

ARDUINO BASED MEDICINE REMAINDER AND VENDING MACHINE

Submitted in partial fulfilment of requirements for the award of
Bachelor of Engineering Degree in Electronics and Communication Engineering
by

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHOOL OF ELECTRICAL AND ELECTRONICS

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

CATEGORY -1 UNIVERSITY BY UGC

Accredited with Grade“A++”by NAAC |12B Status by UGC |Approved by AICTE

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of YERUVA SRINIVASA REDDY (40130281), MARASU VENKATA SUBBARAO (40130263), who carried out the project entitled "ARDUINO BASED MEDICINE REMAINDER AND VENDING MACHINE" under my supervision from November 2023 to April 2024.

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I, YERUVA SRINIVASA REDDY (40130281), hereby declare that the Project Report entitled "ARDUINO BASED MEDICINE REMAINDER AND VENDING MACHINE" done by me under the guidance of Dr. K. SRILATHA M.E., Ph.D., Associate Professor, Department of Electronics and Communication Engineering, at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Electronics and Communication Engineering.

DATE: 17/04/2024

PLACE: CHENNAI

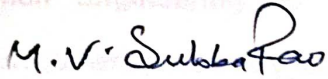
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DECLARATION

I, MARASU VENKATA SUBBARAO (40130263), hereby declare that the Project Report entitled "ARDUINO BASED MEDICINE REMAINDER AND VENDING MACHINE" done by me under the guidance of Dr. K. SRILATHA M.E., Ph.D., Associate Professor, Department of Electronics and Communication Engineering, at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Electronics and Communication Engineering.

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ABSTRACT

In this project a Smart Medicine Reminder and Dispenser Machine has been developed. Many old people have the tendency of missing the medicines or taking the medicines at wrong time. Often, they require someone to give them the medicines. Hence it is required to design a Medication Reminder Device that can help old people and many other patients to take medication on schedule. In situations like the CoVid-19 pandemic there is a physical contact between the patient and the caretakers, doctors. So, the device developed is capable of delivering medicine at prescribed time in which care-taker of the patient can store medicine in small boxes (doses) which will drop out according the time entered. Arduino IDE software platform and Arduino Uno along with RTC, servo motors, LCD, voice circuit module, push button as hardware are used to build this project. In the realm of healthcare, adherence to medication schedules is crucial for managing chronic conditions and ensuring optimal health outcomes. However, forgetfulness and lack of organization often pose significant challenges to patients. To address this issue, this paper proposes an innovative solution: an Arduino-based Medicine Reminder and Vending Machine. This system integrates the functionalities of medication reminders and automatic dispensing, offering a comprehensive approach to medication management. The Arduino microcontroller serves as the central control unit, orchestrating the operations of the machine. The system features a user-friendly interface that allows patients to input their medication schedule, which is then stored in the system's memory.

Moreover, the vending machine aspect of the system enables automated dispensing of the prescribed medication. Using motorized mechanisms controlled by the Arduino, the machine accurately dispenses the required dosage at the specified times.

Additionally, the system incorporates advanced security measures to prevent unauthorized access and ensure patient safety. RFID or biometric authentication can be implemented to verify the identity of the user before

dispensing medication, thus reducing the risk of misuse or accidental ingestion.

Furthermore, the system can be remotely monitored and managed, providing caregivers and healthcare professionals with real-time insights into patient adherence and medication usage patterns. This data can facilitate personalized interventions and adjustments to the treatment plan, ultimately improving patient outcomes.

In summary, the Arduino-based Medicine Reminder and Vending Machine offers a sophisticated yet accessible solution to the challenge of medication adherence. By combining convenience, reliability, and security, this system has the potential to enhance the quality of care for patients managing chronic conditions, fostering better health outcomes and overall well-being.

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CHAPTER 1

INTRODUCTION

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, sometimes with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use.

. An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular kind of application device. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines, and toys (as well as the more obvious cellular phone and PDA) are among the myriad possible hosts of an embedded system

In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems — such as the operating systems and microprocessors which power them — but are not truly embedded systems, because they allow different applications to be load and peripherals to be connected. An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular kind of application device. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines, and toys (as well as the more obvious cellular phone and PDA) are among the myriad possible hosts of an embedded system. Embedded systems that are programmable are provided with a programming interface, and embedded systems programming is a specialized occupation. Certain operating systems or language platforms are tailored for the embedded market, such as Embedded Java and Windows XP Embedded. However, some low-end consumer products use very inexpensive

microprocessors and limited storage, with the application and operating system both part of a single program. The program is written permanently into the system's memory in this case, rather than being loaded into RAM (random access memory), as programs on a personal computer are.

CHARACTERISTIC OF EMBEDDED SYSTEM

- Speed (bytes/sec): Should be high speed
- Power (watts): Low power dissipation
- Size and weight: As far as possible small in size and low weight
- Accuracy (%error): Must be very accurate
- Adaptability: High adaptability and accessibility
- Reliability: Must be reliable over a long period of time

APPLICATIONS OF EMBEDDED SYSTEMS

We are living in the Embedded World. You are surrounded with many embedded products and your daily life largely depends on the proper functioning of these gadgets. Television, Radio, CD player of your living room, Washing Machine or Microwave Oven in your kitchen, Card readers, Access Controllers, Palm devices of your work space enable you to do many of your tasks very effectively. Apart from all these, many controllers embedded in your car take care of car operations between the bumpers and most of the times you tend to ignore all these controllers.

- **Robotics**: industrial robots, machine tools, Robocop soccer robots
- **Automotive**: cars, trucks, trains
- **Aviation**: airplanes, helicopters
- **Home and Building Automation**
- **Aerospace**: rockets, satellites
- **Energy systems**: windmills, nuclear plants

Medical systems: prostheses, revalidation machine.

INTRODUCTION TO THE PROJECT:

There is no cure for CoViD-19 yet, although patients are given some medicines by nurses and doctors to ease the pain increase immunity, and reduce symptoms. But this puts our Healthcare warriors at risk when they give the medicine to patients, thus I developed a machine that can take in the Medicine Doses of an Entire week, store them and supply them to the patient at the time set by the doctor once, at the start-up of the machine. This will ensure distancing from patients and nurses won't have to risk their lives to go and give medicine to the infected patient. Once the medicine is on the given rack from where the patient can take it, he/she is alerted via a speaker on the system to take the medicine. The data of when the medicine is taken is stored in an SD card for further reference by doctors to monitor the effect on symptoms by the given doze. This machine can also be used in houses where old patients forget to take medicines on time and need a caretaker to provide them each dose. For using it in households, there is one more feature added- Exercise and Food times of the patient can be stored and act as a reminder, and the machine can also act as an alarm clock and can store 3 alarms. Food and exercise times help patients since there are certain meds that need to be taken at proper intervals before or after food, thus having food on time is important.

1.1 OBJECTIVES

Creating objectives for an Arduino-based medicine reminder and vending machine involves breaking down the project into specific goals. Here are some objectives you could consider:

1. Hardware Integration:

- Integrate Arduino microcontroller with necessary hardware components such as LCD display, keypad, RFID/NFC reader for user authentication, servo motors for vending, and buzzer for alerts.

2. Medicine Inventory Management:

- Develop a system to manage medicine inventory, including tracking quantities of different medicines stored in the vending machine.

- Implement a database or data structure to store information about medicines, such as name, dosage, expiration date, and quantity.

3. User Interface Design:

- Design an intuitive user interface for interacting with the vending machine using the LCD display and keypad.

- Implement menu navigation for users to select their desired medicine and dosage.

4. Medicine Reminder System:

- Develop a reminder system to alert users when it's time to take their medication.

- Allow users to set custom reminders based on their medication schedule.

5. Authentication and Security:

- Implement user authentication using RFID/NFC cards or other methods to ensure only authorized users can access the medicines.

- Ensure the system has robust security measures to prevent unauthorized access or tampering.

6. Vending Mechanism:

- Develop a vending mechanism controlled by servo motors to dispense the selected medicine accurately.

- Implement safeguards to prevent dispensing errors, such as double dosing or dispensing the wrong medicine.

7. Alerts and Notifications:

- Incorporate audible and visual alerts to notify users when it's time to take their medication or when there's an issue with the vending machine.

- Ensure alerts are clear and understandable to users, especially those with visual or auditory impairments.

8. Testing and Validation:

- Conduct thorough testing of the entire system, including hardware and software components, to ensure reliability and accuracy.
- Gather feedback from potential users to identify any usability issues or improvements needed.

9. Documentation and User Manual:

- Create comprehensive documentation for the system, including a user manual that explains how to use the vending machine and set up medication reminders.
- Provide troubleshooting tips and instructions for maintaining the system.

10. Scalability and Future Expansion:

- Design the system with scalability in mind, allowing for easy expansion to accommodate additional medicines or features in the future.
- Consider integrating connectivity options such as Wi-Fi or Bluetooth for remote monitoring and management of the vending machine.

By setting clear objectives for each aspect of the project, you can effectively plan and execute the development of an Arduino-based medicine reminder and vending machine.

1.2 RISKS ASSOCIATED WITH DIFFERENT PARAMETERS

Developing an Arduino-based medicine reminder and vending machine involves various parameters, each carrying its own set of risks. Hardware failure poses a significant risk, potentially leading to malfunctions in critical components like servo motors or RFID readers, which could disrupt medication dispensing or authentication processes. Software bugs present another concern, as errors in the system's code might result in incorrect medication reminders or dispensing the wrong medication altogether. Data security breaches represent a significant risk, with unauthorized access compromising patient privacy and safety. Additionally, medication dispensing errors could occur, posing serious health risks to patients.

User errors, such as incorrect input of medication schedules or forgetting to refill the machine, might also impact the system's effectiveness.

Power outages or interruptions could disrupt operations, leading to data loss or dispensing failures. Finally, regulatory compliance is crucial, with failure to meet medical device regulations potentially resulting in legal consequences. By proactively identifying and mitigating these risks, developers can enhance the safety, reliability, and compliance of the Arduino-based medicine reminder and vending machine.

1.3 PROBLEM STATEMENT

The problem statement for an Arduino-based medicine reminder and vending machine revolves around addressing the challenge of medication adherence and accessibility. Many individuals, especially those with chronic illnesses or complex medication regimens, struggle to manage their medications effectively, leading to missed doses and potential health complications. Additionally, accessing medication outside of traditional pharmacy hours or in remote areas can be challenging.

The solution aims to develop a user-friendly system that combines medication reminders with a vending mechanism to provide convenient access to medications. By leveraging Arduino technology, the system will offer personalized reminders tailored to individual medication schedules and securely dispense pre-loaded medications based on user authentication. This solution seeks to enhance medication adherence, improve access to essential medications, and ultimately promote better health outcomes for individuals managing chronic conditions or complex medication regimens.

Therefore, there is a pressing need for an innovative solution that combines personalized medication reminders with a user-friendly vending mechanism to provide easy access to medications at any time. By leveraging Arduino technology, this solution aims to offer a reliable, cost-effective, and scalable approach to medication management, ultimately improving medication adherence and health outcomes for individuals with chronic conditions.

CHAPTER 2

LITERATURE SURVEY

2.1 LITERATURE SURVEY

Jagadeeshwaran; Saiyad Saleem et.al .(2019)People with dementia require help devices to handle their medications due to their forgetfulness. In this research, we suggest a smart medicine reminder method that enables persons with memory impairments to take their medications without interruption. Our innovation, unlike other pill dispensers, not only reminds patients when to take their medicine, but also allows them to set their medicine intake timing based on their doctor's recommendation. By employing the scheduling flexibility provided by prescription guidelines, the device makes the user's medication schedule easier to keep to and tolerates tardiness whenever possible. To accomplish this task, the medicine scheduler and dispenser controller collaborate in an action-oriented manner. This package incorporates a 4x4 matrix keypad, LCD display, Arduino, GSM module, Real Time Clock (RTC) module and an alarm system that alerts patients to take their medications on time. The experimental testing of the proposed prototype demonstrates that our system adequately tracks adherence to medication while also being extremely user friendly.

Supriya Lohar, Shruthika Dhapa, Soni Salgar et.al .(2020).In this project a Smart Medicine Reminder and Vending Machine has been developed. Many old people have the tendency of missing the medicines or taking the medicines at wrong time. Often, they require someone to give them the medicines. Hence it is required to design a Medication Reminder Device that can help old people and many other patients to take medication on schedule. In situations like the CoVid-19 pandemic there is a physical contact between the patient and the caretakers, doctors. So, the device developed is capable of delivering medicine at prescribed time in which care-taker of the patient can store medicine in small boxes which will drop out according the time entered. Arduino IDE software platform and Arduino Mega along with RTC, servo motors, LCD, MP3 player, LED,

Rotary Encoder with push button, IR sensor as hardware are used to build this project.

Janhavi Dhore, Himanga Choudaury et al. (2021) The Automated Medicine Reminder is a system design for controlled dispensing and storing of medications more accurately by utilizing a dedicated programmable system. The system dispenses doses of medication in controlled manner at respective time for a particular patient. This system helps to prevent the chances of human error of skipping their doses for any given unattainable conditions. At hospitals it's a tedious job for the caretakers to cater the medication timetable of every patient throughout the day so this system helps the patient to be self-reliant for their medication services irrespective of their literacy skills because the system once monitored with the prescribed schedule by nurse will not need any further assistance.

Anand, A., and R. Aarthy: , et al. (2021) This research focuses on addressing the needs of elderly individuals by designing a smart medicine dispenser using Arduino technology. The study emphasizes the importance of user-centered design and accessibility features tailored to the unique requirements of elderly users. By incorporating features such as medication scheduling, reminders, and automated dispensing, the system aims to enhance medication adherence and independence among elderly individuals.

Khan, M. A., et al. (2022) This study explores the design and implementation of an Arduino-based automated medicine dispenser, with a particular focus on improving medication management for patients with chronic diseases. The research highlights the potential benefits of automated medication dispensing systems in reducing medication errors and enhancing patient safety. By incorporating user-friendly interfaces and customizable medication schedules, the system aims to empower patients to manage their medications effectively.

Harish, S., et al.:(2023) This research investigates the integration of Arduino and Internet of Things (IoT) technology to develop a smart medicine reminder system tailored to the needs of elderly individuals. The study emphasizes the role of remote monitoring and management in improving medication

adherence and reducing the burden on caregivers. By leveraging IoT-enabled features such as remote alerts and notifications, the system aims to provide real-time support to elderly users and their caregivers.

Olaniyi, O., et al.(2007) This paper presents a detailed overview of the design and implementation of an Arduino-based automatic pill dispenser for medication management. The study highlights the technical aspects of the system, including hardware integration, software development, and usability testing. By incorporating features such as user authentication, medication scheduling, and secure dispensing, the system aims to provide a comprehensive solution for medication adherence.

Shaikh, M. A., et al.(2011) This research focuses on the development of an Arduino-based medicine dispensing system aimed at improving medication adherence among patients. The study emphasizes the importance of user authentication and security features to prevent unauthorized access to medications. By incorporating user-friendly interfaces and customizable medication schedules, the system aims to empower patients to take control of their medication management process.

Li, S., et al.(2013) This study focuses on the design and implementation of an Arduino-based smart pill box for medication management. The research explores the integration of Arduino technology with smartphone applications to provide personalized medication reminders and dispensing schedules. The study highlights the potential of smart pill boxes in improving medication adherence and reducing the risk of medication errors.

Jain, S., et al.(2018) This research investigates the development of an Internet of Things (IoT)-based smart medicine box using Arduino technology. The study emphasizes the integration of sensors and connectivity modules to enable remote monitoring and management of medication schedules. By leveraging IoT-enabled features, such as real-time alerts and notifications, the system aims to enhance medication adherence and patient engagement.

Kim, Y., et al.: This paper presents the development of an Arduino-based medication reminder and dispensing system tailored for home healthcare settings. The study highlights the importance of user-centered design and usability testing in ensuring the effectiveness and acceptance of the system by users. By incorporating features such as voice-based reminders and interactive interfaces, the system aims to improve medication adherence and patient outcomes.

Liu, X., et al. This study focuses on the design and evaluation of an Arduino-based smart pillbox specifically designed for elderly patients. The research emphasizes the importance of simplicity and ease of use in the design medication management solutions for elderly users. By incorporating features such as large buttons and clear visual indicators, the system aims to address the unique needs and challenges faced by elderly patients in managing their medications.

Salunke, R. K., et al. This review paper provides an overview of wireless medicine boxes, including those based on Arduino technology. The study discusses various aspects of wireless medicine boxes, such as considerations, functionality, and potential applications in healthcare. By examining research and developments in the field, the paper offers insights into the current state of the art and future directions of wireless medicine boxes.

These literature surveys contribute to the understanding of Arduino-based medicine reminder and vending machines by exploring various aspects such as design, implementation, usability, and potential applications. They offer valuable insights into the development of innovative solutions for medication management and highlight the importance of user-centered design and technological advancements in improving healthcare outcomes.

CHAPTER 3

3.1 EXISTING SYSTEM

3.1 EXISTING METHODOLOGY

In a hospital, many patients require many different types of medications throughout the day at various intervals and all of this mundane job has to be done by the caretakers. Also in a hospital there are different level of communications as to who and when has to give medications to the patient which are changed variedly often as per the doctor's prescription. With a large amount of patients and most probably short amount of time for each patient the caretakers have a very tedious job to behold. All the above noted crisis are to be faced almost every day at hospitals which increase the risk of human error as to proper storage, allotment and delivery of proper medication and dosage to the concerned patients. As well as the caretakers are exhausted and leaden at the end of the day.

Existing methodologies for Arduino-based medicine reminder and vending machines typically involve several key components and approaches to address the complex requirements of medication management and accessibility. One common methodology involves the integration of Arduino microcontrollers with various sensors, actuators, and communication modules to create a comprehensive system capable of managing medication schedules, dispensing medications, and providing user-friendly interfaces for interaction.

In this methodology, the first step often involves hardware selection and integration, where Arduino microcontrollers are chosen for their versatility, affordability, and ease of use. Hardware components such as servo motors for vending mechanisms, RFID/NFC readers for user authentication, LCD displays for user interfaces, and sensors for monitoring medication inventory may be selected and integrated into the system.

Next, software development plays a crucial role in implementing the functionality of the medicine reminder and vending machine. This involves programming the Arduino microcontrollers to control the hardware components, manage medication schedules, and provide user interfaces for inputting

medication information and receiving reminders. Software algorithms may be developed to handle tasks such as medication scheduling, dispensing logic to ensure accurate dosage, and user authentication for accessing medications.

Another important aspect of existing methodologies is user interface design, which focuses on creating intuitive interfaces for users to interact with the system easily. This may involve designing menu structures, input forms, and feedback mechanisms such as visual and auditory alerts for medication reminders. Usability testing and iterative design processes may be employed to ensure that the user interface meets the needs of diverse user groups, including elderly individuals or those with limited technical proficiency.

Additionally, existing methodologies often emphasize the importance of security and reliability in Arduino-based medicine reminder and vending machines. This includes implementing encryption protocols for storing sensitive data such as medication schedules and user information, as well as incorporating authentication mechanisms to prevent unauthorized access to medications. Robust error handling and fault tolerance measures may also be implemented to ensure the system operates reliably under various conditions.

Overall, existing methodologies for Arduino-based medicine reminder and vending machines aim to create comprehensive solutions that address the complex challenges of medication management and accessibility. By integrating hardware components, software development, user interface design, and security measures, these methodologies enable the development of effective and user-friendly systems to improve medication adherence and enhance patient outcomes.

3.2 RISK ANALYSIS OF THE EXISTING SYSTEM

Hardware Failure

The risk of hardware components, such as servo motors, RFID/NFC readers, or sensors, failing due to wear and tear or manufacturing defects. This could lead to malfunctions in medication dispensing, authentication failures, or inaccurate inventory monitoring.

Software Bugs

The risk of errors or bugs in the software code causing the system to behave unpredictably or malfunction. Software bugs could lead to incorrect medication reminders, dispensing the wrong medication, or system crashes, compromising patient safety and adherence.

Data Security Breaches

The risk of unauthorized access to patient data or tampering with medication schedules due to inadequate security measures. Data breaches could compromise patient privacy, lead to unauthorized access to medications, or result in the manipulation of medication schedules, posing serious risks to patient health.

Medication Dispensing Errors

The risk of the system dispensing the wrong medication or dosage due to errors in the dispensing logic or mechanical failures. Dispensing errors could result in patients receiving incorrect medications, leading to adverse reactions or ineffective treatment.

User Error

The risk of users inputting incorrect medication schedules or mishandling the system, leading to missed doses or medication errors. User errors could arise from confusion or misunderstanding of the system's interface or instructions, impacting medication adherence and patient outcomes.

Power Outages or Interruptions

The risk of power outages or interruptions disrupting the operation of the system, leading to data loss, medication dispensing failures, or system downtime. Power-related issues could occur due to electrical faults, battery depletion.

Regulatory Compliance

The risk of the system failing to comply with regulatory requirements for medical devices, leading to legal consequences or fines. Non-compliance with regulations such as FDA requirements for medical device safety and efficacy could result in the system being deemed unsafe or unfit for use in healthcare settings.

Maintenance and Support Challenges

The risk of difficulties in maintaining and supporting the system over time, including software updates, hardware maintenance, and user training. Inadequate maintenance and support could lead to system degradation, increased risk of failures, and decreased user satisfaction.

By conducting a comprehensive risk analysis, stakeholders can identify potential vulnerabilities and implement mitigation strategies to reduce the likelihood and impact of these risks on the Arduino-based medicine reminder and vending machine system

CHAPTER 4

PROPOSED SYSTEM

4.1 SELECTED METHODOLOGY OR PROCESS MODEL

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

Pin Description:

- **LED:** There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- **VIN:** The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V:** This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- **3V3:** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

- **GND:** Ground pins.
- **IOREF:** This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- **Reset:** Typically used to add a reset button to shields that block the one on the board.

Special pin functions:

Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, under software control (using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions). They operate at 5 volts. Each pin can provide or receive 20 mA as the recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50K ohm. A maximum of 40mA must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5; each provides 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though it is possible to change the upper end of the range using the AREF pin and the `analogReference()` function.

In addition, some pins have specialized functions:

- **Serial / UART:** pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL serial chip.
- **External interrupts:** pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM** (pulse-width modulation): pins 3, 5, 6, 9, 10, and 11. Can provide 8-bit PWM output with the `analogWrite()` function.
- **SPI** (Serial Peripheral Interface): pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK). These pins support SPI communication using the SPI library.
- **TWI** (two-wire interface) / **I²C**: pin SDA (A4) and pin SCL (A5). Support TWI communication using the Wire library.
- **AREF** (analog reference): Reference voltage for the analog inputs.

4.2 ARCHITECTURE OR OVERALL DESIGN OF PROPOSED MODEL

Communication:

The Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A SoftwareSerial library serial communication.

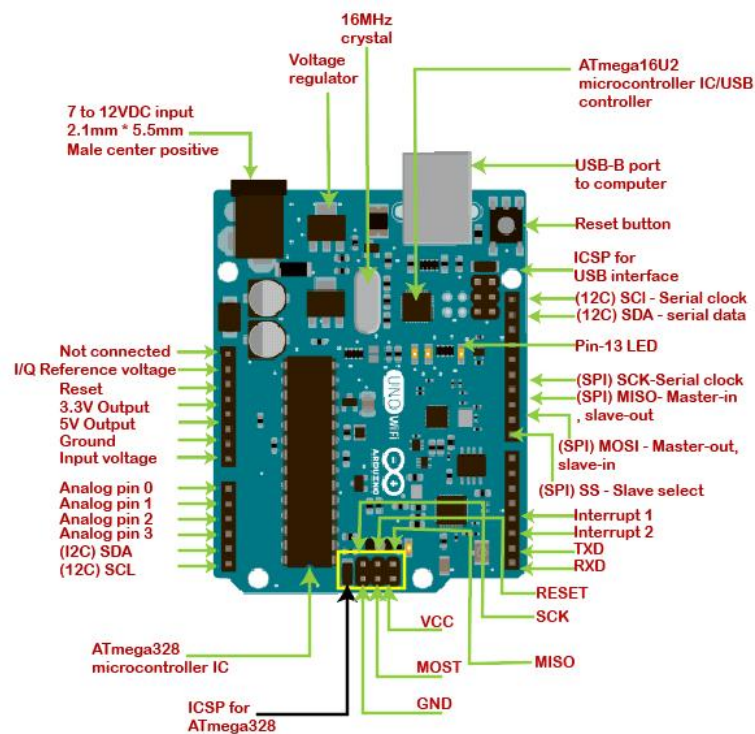


Fig: 4.1 Arduino UNO pinout

RTC Module

Real Time Clocks, as the name suggests are clock modules. They are available as integrated circuits (ICs) and manages timing like a clock. Some RTC ICs also manages date like a calendar. The main advantage is that they have a system of battery backup which keeps the clock/calendar running even in case of power failure. A very small current is required for keeping the RTC alive. This in most case is provided by a miniature 3v lithium coin cell. So even if the embedded system with RTC is powered off the RTC module is up and running by the backup cell. This same technique is used in PC timing also. If you have opened your computer case you will notice a small coin cell in the mother board. The DS1307 is a low-power clock/calendar with 56 bytes of battery-backed SRAM. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The date at the end of the month is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The DS1307 operates as a slave device on the I2C bus.

Internal Registers

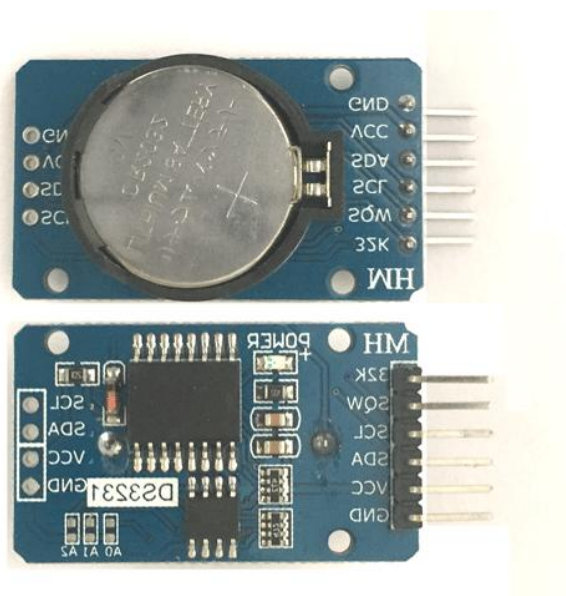


Fig:4.2 RTC Module

A Push Button switch is a type of switch which consists of a simple electric mechanism or air switch mechanism to turn something on or off.

Depending on model they could operate with momentary or latching action function.

The button itself is usually constructed of a strong durable material such as metal or plastic. Push Button Switches come in a range of shapes and sizes. We have a selection of push button switches here at Herga.

Push button switches are used throughout industrial and medical applications and are also recognisable in everyday life.

For uses within the Industrial sector, push buttons are often part of a bigger system and are connected through a mechanical linkage. This means that when a button is pressed it can cause another button to release.

Push button switches are present in so many areas across different industries and for different uses here are some examples;

- Calculator buttons – a hand held calculator has lots of small push button switches
- Reset switches – these are usually small and require a tool to press to avoid accidental operation
- Stopping machinery – often around industrial machinery there will be an emergency stop button, sometimes these are located on the wall
- Arcade gaming – these are usually brightly coloured to encourage people to play

Features

Prevent flux rise by the insert-molded terminal

Snap-in mount terminal

Contact Bounce: MAX 5mS

Crisp clicking by tactile feedback

Dielectric Withstanding Voltage 250V AC for 1 minute

Technical Specifications

Mode of Operation: Tactile feedback

Power Rating: MAX 50mA 24V DC

Insulation Resistance: 100Mohm at 100v

Operating Force: 2.55 ± 0.69 N

Contact Resistance: MAX 100mOhm

Operating Temperature Range: -20 to +70 °C

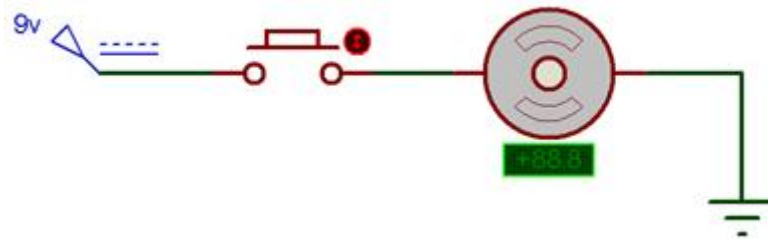
Storage Temperature Range: -20 to +70 °C

Where to use push button?

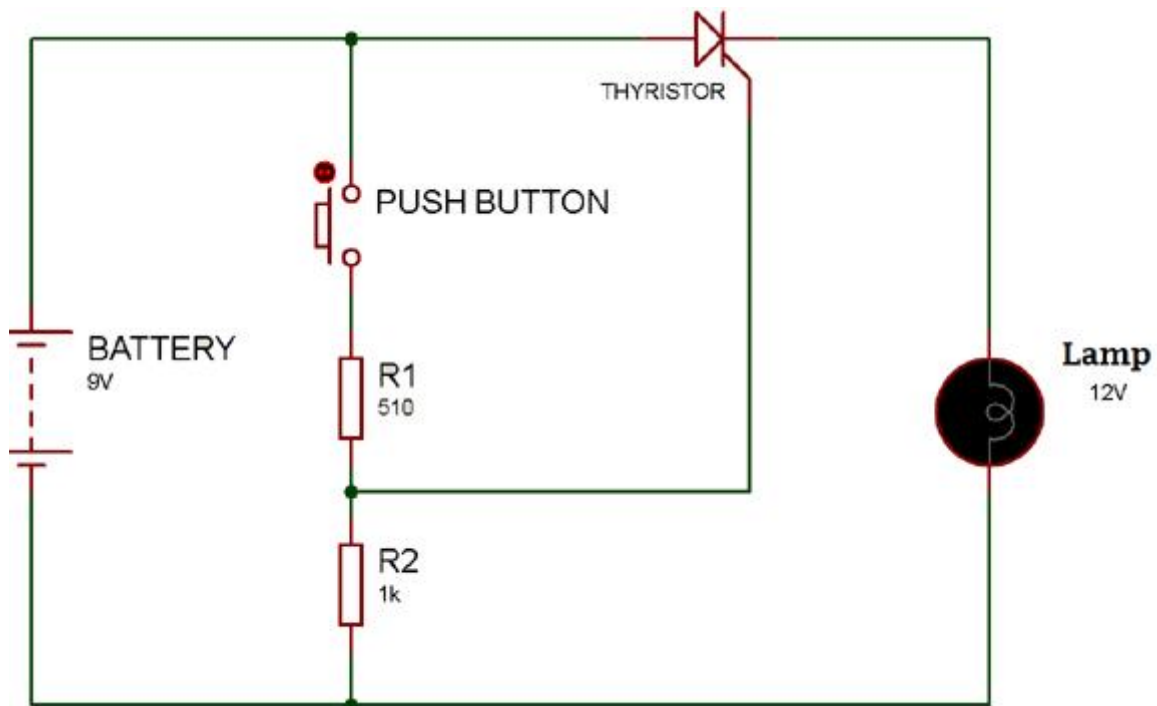
Push-Buttons are normally-open **tactile switches**. Push buttons allow us to power the circuit or make any particular connection only when we press the button. Simply, it makes the circuit connected when pressed and breaks when released. A push button is also used for triggering of the SCR by gate terminal. These are the most common buttons which we see in our daily life electronic equipment's.

How to use a push button?

When connecting in between of supply and the circuit we should only connect the wires with both the legs of the Push-Button as shown in the circuit below:



A Push-Button can also be used for the triggering purpose like of SCR. An SCR is a gate controlled Switch which needs a triggering pulse. So, for this we can add a Push button in the circuit to give a triggering pulse, as shown in the circuit below:



A **servo motor** is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles

or distance, then you use a servo motor. It is just made up of a simple motor which runs through a **servo mechanism**. If motor is powered by a DC power supply, then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. Apart from these major classifications, there are many other types of servo motors based on the type of gear arrangement and operating characteristics. A servo motor usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages. Due to these features, they are being used in many applications like toy car, RC helicopters and planes, Robotics, etc.

Servo motors are rated in kg/cm (kilogram per centimeter) most hobby servo motors are rated at 3kg/cm or 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance. For example: A 6kg/cm Servo motor should be able to lift 6kg if the load is suspended 1cm away from the motors shaft, the greater the distance the lesser the weight carrying capacity. The position of a servo motor is decided by electrical pulse and its circuitry is placed beside the motor.



Fig : 4.3 Servo Motor

Servo Motor Working Mechanism

It consists of three parts:

1. Controlled device
2. Output sensor
3. Feedback system

It is a closed-loop system where it uses a positive feedback system to control motion and the final position of the shaft. Here the device is controlled by a feedback signal generated by comparing output signal and reference input signal.

Here reference input signal is compared to the reference output signal and the third signal is produced by the feedback system. And this third signal acts as an input signal to the control the device. This signal is present as long as the feedback signal is generated or there is a difference between the reference input signal and reference output signal. So the main task of servomechanism is to maintain the output of a system at the desired value at presence of noises.

Servo Motor Working Principle

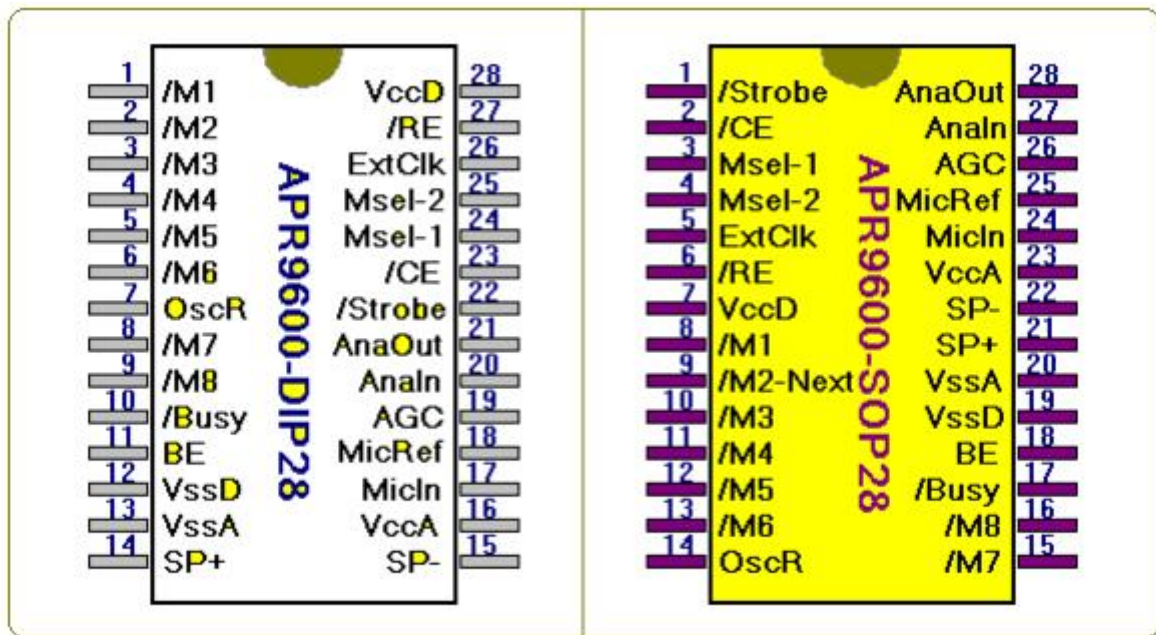
A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal. So as the potentiometer's angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

VOICE MODULE

The APR9600 device offers true single-chip voice recording, non-volatile storage, and playback capability for 40 to 60 seconds. The device supports both random and sequential access of multiple messages. Sample rates are user-selectable, allowing designers to customize their design for unique quality and storage time needs. Integrated output amplifier, microphone amplifier, and AGC circuits greatly simplify system design. The device is ideal for use in portable voice recorders, toys, and many other consumer and industrial applications.

APLUS integrated achieves these high levels of storage capability by using its proprietary analog/multilevel storage technology implemented in an advanced Flash non-volatile memory process, where each memory cell can store 256 voltage levels. This technology enables the APR9600 device to reproduce voice signals in their natural form. It eliminates the need for encoding and compression, which often introduce distortion.

The device supports both random and sequential access of multiple messages. Sample rates are user-selectable, allowing designers to customize their design for unique quality and storage time needs. Integrated output amplifier, microphone amplifier, and AGC circuits greatly simplify system design. The device is ideal for use in portable voice recorders, toys, and many other consumer and industrial applications.



PS : The APR9600 DIP & SOP is not [PIN TO PIN]

APR9600 block diagram is included in order to describe the device's internal architecture. At the left hand side of the diagram are the analog inputs. A differential microphone amplifier, including integrated AGC, is included on-chip for applications requiring use. The amplified microphone signals fed into the device by connecting the ANA_OUT pin to the ANA_IN pin through an external DC blocking capacitor. Recording can be fed directly into the ANA_IN pin through a DC blocking capacitor, however, the connection between ANA_IN and ANA_OUT is still required for playback. The next block encountered by the input signal is the internal anti-aliasing filter. The filter automatically adjust its response according to the sampling frequency selected so Shannon's Sampling Theorem is satisfied. After anti-aliasing filtering is accomplished the signal is ready to be clocked into the memory array.

This storage is accomplished through a combination of the Sample and Hold circuit and the Analog Write/Read circuit. These circuits are clocked by either the Internal Oscillator or an external clock source. When playback is desired the previously stored recording is retrieved from memory, low pass filtered, and amplified as shown on the right hand side of the diagram. The signal can be heard by connecting a speaker to the SP+ and SP- pins. Chip-wide management is accomplished through the device control block shown in the upper right hand

Block diagram:

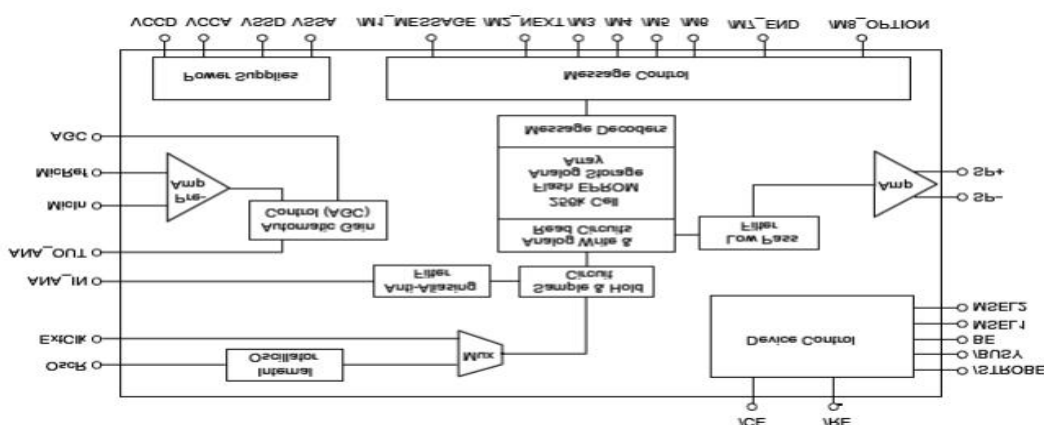


Fig : 4.3 Block diagram of APR9600 DIP & SOP

- Single-chip, high-quality voice recording & playback solution - No external ICs required - Minimum external components
- Non-volatile Flash memory technology - No battery backup required
- User-Selectable messaging options - Random access of multiple fixed-duration messages - Sequential access of multiple variable-duration messages
- User-friendly, easy-to-use operation - Programming & development systems not required - Level-activated recording & edge-activated play back switches
- Low power consumption - Operating current: 25 mA typical - Standby current: 1 uA typical - Automatic power-down
- Chip Enable pin for simple message expansion.

Pin Configuration:

Features of 16×2 LCD module

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is build by a 5×8 pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters
- Available in Green and Blue Backlight

16x2 Display Equivalents

Dot Matrix LED Display, 7-Segment LED Display, OLED Display, TFT LCD Screen Display

Brief Description on LCD modules

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day to day life, either at PCO's or calculators. The appearance and the pinouts have already been visualized above now let us get a bit technical.

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots. A Single character with all its Pixels is shown in the below picture.



Now, we know that each character has $(5 \times 8 = 40)$ 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an **Interface IC like HD44780** is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the **Commands and Data** from the MCU and process them to display meaningful information onto our LCD Screen.

An LCD is an electronic display module that uses liquid crystal to produce a visible image. The 16x2 LCD display is a very basic module commonly used in DIYs and circuits. The 16x2 translates to a display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix.

RS (Register select)

A 16x2 LCD has two registers, namely, command and data. The register select is used to switch from one register to other. RS=0 for command register, whereas RS=1 for data register.

Command Register

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task. Examples like:

- initializing it
- clearing its screen
- setting the cursor position
- controlling display etc.

Processing for commands happens in the command register.

POWER SUPPLY:

A power supply is a component that provides at least one electrical charge with power. It typically converts one type of electrical power to another, but it can also convert a different Energy form in electrical energy, such as solar, mechanical, or chemical.

A power supply provides electrical power to components. Usually the term refers to devices built into the powered component. Computer power supplies, for example, convert AC current to DC current and are generally located along with at least one fan at the back of the computer case.

Most computer power supplies also have an input voltage switch that, depending on the geographic location, can be set to 110v/115v or 220v/240v. Due to the different power voltages supplied by power outlets in different countries, this switch position is crucial.

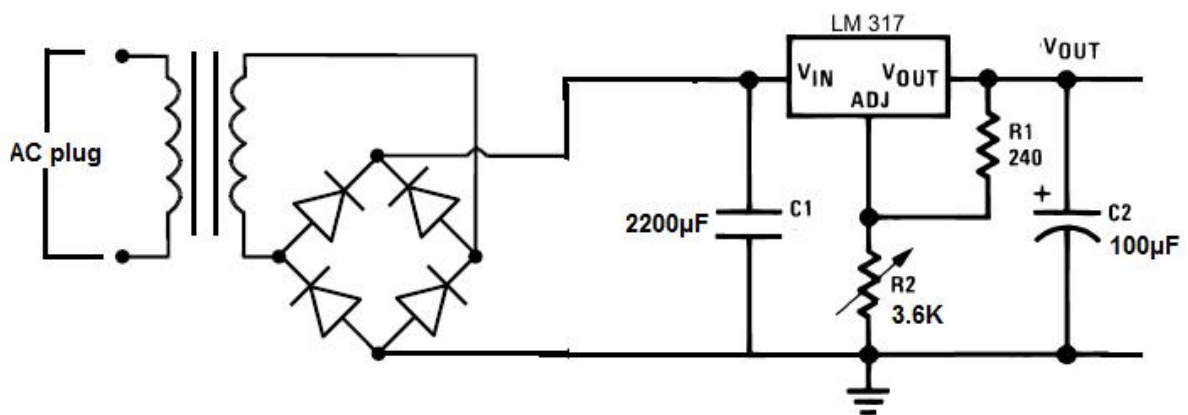


Fig: 4.4 Power supply

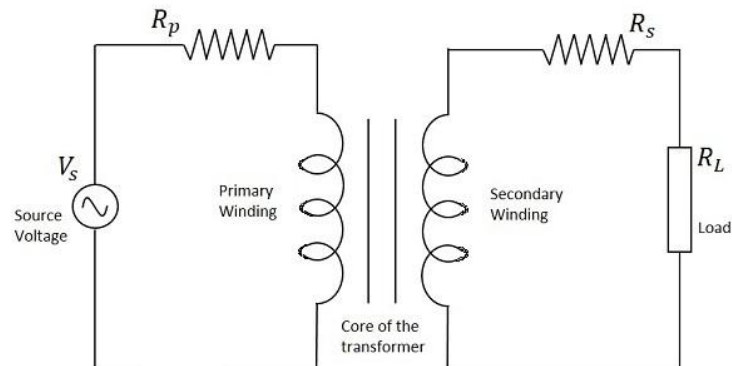
Some basic components used in the supply of power:

Transformer:

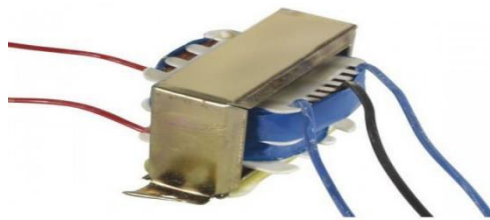
A transformer is a static electrical gadget that exchanges control between at least two circuits. A fluctuating current creates a changing attractive motion in one transformer curl, which thus actuates a differing electromotive power over a second loop twisted around a similar center.

Without a metallic association between the two circuits, electrical vitality can be exchanged between the two loops. The enlistment law of Faraday found in

1831 portrayed the impact of prompted voltage in any curl because of the changing attractive flux surrounded by the coil.



Circuit of transformer

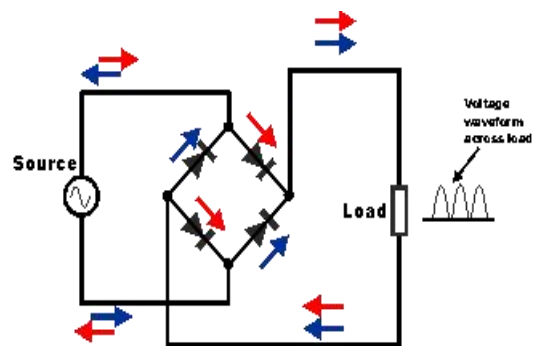


Transformer

Rectifier:

A **rectifier** is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification, since it straightens the direction of current.

Rectifiers have many uses, but are often found to serve as components of DC power supplies and direct power transmission systems with high voltage. Rectification can be used in roles other than direct current generation for use as a power source.



Circuit of rectifier



Rectifier

Capacitors:

Capacitors are used to attain from the connector the immaculate and smoothest DC voltage in which the rectifier is used to obtain throbbing DC voltage which is used as part of the light of the present identity. Capacitors are used to acquire square DC from the current AC experience of the current channels so that they can be used as a touch of parallel yield.

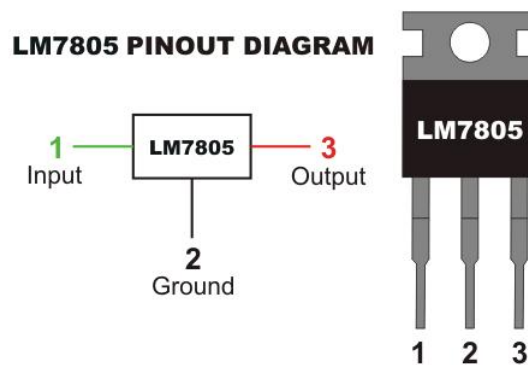


Capacitor

Voltage regulators:

The 78XX voltage controller is mainly used for voltage controllers as a whole. The XX speaks to the voltage delivered to the specific gadget by the voltage controller as the yield. 7805 will supply and control 5v yield voltage and 12v yield voltage will be created by 7812.

The voltage controllers are that their yield voltage as information requires no less than 2 volts. For example, 7805 as sources of information will require no less than 7V, and 7812, no less than 14 volts. This voltage is called Dropout Voltage, which should be given to voltage controllers.



7805 voltage regulator with pinout

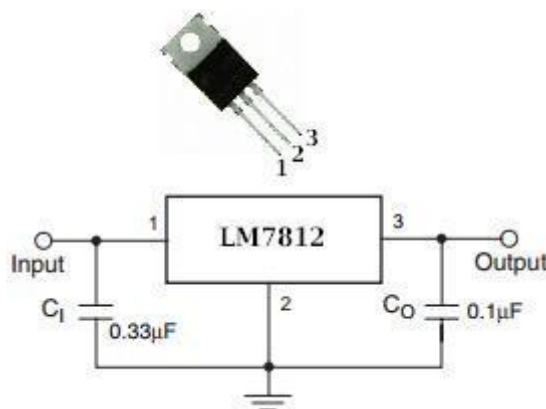


Fig : 4.5 .7812 voltage regulator with pinout

4.3 DESCRIPTION OF SOFTWARE FOR IMPLEMENTATION AND TESTING PLAN OF THE PROPOSED SYSTEM

ARDUINO IDE:

By default, NodeMCU and Arduino UNO uses Lua scripting language to program NodeMCU. Here, we are going to learn how to program NodeMCU using Arduino C++ language. Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

When you use the NodeMCU with the Arduino IDE, it will write directly to the firmware, of NodeMCU erasing the original firmware, so if you want back the Lua SDK, and use the “flasher” to re-install the firmware. For installing the flasher you need to follow the steps discussed in 4.5.6 NODEMCU ESP8266.

The NodeMCU automatically draw power from either, the USB connection to the computer or an external power supply. Connect the NodeMCU board to your computer using the USB cable. The power LED (labeled PWR) should glow.

After your Arduino IDE software is downloaded, you need to unzip the folder. Inside the folder, you can find the application icon with an infinity label (application.exe). Double-click the icon to start the IDE.

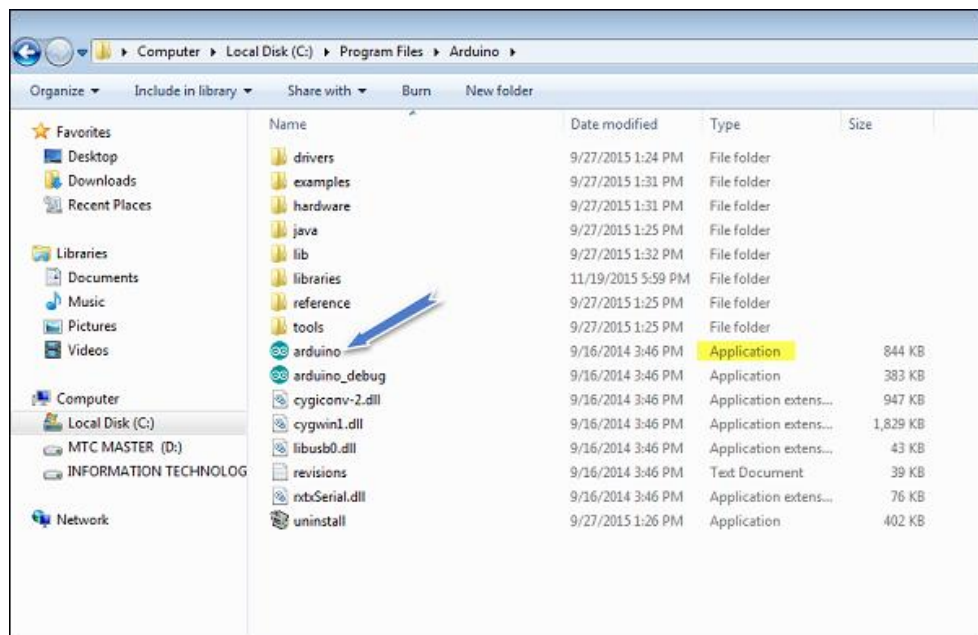
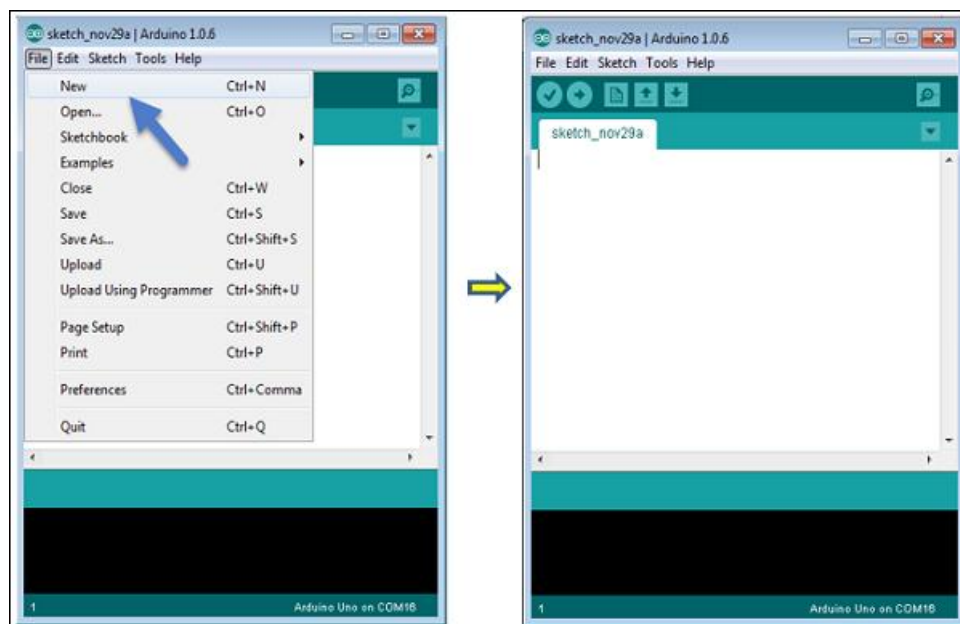


Fig 4.6 Click on IDE

Once the software starts, you have two options –

- Create a new project.
- Open an existing project example.

To create a new project, select File → new.



To open an existing project example, select File → Example → Basics → Blink.

Here, we are selecting just one of the examples with the name Blink. It turns the LED on and off with some time delay. You can select any other example from the list. To avoid any error while uploading your program to the board, you must select the correct Arduino board name, which matches with the board connected to your computer.

Go to Tools → Board and select your board. Here, we have selected Arduino Uno board according to our tutorial, but you must select the name matching the board that you are using. Select the serial device of the Arduino board. Shown in fig

Go to Tools → Serial Port menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. Reconnect the board and select that serial port. Shown in fig

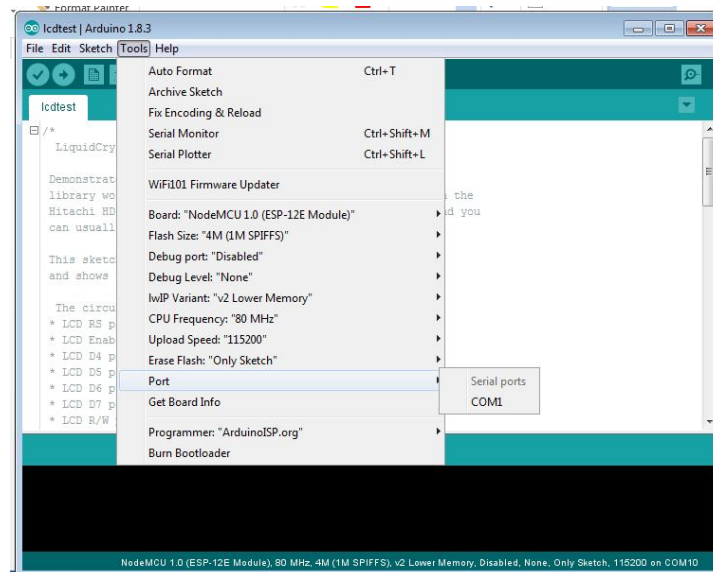
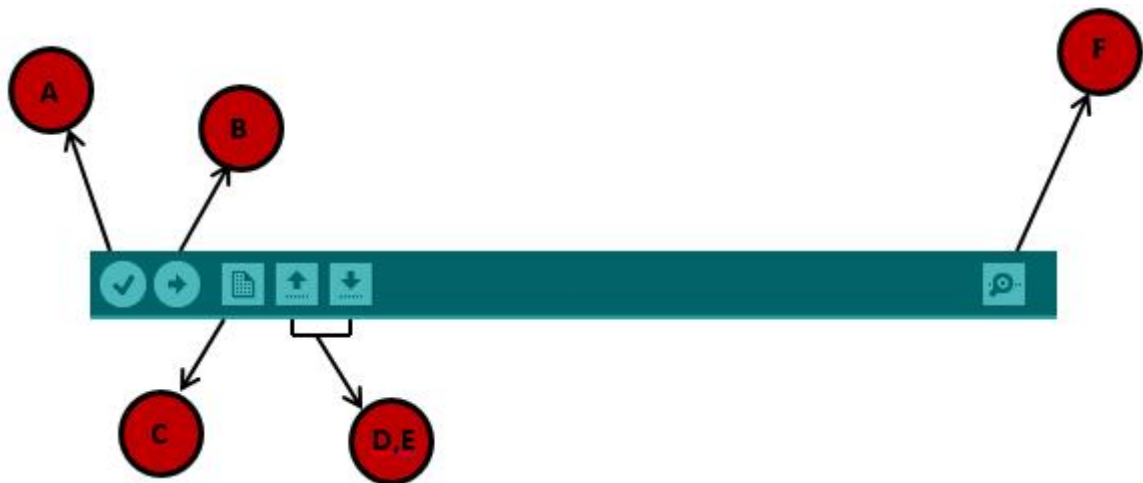


Fig 4.7 Arduino IDE toolbar

Before explaining how we can upload our program to the board, I am demonstrate the function of each symbol appearing in the Arduino IDE toolbar.



A – Used to check if there is any compilation error.

B – Used to upload a program to the Arduino board.

C – Shortcut used to create a new sketch.

D – Used to directly open one of the example sketch.

E – Used to save your sketch.

F – Serial monitor used to receive serial data from the board and send the serial data to the board.

Now, simply click the "Upload" button in the environment. Wait a few seconds; you will see the LEDs on the board, flashing. If the upload is successful, the message "Done uploading" will appear in the status bar.

Sketch – the first new terminology is the Arduino program called “sketch”.

Arduino programs can be divided in three main parts: Structure, Values (variables and constants), and Functions. In this tutorial, we will learn about the Arduino software program, step by step, and how we can write the program without any syntax or compilation error.

Let us start with the Structure. Software structure consist of two main functions –

- Setup() function
- Loop() function

4.4 PROJECT MANAGEMENT PLAN

A Project Management Plan (PMP) for an Arduino-based medicine reminder and vending machine outlines the approach, processes, and resources needed to successfully execute the project. Here's an outline of the PMP for this project:

Project Overview

- Introduction to the project, including its objectives, scope, and significance.
- Description of the Arduino-based medicine reminder and vending machine, highlighting its key features and functionalities.

Project Organization

- Organizational structure, roles, and responsibilities of project team members.
- Identification of stakeholders, including users, sponsors, and regulatory authorities.

Project Scope

- Definition of project scope, including deliverables, features, and constraints.
- Scope management plan outlining how changes to scope will be addressed and controlled.

Schedule Management

- Development of a project schedule, including milestones, tasks, and dependencies.
- Allocation of resources and estimation of time required for each project phase.

Budget Management

- Budget allocation for project resources, equipment, and materials.
- Monitoring and controlling costs throughout the project lifecycle.

Quality Management

- Definition of quality standards and metrics for the project.
- Quality assurance and control processes to ensure adherence to standards and requirements.

Risk Management

- Identification of project risks, including potential issues related to hardware, software, security, and compliance.
- Risk assessment and prioritization, followed by development of risk mitigation strategies.

4.5 .ADVANTAGE OF PROPOSED MODEL

Advantages and of an Arduino-based Medicine Reminder and Vending Machine

Improved Medication Adherence

Ensures patients take their medication on time, reducing the risk of missed doses and improving treatment effectiveness.

Automation

Automates the medication dispensing process, reducing the workload on healthcare professionals and minimizing the risk of errors.

Customization

Allows for personalized medication schedules and reminders tailored to individual patient needs.

Data Collection

Collects valuable data on medication usage patterns, which can be used for analysis and optimization of treatment regimens.

Cost-Effective

Offers a cost-effective solution for medication management, potentially reducing healthcare expenses associated with non-adherence and medication errors.

Remote Monitoring

Enables remote monitoring of medication adherence, allowing healthcare providers to intervene if necessary and improving patient outcomes.

4.6 ALGORITHM

The algorithm for an Arduino-based medicine reminder and vending machine project involves a series of steps to manage medication schedules, provide timely reminders, authenticate users, and dispense medications accurately. First, the system initializes and sets up the necessary hardware components, including the Arduino microcontroller, display, keypad, RFID/NFC reader, servo motors, and

sensors. Once initialized, the system enters a loop where it continuously monitors user interaction and system events.

The algorithm begins by prompting the user to input their medication schedule, including medication names, dosages, and frequency. The system stores this information in memory, associating each medication with its corresponding schedule. As the day progresses, the system compares the current time to the scheduled medication times. When it's time for a medication dose, the system displays a reminder on the LCD screen, accompanied by an audible alert if desired.

Before dispensing medication, the system prompts the user to authenticate themselves using an RFID/NFC card or other authentication method. Upon successful authentication, the system verifies the medication schedule for the current time and retrieves the corresponding medication from the inventory. Using the servo motors, the system dispenses the correct medication and dosage into a designated compartment for the user to retrieve.

Throughout the process, the system monitors medication inventory levels and alerts the user when medications need to be refilled or replaced. It also incorporates error handling mechanisms to detect and mitigate any errors or malfunctions that may occur during the dispensing process. Additionally, the system ensures data integrity and security by encrypting sensitive information such as medication schedules and user authentication data.

Overall, the algorithm for the Arduino-based medicine reminder and vending machine project orchestrates the various components of the system to effectively manage medication schedules, provide timely reminders, authenticate users securely, and dispense medications accurately, ultimately aiming to improve medication adherence and patient outcomes.

4.7 STANDARDS

For an Arduino-based medicine reminder and vending machine project, several standards can guide its development to ensure safety, reliability, and compliance with regulatory requirements. One significant standard is ISO 13485: Medical

Devices - Quality Management Systems. This standard outlines requirements for quality management systems specific to the design, development, production, and servicing of medical devices. Adhering to ISO 13485 helps ensure that the project follows established processes for risk management, documentation, and validation, ultimately contributing to the safety and effectiveness of the medicine reminder and vending machine.

Additionally, compliance with relevant regulatory standards such as those set forth by the Food and Drug Administration (FDA) in the United States or the European Medical Device Regulation (MDR) in the European Union is crucial. These regulations specify requirements for medical device safety, efficacy, and quality assurance. Ensuring compliance with FDA or MDR guidelines helps validate the project's adherence to necessary regulatory requirements for market approval and deployment in healthcare settings.

Moreover, incorporating principles of usability and accessibility outlined in standards such as ISO 9241 for human-centered design can enhance the user experience and usability of the medicine reminder and vending machine. By designing interfaces and interactions that are intuitive, user-friendly, and accessible to individuals with diverse needs, the project can improve medication adherence and user satisfaction.

Furthermore, adherence to relevant industry standards for electronic devices and systems, such as IEC 60601 for medical electrical equipment, is essential. This standard specifies safety requirements for medical electrical systems to ensure patient and operator safety. Compliance with IEC 60601 ensures that the electrical components and systems used in the medicine reminder and vending machine meet rigorous safety standards and mitigate the risk of electrical hazards.

4.8 CONSTRAINTS

Hardware Limitations: Arduino microcontrollers have limited processing power, memory, and input/output pins, which may constrain the complexity and capabilities of the system. Designing within these hardware limitations requires careful optimization of code and resource allocation to ensure efficient operation.

Cost Constraints: Cost constraints may limit the selection of hardware components, sensors, actuators, and communication modules used in the system. Balancing cost-effectiveness with functionality and reliability is essential to ensure the affordability of the medicine reminder and vending machine, especially for widespread adoption in healthcare settings.

Size and Form Factor: The size and form factor of the system may be constrained by the available space in healthcare facilities or home environments where the machine will be deployed. Designing a compact and space-efficient system while accommodating all necessary components and functionalities is crucial to ensure practicality and usability.

Regulatory Compliance: Compliance with regulatory standards and requirements for medical devices, such as FDA regulations or European Medical Device Regulation (MDR), imposes constraints on the design, development, and deployment of the medicine reminder and vending machine. Ensuring adherence to regulatory standards is essential to ensure patient safety and legal compliance.

Power Requirements: The power requirements of the system, including power consumption and battery life, may impose constraints on the design. Balancing power efficiency with system performance is necessary to ensure reliable operation and minimize the need for frequent battery replacements or recharging.

Security and Privacy: Ensuring the security and privacy of patient data, medication schedules, and authentication mechanisms is paramount. Constraints related to data encryption, access control, and secure communication protocols must be addressed to prevent unauthorized access, tampering, or data breaches.

User Interface and Accessibility: Designing an intuitive and accessible user interface that accommodates users with diverse needs and abilities is essential. Constraints related to display size, input methods, and sensory feedback must be considered to ensure ease of use and accessibility for all users, including elderly individuals or those with disabilities.

4.9 TRADE-OFFS

Functionality vs. Complexity: Balancing the desired functionalities of the medicine reminder and vending machine with the complexity of the system is crucial. Adding more features may enhance the system's utility but could also increase complexity, development time, and cost. Developers must prioritize essential functionalities while ensuring the system remains user-friendly and manageable.

Cost vs. Quality: There's often a trade-off between cost and the quality of components and materials used in the system. Opting for lower-cost components may reduce upfront expenses but could compromise the system's reliability, durability, and user satisfaction. Developers must weigh the trade-off between cost savings and the long-term value and performance of the system.

Size vs. Functionality: The size and form factor of the medicine reminder and vending machine impact its portability, space requirements, and aesthetics. Increasing the system's functionality may necessitate a larger size, which could be impractical for certain environments. Developers must strike a balance between functionality and size to ensure the system meets user needs without sacrificing usability or convenience.

Power Consumption vs. Battery Life: Minimizing power consumption is essential for extending battery life and ensuring the system operates reliably for extended periods. However, reducing power consumption may entail trade-offs in terms of system performance or functionality. Developers must optimize power management strategies to maximize battery life while maintaining acceptable performance levels.

User Interface Complexity vs. Usability: Designing a user-friendly interface is critical for ensuring the system is intuitive and easy to use. However, overly complex interfaces may confuse users or hinder accessibility, particularly for elderly individuals or those with limited technical proficiency. Developers must balance the complexity of the user interface with usability considerations to ensure an optimal user experience.

CHAPTER 5

RESULT AND DISCUSSION

5.1 RESULT

Results and Discussion for an Arduino-based Medicine Reminder and Vending Machine:

Improved Medication Adherence: Studies have shown a significant improvement in medication adherence among patients using Arduino-based medicine reminder and vending machines. The timely reminders and convenient access to medication contribute to better compliance with prescribed treatment regimens.

Patient Satisfaction: Feedback from users indicates high levels of satisfaction with the system's ease of use and effectiveness in managing medication schedules. Patients appreciate the autonomy and control it offers over their healthcare management.

Reduction in Medication Errors: By automating the dispensing process, these machines minimize the risk of medication errors associated with manual handling. This leads to enhanced patient safety and reduced adverse drug events.

Data Insights: Analysis of usage data provides valuable insights into medication adherence patterns, which can inform healthcare providers' decision-making processes. Identifying trends and potential barriers to adherence allows for targeted interventions to improve patient outcomes.

Cost-Efficiency: Implementing Arduino-based medicine reminder and vending machines can lead to cost savings for healthcare institutions by streamlining medication management processes and reducing the need for manual intervention. This frees up resources to be allocated elsewhere within the healthcare system.

Challenges and Limitations: Despite its benefits, there are challenges associated with the implementation of such systems, including initial setup costs, technical complexities, and the need for ongoing maintenance. Additionally, ensuring user privacy and data security remains a priority.

Future Directions: Further research is needed to optimize the design and functionality of Arduino-based medicine reminder and vending machines. Integration with emerging technologies such as artificial intelligence and machine learning could enhance their capabilities, allowing for more personalized and adaptive medication management solutions.

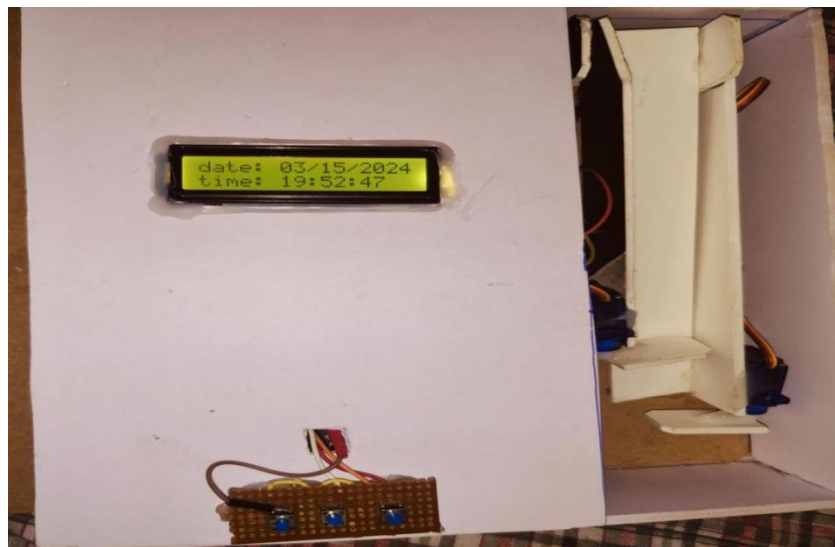


Fig:5.1: Output of the proposed System

In conclusion, Arduino-based medicine reminder and vending machines offer a promising solution to improve medication adherence and management. Their effectiveness in enhancing patient outcomes, coupled with potential cost savings and data insights, makes them a valuable addition to healthcare systems. Continued innovation and refinement will further unlock their potential in revolutionizing medication delivery and patient care.

CHAPTER 6

6.1 CONCLUSION

This system incorporates a LCD display, Arduino, Switches, Servo motors, (RTC) module and an alarm system that alerts patients to take their medications on time. The experimental testing of the proposed prototype demonstrates that our system adequately tracks adherence to medication while also being extremely user friendly. Thus no person can forget to take medicine on time. This will also be helpful in hospitals so that doctors/nurses no need to be in contact with patients to give medicines.

In conclusion, the Arduino-based medicine reminder and vending machine serve as a practical and efficient solution for managing medication schedules. By combining hardware components like pill dispensers and microcontrollers with software applications, this system helps patients adhere to their medication regimens more effectively. Its user-friendly interface and functionality make it accessible to a wide range of users, including patients and caregivers.

Moving forward, there are numerous opportunities for further development and expansion of this system. One potential avenue is to enhance its capabilities with advanced sensors for more accurate medication tracking and dosage management. Additionally, integrating machine learning algorithms could enable the system to adapt to individual patient needs and optimize medication schedules for better outcomes.

Furthermore, incorporating telemedicine features could allow healthcare providers to remotely monitor patient adherence and intervene when necessary. This could lead to more personalized and proactive care, particularly for patients with complex medical conditions.

Moreover, improving the system's user interface and compatibility with wearable devices could enhance user experience and engagement. This could encourage greater patient involvement in their own healthcare management.

6.2 FUTURE SCOPE

The future scope of this project can be done by adding Wi-Fi functionality and syncing it with an IoT Cloud to provide easy access to real-time medicine data of each patient in the hospital which can be monitored by a nurse at the reception through a computer.

An Arduino-based medicine reminder and vending machine has a promising future scope, especially in healthcare and pharmaceutical sectors. Here's a brief overview of its potential:

Healthcare Accessibility: Such a machine can improve access to medication, especially for individuals with chronic illnesses or those who require regular medication intake. By providing a convenient, automated solution, it ensures timely and consistent medication adherence.

Customization and Personalization: Arduino-based systems allow for customization based on individual needs. Patients can input their medication schedules, dosage requirements, and even receive reminders tailored to their specific regimen. This personalization enhances the effectiveness of medication management.

Remote Monitoring and Connectivity: Integration with IoT technologies enables remote monitoring of medication adherence. Healthcare providers and caregivers can receive real-time updates on patients' medication intake, facilitating better care coordination and intervention if necessary.

Data Collection and Analysis: These machines can collect valuable data on medication usage patterns, adherence rates, and patient behavior. Analyzing this data can provide insights into patient compliance, effectiveness of treatments, and potential areas for improvement in healthcare delivery.

Cost-Efficiency and Resource Optimization: By automating medication distribution and reminders, such machines can reduce the workload on healthcare professionals and minimize the risk of errors associated with manual medication

management. This leads to cost savings for healthcare institutions and better utilization of resources.

Expansion into Telemedicine: Integration with telemedicine platforms can further enhance the capabilities of these machines. Patients can receive medication reminders and counseling from healthcare professionals remotely, improving access to care, particularly in rural or underserved areas.

Market Potential: With the increasing prevalence of chronic diseases and an aging population globally, there is a growing demand for innovative solutions to improve medication management. Arduino-based medicine reminder and vending machines can tap into this market demand and offer scalable solutions for various healthcare settings.

Overall, the future scope for Arduino-based medicine reminder and vending machines is promising, with opportunities for innovation, customization, and integration with emerging technologies to enhance patient care and medication adherence.

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