corresponding dosage and corresponding medicine or mask is vended out .

4.2 METHODOLOGY

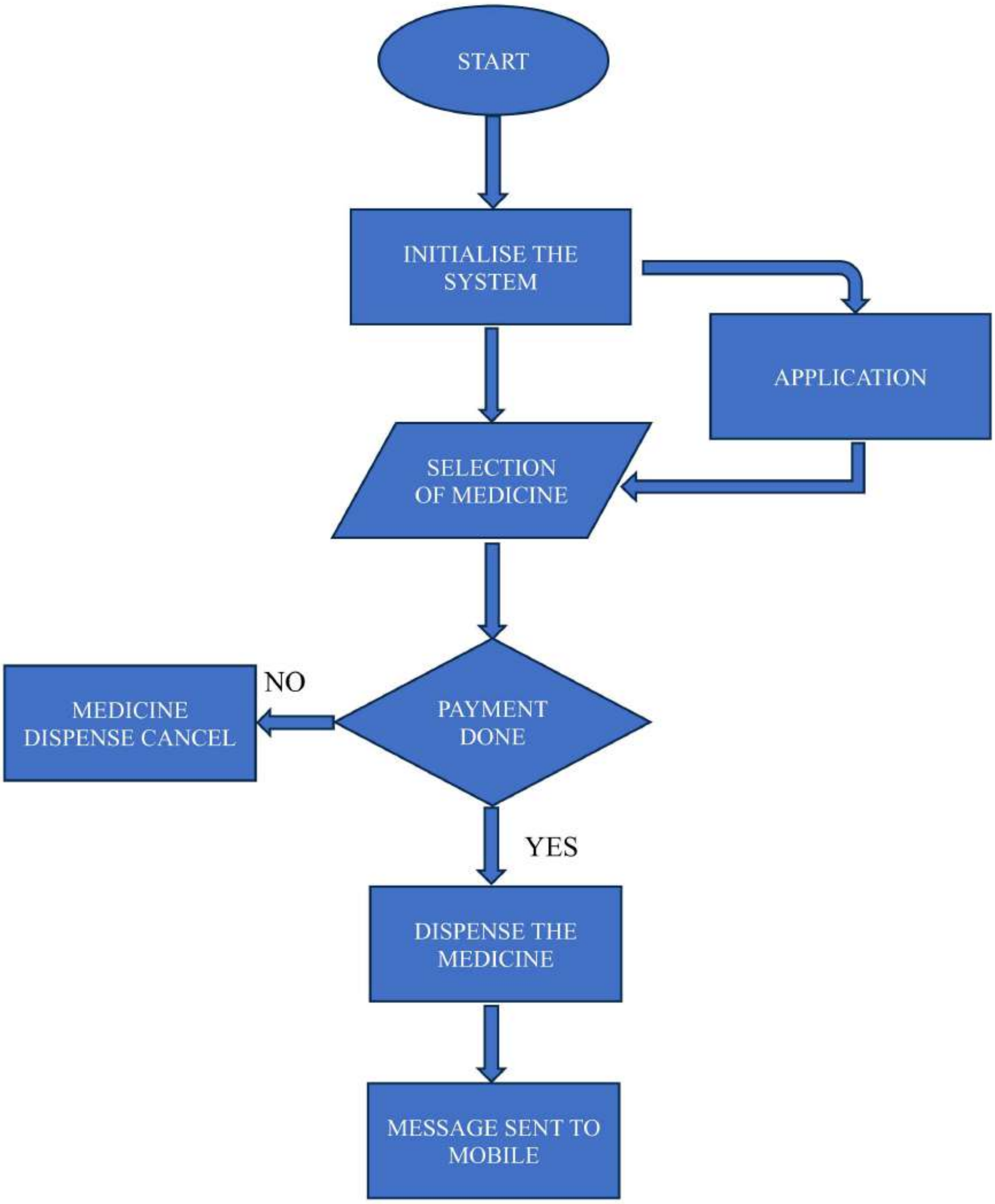

Fig. 4.2 : Flowchart for Dispensing Process

From the above flow chart we can understand the dispensing process of medicines and the explanation is as follows

- **Inventory Management**: The machine is stocked with various types of medicines, which are tracked electronically. When setting up the vending machine, a variety of medicines are loaded into compartments or storage areas within the machine. By employing these strategies, a smart medicine vending machine can effectively manage its inventory to ensure that essential medications are always available to users while minimizing stockouts and optimizing operational efficiency.
- **User Interaction:** Users interact with the vending machine through a touchscreen interface or buttons. The vending machine is equipped with a user-friendly interface, typically a touchscreen display or buttons, positioned at an accessible height for users of different heights and abilities. Once users have located the desired medicine, they select it by pressing the corresponding button.
- **User Authentication:** Users may need to authenticate themselves, possibly through biometric scanning, RFID cards, or PIN codes, to ensure authorized access to medicines. In some cases, users may need to authenticate themselves before proceeding with the transaction. This could involve scanning a RFID card or through application.
- **Dispensing :** Once payment is confirmed, the machine dispenses the selected medicine. The vending machine dispenses the selected medicine through a secure compartment or slot. Depending on the complexity of the machine, additional safety measures may be in place to prevent unauthorized access to the dispensed medication.
- **Secure Access:** To access the dispensed medication, the vending machine's secure dispensing mechanism is activated. This mechanism typically includes locked compartments or drawers to prevent unauthorized access and connection for mobile by using Bluetooth connection and a message will be sent to the user’s mobile.
- **Confirmation:** After the medication has been dispensed, the vending machine's interface displays a confirmation message to the user, indicating that the transaction is complete.

At first the system gets initialised and it will be waiting for the keypad data to be send to it. When the consumer selects the medicine for him through keypad , it will be waiting for the payment through RFID card or through application wallet. Once the payment is confirmed the medicine is ready to dispense and the consumer is able to collect it from the base drawer.

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4.2.1 HARDWARE COMPONENTS

1. STM 32 – F103C8T6 Microcontroller

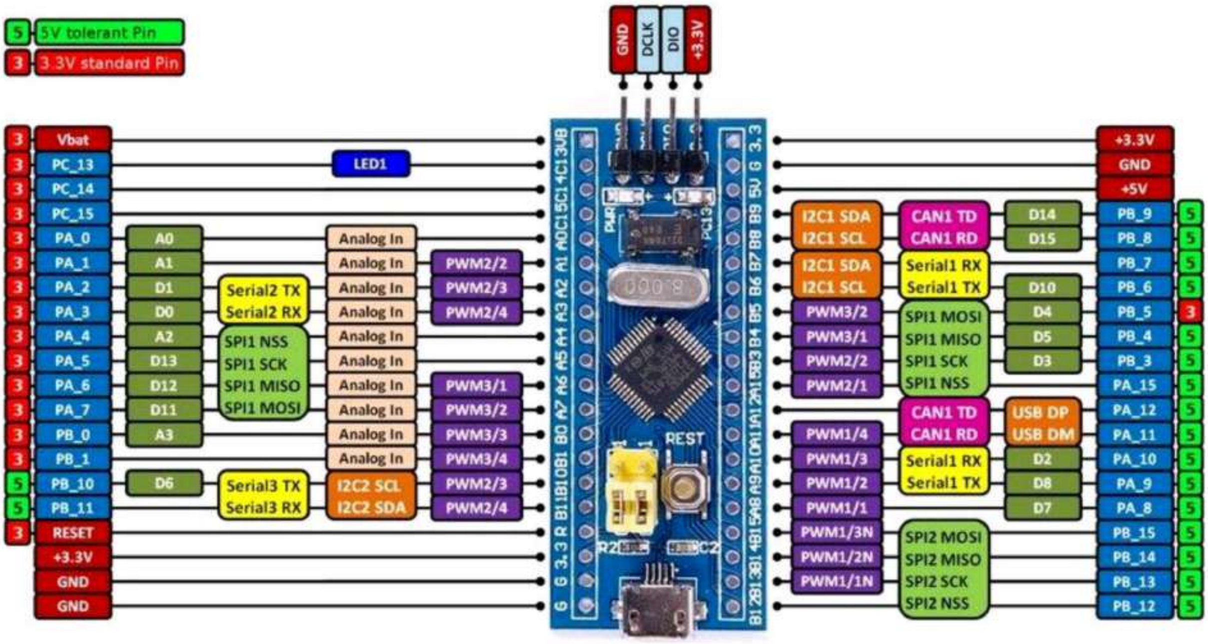


Fig. 4.3 : STM 32 Pin Diagram

The STM32F103C8T6 medium-density performance line family incorporates the high performance Arm® Cortex®-M3 32-bit RISC core operating at a 72 MHz frequency, high speed embedded memories (Flash memory up to 128 Kbytes and SRAM up to 20 Kbytes), and an extensive range of enhanced I/Os and peripherals connected to two APB buses. All devices offer two 12-bit ADCs, three general purpose 16-bit timers plus one PWM timer, as well as standard and advanced communication interfaces: up to two I2Cs and SPIs, three USARTs, an USB and a CAN. The devices operate from a 2.0 to 3.6 V power supply. They are available in both the –40 to +85°C temperature range and the –40 to +105 °C extended temperature range. A comprehensive set of power-saving mode allows the design of low-power applications.

The Arm® Cortex®-M3 processor is the latest generation of Arm processors for embedded systems. It has been developed to provide a low-cost platform that meets the needs of MCU implementation, with a reduced pin count and low-power consumption, while delivering outstanding computational performance and an advanced system response to interrupts.

Pin Description

Type	Pin Name	Function
Power	– 3.3 Volts – 5 Volts – GND	1.Operational Voltage 2. Power Supply from USB or 5V external source pin 3. Ground Pin
Analog Pins	PA0-PA7, PB0-PB1	10, 12-bit resolution ADC pins
I/O Pins	PA0-PA15, PB0-PB15, PC13-PC15	37 General Purpose I/O pins
External Interrupts	PA0-PA15, PB0-PB15, PC13-PC15	Interrupt pins
PWM	PA0-PA3, PA6-PA10, PB0-PB1, PB6-PB9	15 Pulse-width Modulation pins
Serial Communication (UART)	TX1, RX1, TX2, RX2, TX3, RX3	RTS, CTS USART pins
SPI	MISO0, MOSI0, SCK0, MISO1, MOSI1, SCK1, CS0	2 Serial Peripheral Interface pins
CAN	CAN0TX, CAN0RX	Controller Area Network Bus pins
I2C	SCL1, SCL2, SDA1, SD2	Inter-Integrated Circuit Serial Data and Clock pins
Built-in LED	PC13	LED for Indication

Table 4.1 : STM 32 Pin Description

- **External Interrupts:** The hardware interrupts are operated to detect external signals.
- **PWM:** A total of 15 pulse width modulations pins to generate Analog voltage signals from digital PWM outputs.
- **RTS/CTS:** Request-to-Send/Clear-to-Send is a protocol that tells about the transmission and reception of data to keep the flow of data and signals in check.
- **SPI:** Serial Peripheral Interface to communicate between the Microcontroller Unit and peripherals.
- **CAN:** A multi-serial bus also responsible for dual directional communication.

- **I2C:** Another serial interface protocol for synchronized bit-wise data transmission.

Some of the detailed features include :

- A Cyclic Redundancy Check (CRC) for monitoring the data corruption.
- Three different boot options(through user flash or system memory or SRAM) to reorganize the Flash Memory through USART1.
- 7 different timers for different sampling rates for Analog signals.
- A JTAG(Joint Test Action Group) serial protocol for debugging and testing the microcontroller unit.
- A Phase-Locked Loop(PLL) clock for stability by phasing output and input signals.
- A Window watchdog timer for observing the errors in signal reception and transmission.

There are up to three synchronized general-purpose timers embedded in the STM32F103xx performance line devices. These timers are based on a 16-bit auto-reload up/down counter, a 16-bit pre scaler and feature four independent channels each for input capture/output compare, PWM or one-pulse mode output. This gives up to 12 input captures/output compares/PWMs on the largest packages. The general-purpose timers can work together with the advanced-control timer via the Timer Link feature for synchronization or event chaining. Their counter can be frozen in debug mode. Any of the general-purpose timers can be used to generate PWM outputs. They all have independent DMA request generation. These timers are capable of handling quadrature (incremental) encoder signals and the digital outputs from one to three Hall-effect sensors.

Low- and high-density devices are an extension of the STM32F103x8/B devices, they are specified in the STM32F103x4/6 and STM32F103xC/D/E datasheets, respectively. Low-density devices feature lower Flash memory and RAM capacities, less timers and peripherals. High-density devices have higher Flash memory and RAM capacities, and additional peripherals like SDIO, FSMC, I2S and DAC, while remaining fully compatible with the other members of the STM32F103xx family.

The Arm® Cortex®-M3 processor is the latest generation of Arm processors for embedded systems. It has been developed to provide a low-cost platform that meets the needs of MCU implementation, with a reduced pin count and low-power consumption, while delivering outstanding computational performance and an advanced system response to interrupts.

Features and Specifications

Table 4.2 : STM 32 Features

Features and Peripherals	Availability
Architecture	RISC
Pin Count	47
SRAM	20 kilo-Bytes
Serial wire Debug	1
Flash Memory	64/128 Kilo-Bytes
CPU speed	72 MHz (max)
USB Connector	Micro
ADC	2
Number of Timers	7
Communication Interfaces	9
USB module	Yes
I^2C	2
SPI	2
Operational Temperature	-40^0C – 105^0C
Source/Sink Current	6 mA
Operational Voltage	2.0V – 3.6V
USART module	3
Internal Oscillator	4-16 MHz
Window watchdog timer (WWDT)	Yes
JTAG debug Interface	1

Overview

Embedded Flash memory

64 or 128 Kbytes

Embedded SRAM

20 Kbytes of embedded SRAM accessed (read/write) at CPU clock speed with 0 wait states.

External interrupt/event controller (EXTI)

The interrupt/event controller consists of 19 edge detector lines used to generate interrupt/event requests. Each line can be independently configured to select the particular trigger event (rising edge, falling edge, both) and can be masked independently. A pending register maintains the status of the interrupt requests.

Power supply schemes

VDD = 2.0 to 3.6 V: external power supply for I/Os and the internal regulator. Provided externally through VDD pins.

Universal synchronous/asynchronous receiver transmitter (USART)

One of the USART interfaces is able to communicate at speeds of up to 4.5 Mbit/s

Serial peripheral interface (SPI)

Up to two SPIs are able to communicate up to 18 Mbits/s in slave and master modes in full-duplex and simplex communication modes. The 3-bit pre scaler gives 8 master mode frequencies and the frame is configurable to 8 bits or 16 bits. The hardware CRC generation/verification supports basic SD Card/MMC modes.

Controller area network (CAN)

The CAN is compliant with specifications 2.0A and B (active) with a bit rate up to 1 Mbit/s. It can receive and transmit standard frames with 11-bit identifiers as well as extended frames with 29-bit identifiers. It has three transmit mailboxes, two receive FIFOs with three stages and 14 scalable filter banks.

Universal serial bus (USB)

The STM32F103xx performance line embeds a USB device peripheral compatible with the USB full-speed 12 Mbs. The USB interface implements a full-speed (12 Mbit/s) function interface. It has software-configurable endpoint setting and suspend/resume support. The dedicated 48 MHz clock is generated from the internal main PLL (the clock source must use a HSE crystal oscillator)

2. KEYPAD

Fig. 4.4 : 4x4 keypad matrix

A 4x4 keypad is a type of input device that consists of a grid of 16 buttons or keys, arranged in four rows and four columns. It is commonly used as an interface for entering numerical and text data, as well as for navigating through menus and other graphical user interfaces.
Each button on the keypad is typically labeled with a number, letter, or symbol, and pressing the button sends an electrical signal to the device or computer it is connected to. The device or computer then interprets the signal and performs the appropriate action, such as displaying the corresponding character on a screen, or executing a specific command.
As given in above table a 4X4 KEYPAD will have EIGHT TERMINALS. In them four are ROWS of MATRIX and four are COLUMNS of MATRIX. These 8 PINS are driven out from 16 buttons present in the MODULE. Those 16 alphanumeric digits on the MODULE surface are the 16 buttons arranged in MATRIX formation.

4X4 KEYPAD MODULE Features and Specifications

- Maximum Voltage across EACH SEGMENT or BUTTON: 24V
- Maximum Current through EACH SEGMENT or BUTTON: 30mA
- Maximum operating temperature: 0°C to + 50°C
- Ultra-thin design
- Adhesive backing

4X4 KEYPAD MODULES are available in different sizes and shapes. But they all have same pin configuration. It is easy to make 4X4 KEYPAD by arranging 16 buttons is matrix formation by yourself.

Pin Number	Description
ROWS	
1	**PIN1 is taken out from 1st ROW**
2	**PIN2 is taken out from 2nd ROW**
3	**PIN3 is taken out from 3rd ROW**
4	**PIN4 is taken out from 4th ROW**
COLUMN	
5	**PIN5 is taken out from 1st COLUMN**
6	**PIN6 is taken out from 2nd COLUMN**
7	**PIN7 is taken out from 3rd COLUMN**
8	**PIN8 is taken out from 4th COLUMN**

Table 4.3 : Pin configuration

As given in above table a 4X4 keypad will have eight terminals. In them four are rows of matrix and four are column of matrix. These 8 pins are driven out from 16 buttons present in the module. Those 16 alphanumeric digits on the module surface are the 16 buttons arranged in matrix formation.

3. RFID MODULE

Fig. 4.5 : RFID Module (RC522)

The **RC522** is a **13.56MHz RFID module** that is based on the **MFRC522 controller from NXP semiconductors**. The module can supports I2C, SPI and UART and normally is shipped with a RFID card and key fob. It is commonly used in attendance systems and other person/object identification applications.

An RFID (Radio Frequency Identification) module is an electronic device that is used to read and write data on RFID tags or cards. RFID tags contain a small integrated circuit and an antenna, which can be used to store and transmit data wirelessly using radio waves. An RFID module consists of a reader and an antenna, which can be designed to work with different frequencies and protocols, depending on the application. The module can be connected to a microcontroller or other electronic device, which can then process the data received from the RFID tag and perform the appropriate action.

RC522 Features

- 13.56MHz RFID module
- Operating voltage: 2.5V to 3.3V
- Communication : SPI, I2C protocol, UART
- Maximum Data Rate: 10Mbps
- Read Range: 5cm

RFID reader pin configuration :

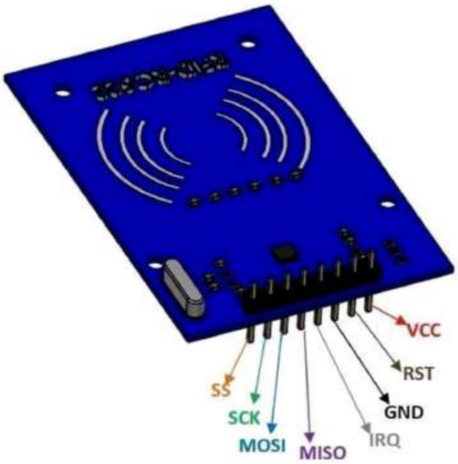


Fig. 4.6: RFID pin configuration

The pin configuration of an RFID module can vary depending on the manufacturer and model of the module. However, here are the common pin configurations of an RFID module:

- **VCC** - This pin is used to supply power to the module. It typically requires a voltage of 3.3V or 5V, depending on the module's specifications.
- **GND** - This pin is connected to the ground of the system.
- **TX** - This pin is used to transmit data from the RFID module to the microcontroller or other device it is connected to.
- **RX** - This pin is used to receive data from the microcontroller or other device and send it to the RFID module.
- **SDA** - This pin is used for data transfer in I2C communication mode.
- **SCL** - This pin is used for clock signal in I2C communication mode.

It's important to consult the datasheet or documentation of the specific RFID module you are using to confirm the pin configuration and the corresponding functions of each pin.

The keychain has 1kB memory in it which can be used to stored unique data. The RC522 reader module can both read and write data into these memory elements. The reader can read data only form passive tags that operate on 13.56MHz. Since in application, most of the time reader module will be waiting for the tag to come into proximity. The Reader can be put into power down mode to save power in battery operated applications. This can be achieved by using the IRQ pin on the module.

3(a) RFID CARD

Fig. 4.7 : RFID Card

RFID (radio frequency identification) is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person.

Every RFID system consists of three components: a scanning antenna, a transceiver and a transponder. When the scanning antenna and transceiver are combined, they are referred to as an RFID reader or interrogator. There are two types of RFID readers -- fixed readers and mobile readers. The RFID reader is a network-connected device that can be portable or permanently attached. It uses radio waves to transmit signals that activate the tag. Once activated, the tag sends a wave back to the antenna, where it is translated into data.

smart labels are simple RFID tags. These labels have an RFID tag embedded into an adhesive label and feature a barcode. They can also be used by both RFID and barcode readers. Smart labels can be printed on-demand using desktop printers, where RFID tags require more advanced equipment.

There are two main types of RFID tags:

- **Active RFID -** An active RFID tag has its own power source, often a battery.
- **Passive RFID -** A passive RFID tag receives its power from the reading antenna, whose electromagnetic wave induces a current in the RFID tag's antenna.

4. OLED DISPLAY

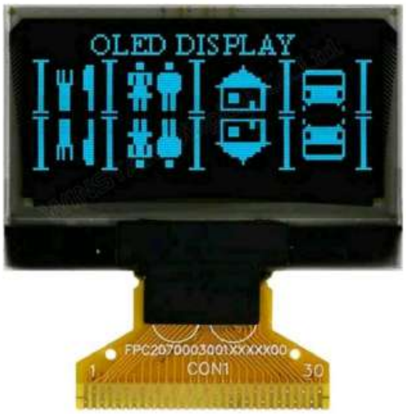


Fig. 4.8: OLED display

An organic light-emitting diode (OLED), also known as organic electroluminescent (organic EL) diode is a type of light-emitting diode (LED) in which the emissive electroluminescent layer is an organic compound film that emits light in response to an electric current .

The working principle of this OLED display is very simple. This LED display consists of organic material layers which are situated between two electrodes that are called anode and cathode. When these electrodes are connected to dc supply then current is passed through these electrodes then electrons are deposited on electrode substrate. Basically, organic material is made of semiconductor material whose electrical properties are in between conductor and semi-conductor. Therefore, when current is supplied to their electrodes then the electrons which are deposited at electrode substrate, delocalize the organic molecule.

Power Pins

PINS	DETAILS	
Pin1	GND	Connect the Pin1 with the ground pin to make the common ground for proper working.
Pin2	Power (VCC, VDD, 5V)	OLED uses a single power pin for all the power inputs.

Table 4.5 : OLED DISPLAY POWER PINS

Communication Pins :

PINS	DETAILS	
Pin3	SCK (CLK, SCL)	The Pin3 will perform a common clock signal for both microcontroller/Arduino with OLED. In SPI and I2C communication, it will act as a clock pin.
Pin4	SDA (MOSI, DI)	This pin will receive the data from the controlling device/Arduino. In OLED only "data" in should have to receive data, there won't be any data output. So, the Pin4 will act as data input for both SPI and I2C.
Pin5	RES (Reset, RST)	The reset pin will reset all the internal buffer of the OLED driver.
Pin6	D/C (A0)	The Pin6 will change the data and command registers on the input requirements.
Pin7	Chip Enable (CS, CE)	The Pin7 is an enable pin, which will activate the display on the LOW input signal.

Table 4.4 : OLED DISPLAY COMMUNICATION PINS

5. SERVO MOTOR

Fig. 4.9: Servo motor

A servomotor (or servo motor or simply servo) is a rotary or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration in a mechanical system. It constitutes part of a servomechanism, and consists of a suitable motor coupled to a sensor for position feedback.

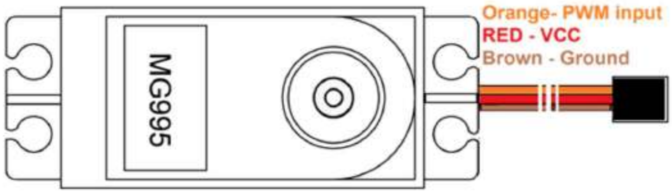


Fig. 4.10 : Servo motor Pins

Servo Motor Pins description :

Pin	Name	Function
1	Signal pin (Orange pin)	The PWM signal which states the axis position is given through this pin.
2	VCC (Red pin)	Positive power supply for servo motor is given to this pin.
3	Ground(Brown pin)	This pin is connected to ground of circuit or power supply.

Table 4.6 : Servo Motor Pins

MG995 Features and Electrical characteristics

- Fast control response
- Constant torque throughout the servo travel range
- Excellent holding power
- Weight: 55 g
- Dimension: 40.7×19.7×42.9mm
- Operating voltage range: 4.8 V to 7.2 V
- Stall torque: 9.4kg/cm (4.8v); 11kg/cm (6v)
- Operating speed: 0.2 s/60º (4.8 V), 0.16 s/60º (6 V)
- Rotational degree: 180º
- Dead band width: 5 µs
- Operating temperature range: 0ºC to +55ºC
- Current draw at idle: 10mA
- No load operating current draw: 170mA
- Current at maximum load: 1200

6. BLUETOOTH MODULE

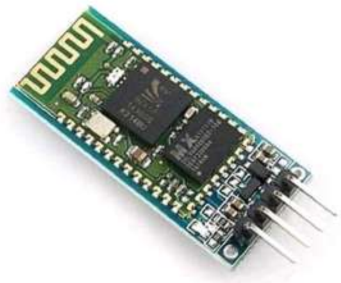


Fig. 4.11 : Bluetooth module (HC - 05)

HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration. It is used for many applications like wireless headset game controllers, wireless mouse, wireless keyboard, and many more consumer applications. It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions. It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

HC- 05 PINS :

Fig. 4.l2 : Bluetooth module HC-05 pins

1. **Data mode:** Between devices.
2. **Command mode:** It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.
3. **VCC:** 5 V or 3.3 V pin is connected.
4. GND: Ground Pin of module.

5. **TXD:** Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)
6. **RXD:** Receive data serially (received data will be transmitted wirelessly by Bluetooth module).
7. **State:** It tells whether module is connected or not.

7. HELICAL SPRING

Fig. 4.13 : Helical spring used for dispense process

A helical spring, also known as a coil spring, is a mechanical device typically made of metal wire formed into a helix shape. It's commonly used to store and release energy or to apply force when compressed or stretched. Helical springs are found in various applications, including automotive suspensions, mattresses, and mechanical watches, vending machines etc.

4.2.2 SOFTWARE REQUIRED

STM32CubeIDE is an advanced C/C++ development platform with peripheral configuration, code generation, code compilation, and debug features for STM32 microcontrollers and microprocessors. It is based on the Eclipse®/CDT™ framework and GCC toolchain for the development, and GDB for the debugging. It allows the integration of the hundreds of existing plugins that complete the features of the Eclipse® IDE.

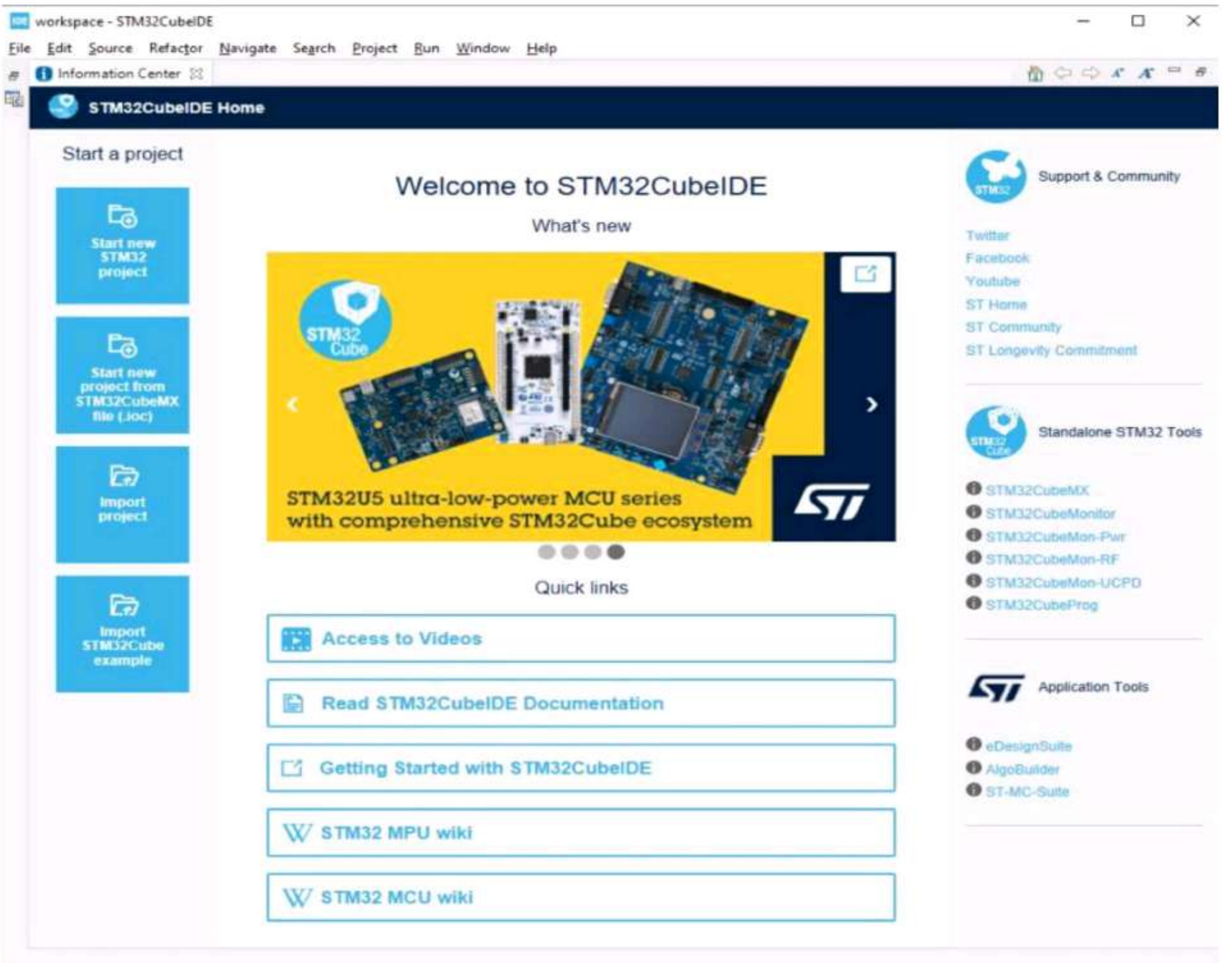


Fig. 4.14 : Integrated development environment for STM32 products

4.2.3 HARDWARE IMPLEMENTATION

1. STM 32 MICROCONTROLLER PROGRAMMING

Tools required :

- STM32 development board
- ST-LINK downloader
- STM32CubeMX and support pack
- Keil5 (MDK-Arm)
- Breadboard

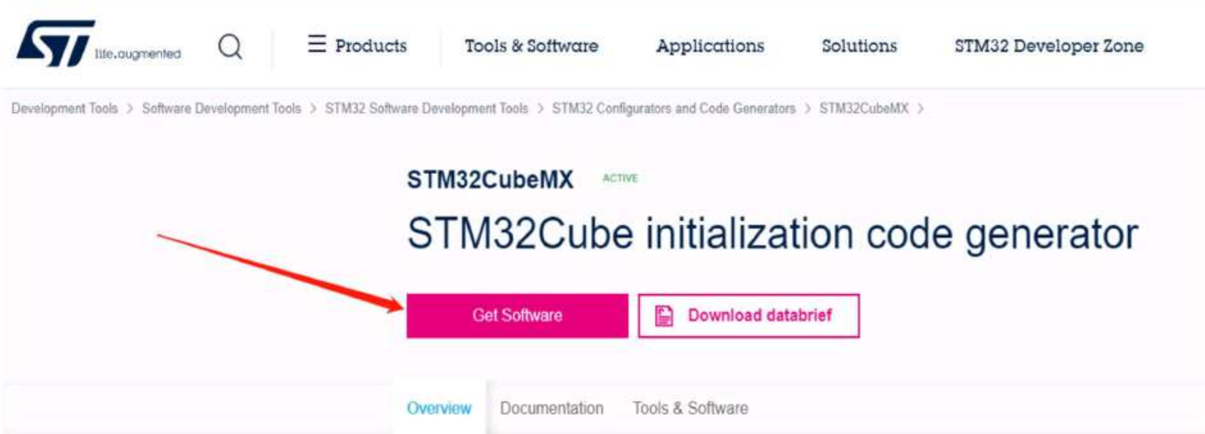
Procedure

Step 1: Connect the Dev Board to your Computer

The first step is to select the right STM32 development board for your application and then connect it to the computer by ST-LINK downloader. You should consider factors such as the size, cost, performance, and features.

Step 2: Download STM32CubeMx and Keil5 Tool Kits

Download the "STM32CubeMX" software on ST official website or below URL:
https://www.st.com/en/development-tools/stm32cubemx.html



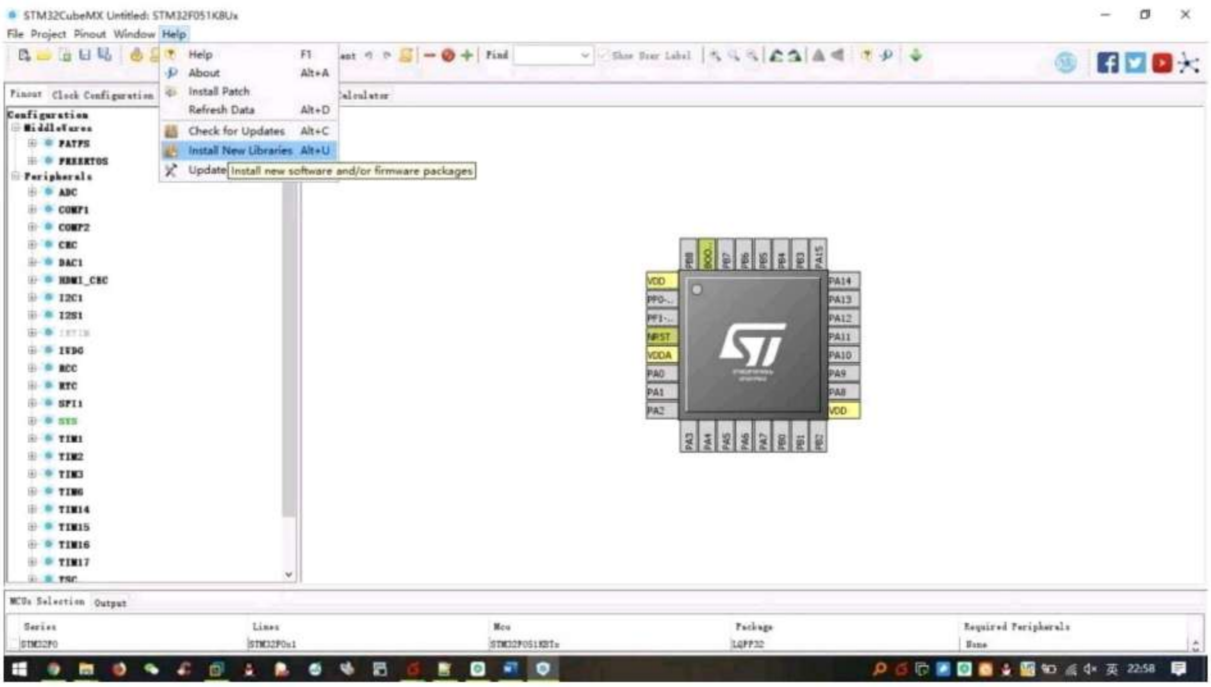
Download STM32CubeMX

Download the Keil MDK development kit on Keil5 website or this URL:
https://www2.keil.com/mdk5

Step 3: Create a New Project in STM32CubeMX

Double-click to open “STM32CubeMX”:

Click the “New Project” option:



Step 4: Install New Libraries for STM32 Development Board Download the library of stm32f051k8u6, as shown in the figure below “Help-> Install New Libraries”

Step 5: Generate the Code and Save the Project

Writing the code is the process of writing the instructions for the microcontroller in C or C++. This is usually done using an Integrated Development Environment (IDE) such as Keil, IAR, or Eclipse. Of course, as an alternative, you can also use STM32CubeMX to generate the code. As figure shows below, click the button to generate the chip code.

Step 6: Compile the Program Code in Keil5

Once the code is written, it must be compiled. Compiling the code is the process of converting the code into a format that can be read by the microcontroller. Here we use Keil software to finish the process. At first, we click "Open Project" button to open the stm32 project saved in last step.

Step 7: Debug the Program Code with µVision® Debugger

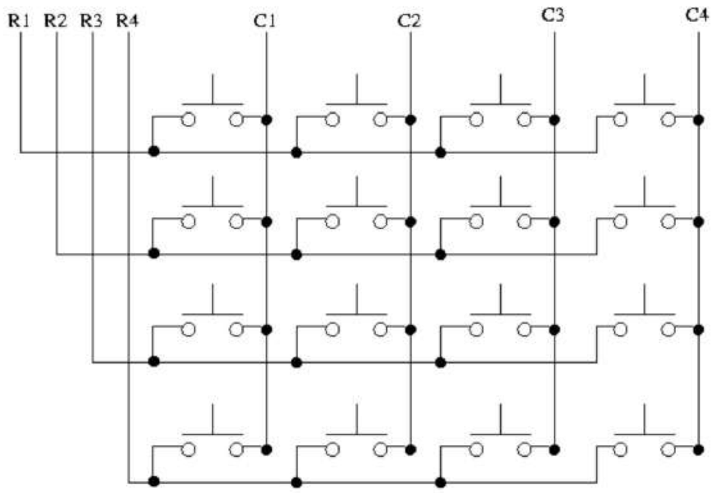
In Keil5, we can use µVision® Debugger to debug the program code of STM32 dev board. It provides a series of test functions such as "Event Statistics", "Performance Analyzer", "Execution Timing", "Component Viewer", and "Event Recorder".

Step 8: Upload the Program Code to the STM32f051k8u6 Dev Board

Then click "Download" or press the keyboard shortcut "F8" to complete the programming.

Debugging can be difficult because it requires a lot of patience and trial and error. It is important to use a debugger that supports the STM32 microcontroller and to test your code thoroughly before uploading it.

Another common issue is memory allocation. Memory allocation is the process of allocating memory to the microcontroller. This can be difficult because you need to make sure that there is enough memory for all the code and data. It is important to use a memory allocation tool to help you allocate the memory correctly.



2. KEYPAD INTERFACING

Fig. 4.15 : 4X4 Keypad basic operation

Consider we have connected the keypad module to a microcontroller.

STEP 1: First set all rows to output and set them at +5V. Next set all columns as input to sense the HIGH logic. Now consider a button is pressed on keypad. And that key is at 2ND column and 3rd row.

With the button being pressed the current flows as shown in figure. With that a voltage of +5V appears at terminal C2. Since the columns pins are set as inputs, the controller can sense C2 going high. The controller can be programmed to remember that C2 going high and the button pressed is in C2 column.

STEP 2: Next set all column to output and set them at +5V. Next set all rows as input to sense the high logic. Since the key pressed is at 2ND column and 3rd row. The current flows as shown below.

With that current flow a positive voltage of +5V appears at R3 pin. Since all rows are set as input, the controller can sense +5V at R3 pin. The controller can be programmed to remember the key being pressed at third row of keypad matrix.

STEP 3: From previous step, we have known the COLUMN number of key pressed and now we know ROW number. With that we can match the key being pressed. We can take the key INPUT provided by this way for 4X4 KEYPAD MODULE.

Some common applications of 4x4 keypads include ATM machines, electronic locks, security systems, and industrial control systems. They are also commonly used in embedded systems and microcontroller-based projects, where they can provide a simple and cost-effective means of user input.

3. RFID MODULE – RC 522

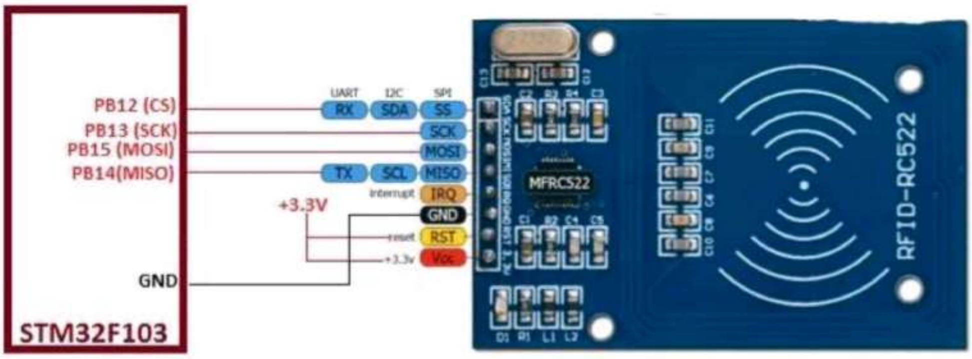


Fig. 4.16 : RC522 RFID module connection with STM 32 microcontroller

The RC522 identifies the host interface by sensing the logic levels on the control pins after the reset phase. This is done using a combination of fixed pin connections.

Select UART interface:

Pin -1 (I2C) must be connected to 0 voltage

Pin -32 (EA) must be connected to 0 voltage

Select SPI interface:

Pin -1 (I2C) must be connected to 0 voltage

Pin -32 (EA) must be connected to 1 voltage

The SPI2 of STM32 is selected to communicate with RC522 at 9MHz speed.

* STM32 is operating as Master, and RC522 is operating as Slave.
* Both the RTS and VCC pins of RC522 must be connected to +3.3V supply and the GND pin of RC522 to the GND pin of STM32.

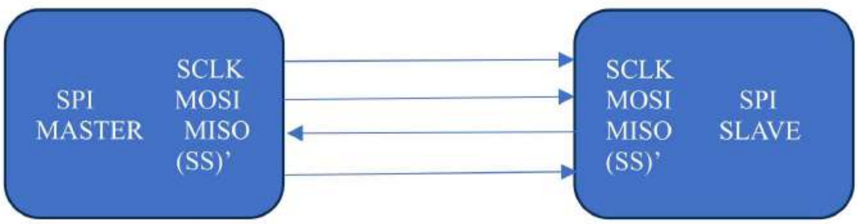


Fig. 4.17 : Master – slave diagram of RC522

4. OLED DISPLAY INTERFACING

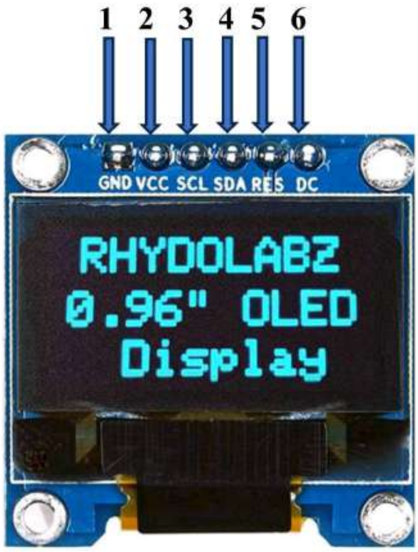


Fig. 4.18 : OLED display connection with STM 32 microcontroller

Connection in STM 32 Development board :

1 = GND
2 = VCC
3 = D10 (PB 2)
4 = D9 (PB 1)
5 = RESET
6 = D11 (PB 3)

We will use STM32Cube IDE to program our STM32 board. Open the IDE and head over to a new project. Then for the target selection, specify the STM32 Blue Pill board number. After that click on any column as shown in the picture below. Then click the 'Next' button. Specify the name of your project then click 'Finish' to complete the setup of your project. Now head over to Connectivity > I2C1. Select the I2C mode as 'I2C.' Then go to 'Parameter Settings' and set the I2C speed mode as 'Fast Mode.' This is necessary for the SSD1306 OLED.

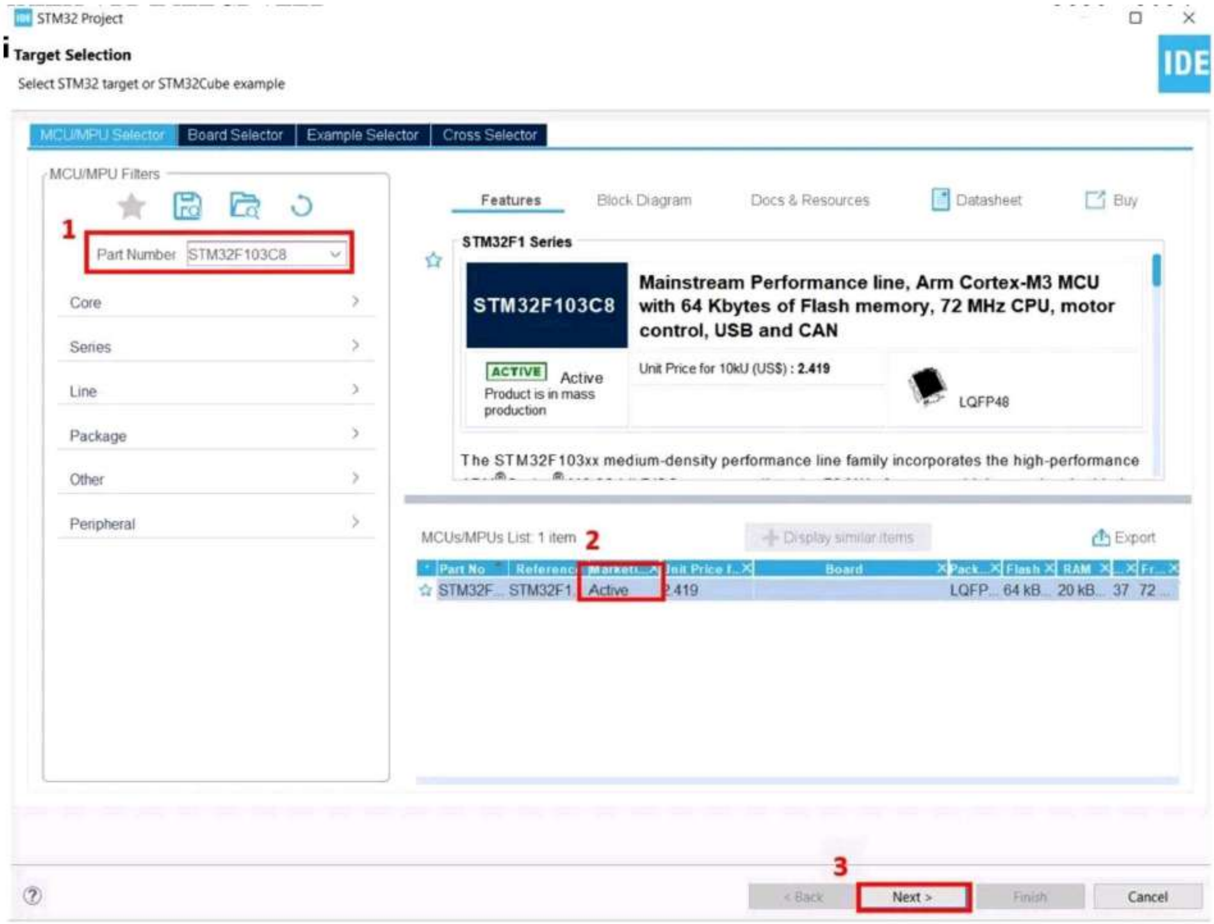


Fig. 4.19 : Selecting the series of STM 32 for target selection

Now go to System Core > RCC then select 'Crystal/Ceramic Resonator' in from the High Speed Clock feature.

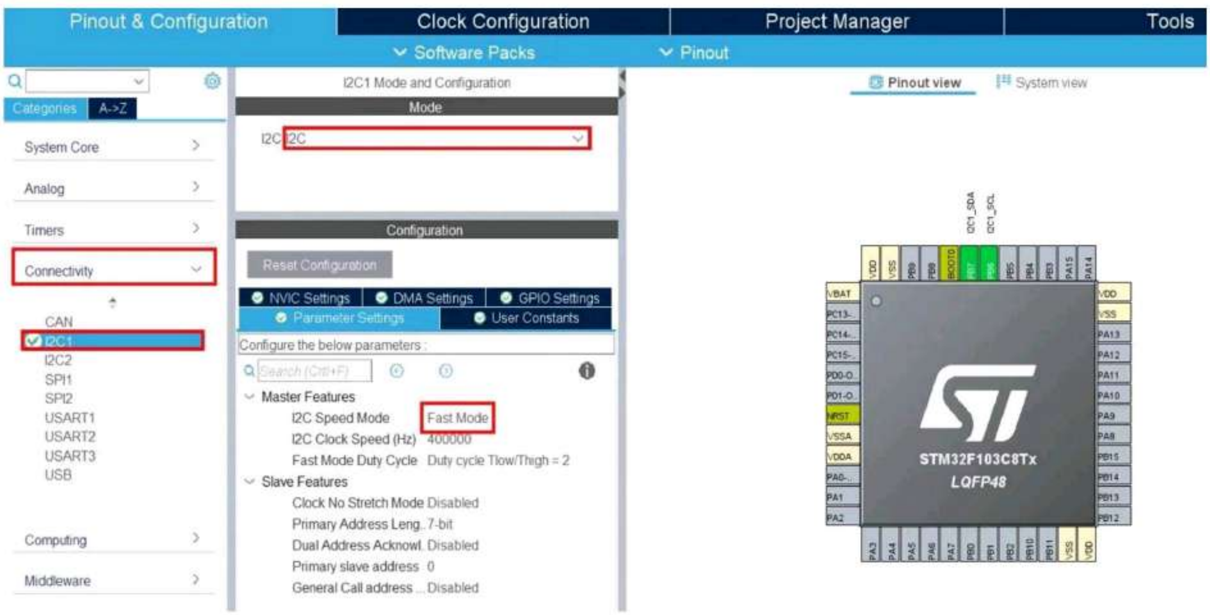


Fig. 4.20 : Selection of clock configuration (SCL and SDA)

In the above Fig , the pinout which are in green in colour are connected to the OLED display from the microcontroller.

5. SERVO MOTOR INTERFACING

Fig. 4.21 : Connection of Servo motor pins with STM 32 Microcontroller

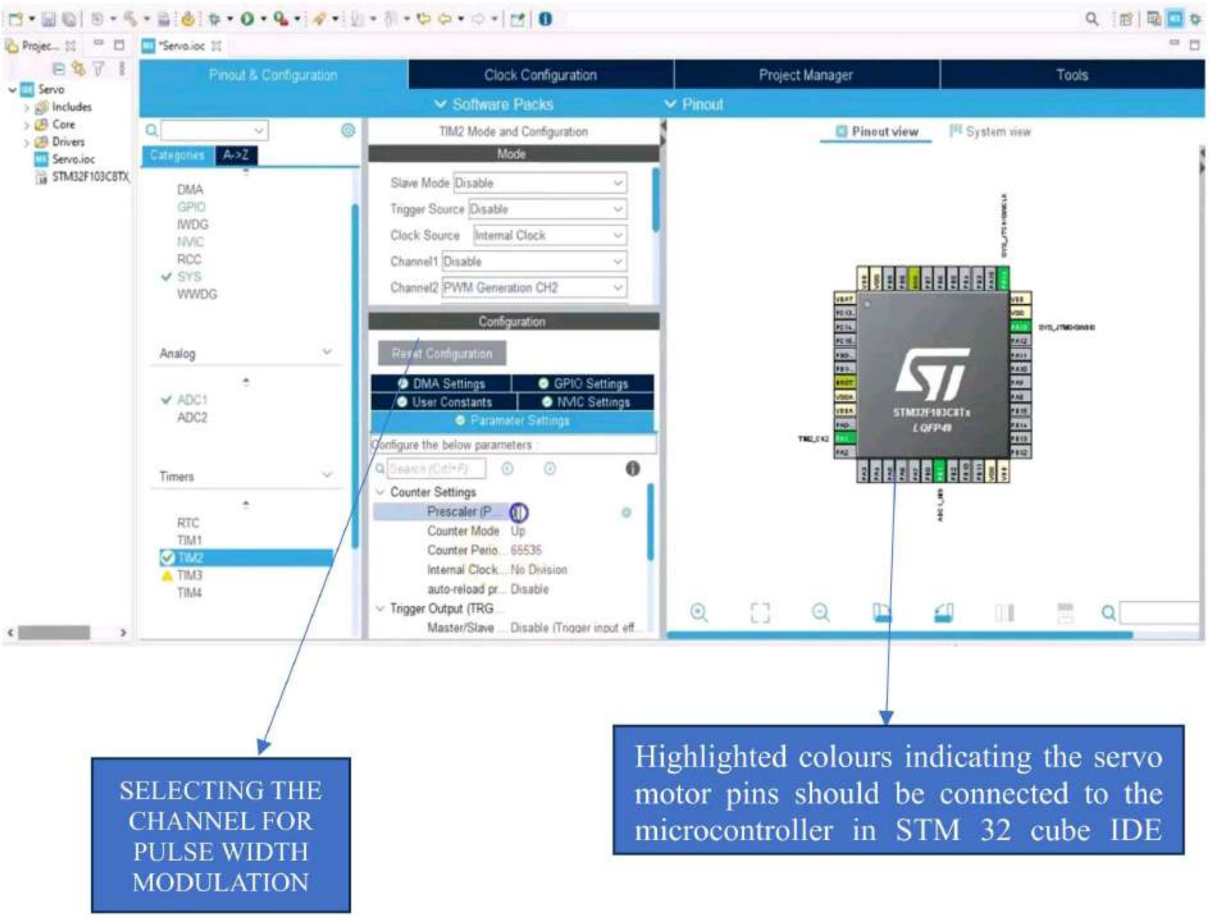


Fig. 4.22 : STM 32 cube IDE software page interfacing with servo motor

6. BLUETOOTH MODULE HC – 05

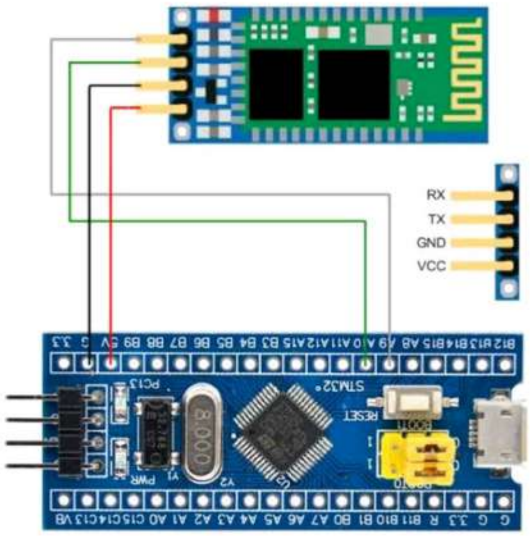


Fig. 4.23 : Connection diagram of Bluetooth module with STM 32 microcontroller

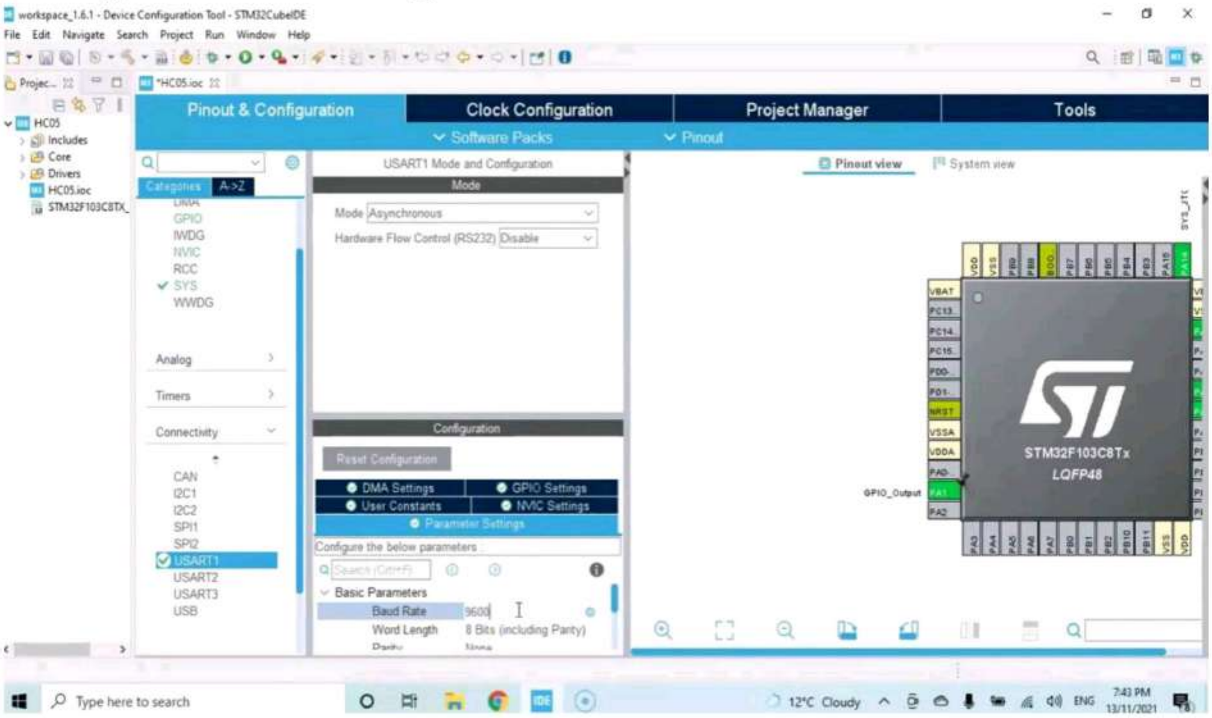


Fig. 4.24 : Software page of interfacing HC-05 Bluetooth module

Click on the System Core option and select the SYS drop down box where we will see serial wire option and select it. Make the serial wire as pin PA1 and GPIO output pin and click connectivity. Click on USART 1 for Mode Asynchronous configuration and parameters settings of desired value. Select the Baud rate as 9600 Bits/s .

4.2.4 SOFTWARE IMPLEMENTATION

This program first initializes the system for the selection of medicine from the input factor as keypad matrix provided. The keypad sends the data to the microcontroller that which key has been pressed . The microcontroller holds the data and commands for the respective servo motor to rotate if and only if the payment is successful . Then the code for servo motor code runs in microcontroller memory and servo motors helps to dispense the medicine and the code is given below

```
#include "stm32f4xx_hal.h"
#define SERVO_PWM_PIN GPIO_PIN_0
#define SERVO_PWM_PORT GPIOA

TIM_HandleTypeDef htim2;

void SystemClock_Config(void);
static void MX_GPIO_Init(void);
static void MX_TIM2_Init(void);

int main(void)
{
 HAL_Init();
SystemClock_Config();
MX_GPIO_Init();
MX_TIM2_Init();
HAL_TIM_PWM_Start(&htim2, TIM_CHANNEL_1);
while (1)
{
// Rotate servo to 90 degrees
TIM2->CCR1 = 150; // Adjust this value to set the angle (duty cycle)
HAL_Delay(1000);
```

```
// Rotate servo to 0 degrees
TIM2->CCR1 = 50; // Adjust this value to set the angle (duty cycle)
HAL_Delay(1000);
}
}
void SystemClock_Config(void)
{
RCC_OscInitTypeDef RCC_OscInitStruct = {0};
RCC_ClkInitTypeDef RCC_ClkInitStruct = {0};
 __HAL_RCC_PWR_CLK_ENABLE();
__HAL_PWR_VOLTAGESCALING_CONFIG(PWR_REGULATOR_VOLTAGE_SCALE1
);
RCC_OscInitStruct.OscillatorType = RCC_OSCILLATORTYPE_HSE;
RCC_OscInitStruct.HSEState = RCC_HSE_ON;
RCC_OscInitStruct.PLL.PLLState = RCC_PLL_ON;
RCC_OscInitStruct.PLL.PLLSource = RCC_PLLSOURCE_HSE;
RCC_OscInitStruct.PLL.PLLM = 25;
RCC_OscInitStruct.PLL.PLLN = 336;
RCC_OscInitStruct.PLL.PLLP = RCC_PLLP_DIV2;
RCC_OscInitStruct.PLL.PLLQ = 7;
if (HAL_RCC_OscConfig(&RCC_OscInitStruct) != HAL_OK)
{
Error_Handler();
}
RCC_ClkInitStruct.ClockType = RCC_CLOCKTYPE_HCLK |
RCC_CLOCKTYPE_SYSCLK | RCC_CLOCKTYPE_PCLK1 |
RCC_CLOCKTYPE_PCLK2;
RCC_ClkInitStruct.SYSCLKSource = RCC_SYSCLKSOURCE_PLLCLK;
RCC_ClkInitStruct.AHBCLKDivider = RCC_SYSCLK_DIV1;
RCC_ClkInitStruct.APB1CLKDivider = RCC_HCLK_DIV4;
RCC_ClkInitStruct.APB2CLKDivider = RCC_HCLK_DIV2;
if (HAL_RCC_ClockConfig(&RCC_ClkInitStruct, FLASH_LATENCY_5) != HAL_OK)
{
```

```
Error_Handler();
}
}

static void MX_GPIO_Init(void)
{

GPIO_InitTypeDef GPIO_InitStruct = {0};

__HAL_RCC_GPIOA_CLK_ENABLE();

HAL_GPIO_WritePin(SERVO_PWM_PORT, SERVO_PWM_PIN, GPIO_PIN_RESET);
GPIO_InitStruct.Pin = SERVO_PWM_PIN;
GPIO_InitStruct.Mode = GPIO_MODE_AF_PP;
GPIO_InitStruct.Pull = GPIO_NOPULL;
GPIO_InitStruct.Speed = GPIO_SPEED_FREQ_LOW;
GPIO_InitStruct.Alternate = GPIO_AF1_TIM2;
HAL_GPIO_Init(SERVO_PWM_PORT, &GPIO_InitStruct);

}

static void MX_TIM2_Init(void)

{
TIM_MasterConfigTypeDef sMasterConfig = {0};
TIM_OC_InitTypeDef sConfigOC = {0};
 __HAL_RCC_TIM2_CLK_ENABLE();
htim2.Instance = TIM2;
htim2.Init.Prescaler = 10000 - 1;
htim2.Init.CounterMode = TIM_COUNTERMODE_UP;
htim2.Init.Period = 20000 - 1; // 20ms period (50Hz)
htim2.Init.ClockDivision = TIM_CLOCKDIVISION_DIV1;
htim2.Init.AutoReloadPreload = TIM_AUTORELOAD_PRELOAD_ENABLE;
```

```
if (HAL_TIM_PWM_Init(&htim2) != HAL_OK)
{

Error_Handler();
}
sMasterConfig.MasterOutputTrigger = TIM_TRGO_RESET;
sMasterConfig.MasterSlaveMode = TIM_MASTERSLAVEMODE_DISABLE;
if (HAL_TIMEx_MasterConfigSynchronization(&htim2, &sMasterConfig) != HAL_OK)

{
Error_Handler();

}
sConfigOC.OCMode = TIM_OCMODE_PWM1;
sConfigOC.Pulse = 0; // Initial pulse width
sConfigOC.OCPolarity = TIM_OCPOLARITY_HIGH;
sConfigOC.OCFastMode = TIM_OCFAST_ENABLE;
if (HAL_TIM_PWM_ConfigChannel(&htim2, &sConfigOC, TIM_CHANNEL_1) !=
HAL_OK)
{
Error_Handler();
}
HAL_TIM_MspPostInit(&htim2);
}
while (1)
{
// Example: Dispense medicine from servo 1 with quantity 1
DispenseMedicine(1, 1);
HAL_Delay(1000); // Delay between dispensing actions
}
}

void SystemClock_Config(void)
```

```
{
pinMode(pin_no,INPUT);
pinMode(pin_no,OUTPUT);
digitalWrite(pin_no,HIGH);
delay();
digitalWrite(pin_no,LOW);
delay();
Duration;
Distance;
}
Void setup()
{
pinMode(13,OUTPUT);
}
Void loop()
{
digitalWrite(13,HIGH);
delay(1000);
digitalWrite(13,HIGH);
delay(1000);
Void setup()
{
int pinButton = 8;
long t = 0;
int i = 0;
void setup(){
Serial.begin(9600);
pinMode(pinButton, INPUT);
for(int e =9;e < 14; e++)
{
pinMode(e, OUTPUT);
}
```

```
}
void loop(){
t++;
if (t%20==0)
{
digitalWrite(i+9,HIGH);
i++;
}
if(digitalRead(pinButton)==HIGH)
{
i=0;
for(int e =9;e < 14; e++)
{
digitalWrite(e,LOW);
}
}
Serial.print(i);
Serial.print("");
pinMode(pin_no,INPUT);
pinMode(13,OUTPUT);
}
Void loop()
{
digitalRead(pin_no);
If { GPIO ==1
}
void GPIO_Init(void)
{
  // Initialize GPIO pins
}
void Servo_Init(void)
{
  TIM_OC_InitTypeDef sConfigOC = {0};
```

```
}

void DispenseMedicine(int servo_number, int quantity)
}
// Calculate angle of servo motor based on quantity (you'll need to adjust this calculation)
   int angle = quantity * 10; // Assuming 10 degrees per unit
// Set angle for the specified servo motor
switch (servo_number)
{
case 1:
Adjust the GPIO pin and port for servo 1
HAL_GPIO_WritePin(SERVO_1_PORT, SERVO_1_PIN, GPIO_PIN_SET);
// Adjust the PWM signal for servo 1 to control its angle
// Code to set PWM signal for servo 1
break;
 // Add cases for other servo motors if necessary
default:
 // Invalid servo number
break;
}
// Delay to allow the servo to move to the desired angle
HAL_Delay(1000); // Adjust the delay time as needed
// Turn off the PWM signal to stop the servo
// Code to stop PWM signal for the specified servo
HAL_GPIO_WritePin(SERVO_1_PORT, SERVO_1_PIN, GPIO_PIN_RESET);
}
```

4.2.5 DESCRIPTION OF MOBILE APP

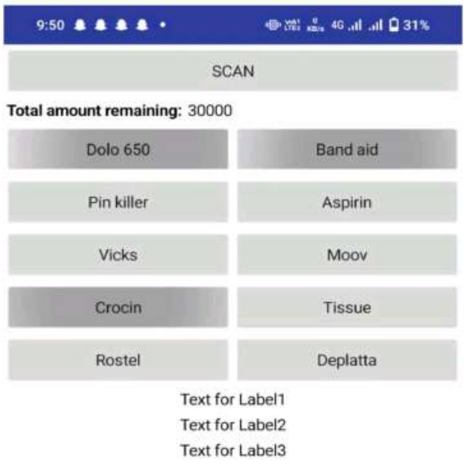


Fig. 4.25 : Mobile application user interface

The integration of a mobile application in conjunction with a smart dispensing machine marks a significant advancement in the realm of automated systems. This innovative approach leverages modern technologies to enhance user experience, accessibility, and efficiency. The mobile application serves as a seamless interface between the user and the dispensing machine, offering a convenient means of interaction and control.

At the heart of this system lies the STM32 microcontroller, which orchestrates the various functionalities and interfaces with external components. Through the mobile application, users can effortlessly navigate through a range of options, such as selecting items for dispensing, checking inventory levels, and monitoring transaction history. The application interfaces with the microcontroller via wireless communication protocols, enabling real-time data exchange and command execution.

Integral to the operation of the smart dispensing machine are RFID card readers, which authenticate users and authorize transactions. Upon presenting their RFID cards, users gain access to the machine's functionalities, with the mobile application acting as a gateway to initiate and finalize transactions. This seamless integration of RFID technology enhances security and streamlines the user experience.

Furthermore, the mobile application provides users with insightful data analytics and reporting features, allowing them to track usage patterns, consumption trends, and inventory management metrics. By harnessing the power of data analytics, operators can optimize stock levels, anticipate demand fluctuations, and enhance operational efficiency.

CHAPTER -5

RESULTS

5.1 Result

Fig. 5.1 : Front View

Fig. 5.2 : Top View

CHAPTER-6

CONCLUSION AND FUTURE SCOPE OF WORK

6.1 CONCLUSION

As pharmacists, our commitment to advancing patient care drives us to continually seek ways to enhance the quality and efficiency of our services. In today's rapidly evolving healthcare landscape, there is a growing expectation for the field of medicine to embrace technological advancements and minimize the risk of medication errors. Automated product delivery systems represent a crucial step towards meeting these demands within the medical industry. By implementing such machines, we aim to streamline the dispensing process while ensuring accuracy and accessibility for patients and healthcare professionals alike.

The integration of software and hardware components is essential to the successful implementation of automated medicine vending machines. Through meticulous design and testing, we strive to create systems that are not only user-friendly but also compact and portable, facilitating deployment in various healthcare settings. Utilizing the Arduino UNO microcontroller enhances the versatility of the system, allowing for seamless integration with other technologies and peripherals.

One of the primary advantages of automated medicine vending machines is their ability to provide round-the-clock access to essential medications without requiring human intervention. By leveraging Arduino microcontrollers and RFID technology, we can develop cost-effective solutions that minimize operational costs and maintenance requirements. The static nature of most components further contributes to the system's reliability and longevity, ensuring uninterrupted service for patients and healthcare providers.

Moreover, the implementation of automated medicine dispensers holds the potential to alleviate the burden on healthcare professionals by reducing the time and effort required for medication management. This is particularly beneficial for patients with special needs, such as the visually impaired, elderly individuals, and those affected by conditions like COVID-19, who may face additional challenges in accessing healthcare services.

By developing an automated medicine dispenser that caters to the specific needs of diverse patient populations, we can significantly enhance the quality of care and promote greater independence and autonomy. For instance, by incorporating features such as inventory control modules and cameras, we can further optimize the delivery process and ensure the timely availability of medications.

6.2 FUTURE SCOPE OF WORK

1) **Integration with electronic medical records:** The integration of automated medicine vending machines with electronic medical records can improve the accuracy and efficiency of prescription management. This integration can also facilitate better tracking of medication adherence, reducing the likelihood of medication errors and improving patient outcomes.
2) **Increased use in rural and underserved areas:** Automated medicine vending machines have the potential to increase access to medications in rural and underserved areas where traditional pharmacies are not readily available.
3) **Personalized medicine dispensing:** The development of personalized medicine dispensing systems can enable the vending machine to dispense customized doses of medications based on an individual's specific needs and medical history.
4) **Integration with telemedicine:** Automated medicine vending machines can be integrated with telemedicine technologies, enabling patients to receive remote consultations and prescriptions from healthcare providers, and then pick up their medication from the vending machine.
5) **Incorporation of artificial intelligence:** The incorporation of artificial intelligence can enable the vending machine to analyze medication dispensing patterns and provide insights into medication usage and adherence.
6) **The pillbox will accept coin payment:** Currently, the payment is being carried out using smart card and those who don’t have it can’t purchase medicine from the pillbox. But in future cash accepting module will be implemented which will use to concept of image processing from the reorganization of the coin.

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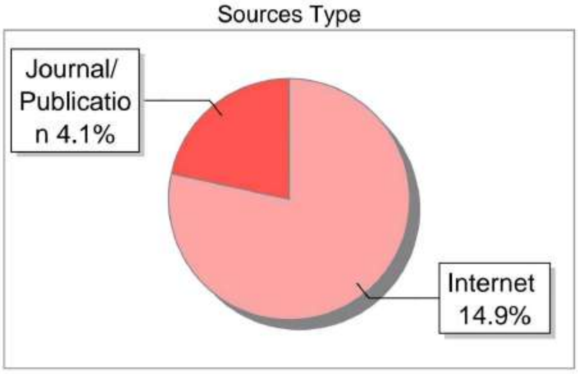

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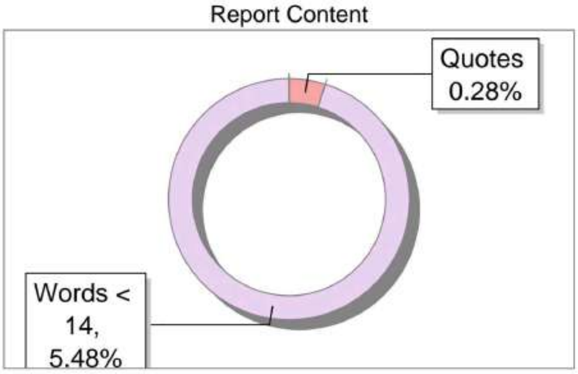

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