Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An Autonomous institution, Aided by Govt. of Karnataka)

Near Jnana Bharathi Campus, Malathahalli, Bengaluru – 560056

Mini Project Report

On

"DESIGN AND DEVELOPMENT OF SYRINGE INFUSION PUMP"

SUBMITTED BY

ABHISHEK CHAKRABORTY [1DA19ML001]

APSARA C [1DA19ML004]

HARSHITHA S [1DA19ML010]

RUCHITA LINGARAJU [1DA19ML015]

Under the Guidance

Of

KAMALA C

ASSISTANT PROFESSOR

Dept. of ML

Dr.A.I.T

DEPARTMENT OF MEDICAL ELECTRONICS

2019-2023

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An Autonomous institution, Aided by Govt. of Karnataka)

Aided By Govt. of Karnataka

CERTIFICATE

This is to certify that the mini project **[18MLM68]** work entitled **"DESIGN AND DEVELOPMENT OF SYRINGE INFUSION PUMP"** is bonified work carried out by **ABHISHEK CHAKRABORTY [1DA19ML001], APSARA C [1DA19ML004], HARSHITHA S [1DA19ML010], RUCHITA LINGARAJU [1DA19ML015],** in 6th Semester 2022, Medical Electronics Engineering in **Dr. Ambedkar Institute of Technology**. This is to certify that all corrections and suggestions indicated for internal assessment have been incorporated in the report deposited in the department library. The mini-project report has been approved as it satisfies the academic requirement in report of mini-project work prescribed for Bachelor of Engineering Degree.

SIGNTURE OF GUIDE

KAMALA C

Assistant Professor

Dept. of ML

SIGNATURE OF HOD

Dr. K J SHANTHI

Prof. & Head

Dept. of ML

SIGNATURE OF PRINCIPAL

Dr. M. MEENKASHI

Principal, Dr.AIT

External Viva

Name of the examiners:

1.

2.

ACKNOWLEDGEMENT

The satisfaction that accompanies this project would be incomplete without the mention of the people who made it possible, without whose constant guidance and encouragement would have made our efforts go in vain.

We consider ourselves privileged to express our gratitude and respect towards all those who guided us through the MINI PROJECT **"DESIGN AND DEVELOPMENT OF SYRINGE INFUSION PUMP".**

We would like to express our gratitude to **Dr. M Meenakshi, Principal, Dr.AIT,** for providing us the congenial environment to work in.

We would like to express our profuse gratitude to **Dr. K J SHANTHI, HOD, Dept. of MEDICAL ELECTRONICS, Dr.AIT,** for giving us the support, encouragement and providing us the required lab facilities that was necessary for the completion of this project.

As a token of gratitude, we would like to acknowledge our sincere gratefulness to the internal guide **Mrs. KAMALA C, Assistant Professor, Dept. of MEDICAL ELECTRONICS, Dr.AIT,** for her unlimited support and encouragement provided throughout the process.

We also express our gratitude and sincere thanks to all teaching and non-teaching staff of **MEDICAL ELECTRONICS**.

Finally, yet importantly, we would like to express our heartfelt thanks to our beloved **Parents** for the blessings and our **Friends** for their help and wishes for the successful completion of this project report.

ABHISHEK CHAKRABORTY [1DA19ML001]

APSARA C [1DA19ML004]

HARSHITHA S [1DA19ML010]

RUCHITA LINGARAJU [1DA19ML015]

ABSTRACT

A syringe pump is a precision-based pumping device that can be mounted with one or more syringes for high precision delivery of fluids. Syringe pumps are widely used in medical sector to provide a small but accurate number of medications. This is done using precision motorized systems to drive syringe pistons and achieve desired dosages. Syringe pump settings are used to set the dosage in ml for the required fluids to be delivered to patient as per doctor instructions. Syringe pumps are usually mounted on side tables or IV poles for usage. The settings on a syringe pump may include direction of flow, flow rate of fluid, time period for which the delivery is to be done. This ensures delivery of the fluid in desired amounts so as to achieve desired dosages.

We here propose to build a syringe infusion pump that can be monitored as well as controlled via doctors or nurses. This syringe pump allows the doctor to set, modify the flow, stop the infusion of pump as per patient response. The system makes use of a microcontroller board, Arduino, to handle the entire processing system. We here use an LCD display to display settings and other parameters. The machine consists of a syringe mounting to hold the syringe in place as well as press the plunder gradually as per set requirements. The device settings include adjustment the direction flow, the flow rate, the syringe brand and size, total dosage to be delivered and so on. Once settings are fed by user the machine calculates the push rate of plunger. Based on this the motor operates with accuracy to ensure the delivery of fluid gradually at set flow rate till it delivers the desired amount of fluid and stops automatically to signal the successful delivery of set dosage.

CONTENTS

FIGURE AND TABLE CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Introduction:

Syringe injection pumps for therapeutic or diagnostic purposes are used for the slow injection of drugs. These devices are also used for injection of blood components, such as plasma. The syringe injection pump consists of a fluid bag and a clamp or a hook that is hung at the top of the pump with a tube connected. Inside the pump, the tube, which is filled with fluid, is fixed on some small gears and a roller. When the roller rotates and the gears move, the fluid transfers from the tube to the patient. The user adjusts the fluid flow and required volume through the device, so the gears and roller move based on the adjusted speed. Every time the required volume of fluid is released, the fluid flow stops. The syringe injection pump monitors the fluid pressure rate, resulting in fluid pressure control, which avoids excessive injection pressure on the patient's vein and possible pain at the injection site. Thus, the speed and accuracy of injection of a given amount of drug at a predetermined time, without using human resources, as well as the health of intensive care patients, were found to be important. The plastic syringe containing fluid is placed in a holder, a tube and the holder are set with a needle or cannula and both are connected to the patient's vein or directly to the stomach. When the rate of the fluid flow was indicated, the pump placed pressure on the syringe plunger to push fluid into the injection site. The rate of injection (plunger movement) depends on the syringe diameter and the adjusted flow rate of the pump. High or even low injection dosages of a specific drug can be dangerous for patients. Plastic syringes manufactured by different companies are not identical; therefore, pumps are adjustable to work with different syringe models. All types of usable syringes are specified by labels on the device. Substantial errors in flow rate changes and fluid volume are observed when unauthorized syringes are used. Using syringe injection pumps controls injected fluid pressure and avoids damaging the patient's vein due to excessive injection pressure. The measurement units are millilitres per hour (mL/h), and typical values are 0-250 mL per hour.

The first attempt at manufacturing an intravenous therapy device was conducted in 1492. Then, this branch of medical sciences progressed slowly, until the first injection device was produced by Christopher Ren in 1658. Then, many experiments were performed using this syringe, and better syringes were developed. These experiments led to patient death, and syringe production

was stopped for a while. When the production ban was lifted, the first samples of adjustable pumps for controlled drug injection into veins were made. In the 20th century, empty bottles were used instead of plastic bags, which reduced the blood flow in contact with air. Major developments occurred in 1970, when Dean Came invented the first ambulatory injection pump. This pump was connected to the patient for treatment while the patient was being moved. This device helped diabetic patients who needed injections at appropriate times. These pumps also released a certain quantity of a drug over a certain length of time. The injection pumps developed during this time period have manual and electronic records for the alarms. These pumps will also alarm if they become stuck during an injection. To avoid drug errors for high-alert medications, smart pumps are used in intensive care units. Foreign injection pumps are portable devices that continuously inject drugs into patients. These pumps are the size of a cassette player and are attached around the patient's waist. These devices are powered by batteries. Drug delivery pathways for these pumps are intravenous, subcutaneous, epidural, internal and in the spinal cord. This device is used for morphine injection and other strong painkillers to control intensive pain and chronic cancers.

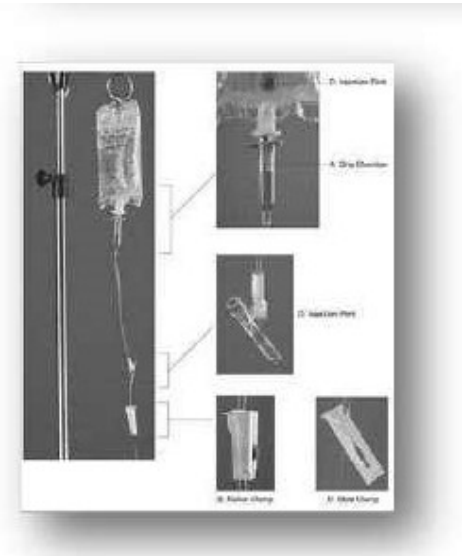

Fig1.1: Typical drug delivery system

Annually, the Medicinal and Health Regulatory Agency (MHRA) reports safety incidents related to injection devices. After ten years of investigating such incidents, showed that in more than 50% of incidents, there is no device error, and user error accounts for 19% of incidents. Several studies have investigated continuous injection of drugs for treatment of radiolopsey. Anaesthesia trials by drug injection via the epidural catheter and via bolus injection only for

neck radiocolopsey were conducted. These studies showed that the epidural catheter is more efficient than injection alone also studied radiocolopsey by epidural catheter and injection pump. They found that the injection pump is more efficient than a catheter system. They found that complications in the syringe pump were not significant studied a continuous epidural block with steroids and anaesthesia connected by an infuser to the epidural catheter. They also found no significant complication in this method. An injection pump was used for continuous or alternate injection of a drug, and the injection pathways included intravenous, subcutaneous, epidural, and spinal cord pathways. These pumps have been placed in an infraclavicular block and a catheter to the desired position. Catheter position and spinal cord pathways are used for spinal cord injuries. Drug transmission includes the circular motion mechanism, osmotic pressure, combination of the osmotic pressure with an oscillating piston and layer fluoride fuel.

1.2 Purpose of Design:

The design for this product is geared to produce a device that can act as an automatic medication pusher. Without constant presence of doctors or nurses for injecting the medicine into patients, medicine can itself be pressed in the human body just by typing the amount using the keypad. The medication will be put in an exact amount without any error.

1.3 Application of Syringe Infusion Pump:

The application of automated drug delivery continues to grow, such as the delivery of heparin for chronic anticoagulation, cytostatic drug infusion for cancer chemotherapy, morphine delivery for pain control, insulin infusion for diabetes, hypertension control, intractable pain control, drug and alcohol antagonist, delivery chronic hormone supplement, and anti-arrhythmia control. In addition, it is used to inject the radio-opaque contrast media into the body to enhance the visibility of tissues for a medical imaging procedure for CT scan, MRI, PET, Cardiovascular/Angiography fluoroscopy and Ultrasound image. For meeting the exacting requirements of these applications in term of flow rate of the fluids in safe and effective manner, the pumps are becoming smaller and smarter. The use of microprocessor technology has allowed the systems to provide performance and functionality that were unattainable only several years ago and most new systems are designed for easy addition of new features through simple software improvement.

CHAPTER 2

LITERATURE SURVEY

A recent study, which has been published in August 2019, "Evaluation of a novel flow-controlled syringe infusion pump for precise and continuous drug delivery at low flow rates: a laboratory study" has some commons with our work in this paper among the use of a flow sensor to control the drug delivery. However, our work goes in-depth to address all the safety issues related to intelligent syringe infusion pumps, since the safety of intelligent syringe pumps includes other issues such as an electrical safety, an infection control safety as well as a cyber security safety.

Moreover, and as mentioned before, an LD20 flow sensor provides more capabilities by comparison to other commercial flow sensors among the ability to detect a patient's heartbeat, and consequently providing a monitoring capability of patient's physiological parameters.
The above-mentioned paper is the only published work, which has similarities in relation to our work.

[1] Erin Quattromani et.al, made a study to determine whether the smart pump app will be effective and engaging education tool for junior nursing students when compared with the traditional methods. Students assessed the application based on their knowledge and performance for learning infusion pumps users. Since, there was no difference they rated the app as an education tool.

[2] C. Luca, D.Andritoi et.al., have discussed about the techniques based on wireless to reduce the electromagnetic interference and conducted some tests to identify the source of equipment that disrupts the operation of diffusion pumps and concluded that changes gets disappear with the removal of source of equipment that causes disruption and promote awareness of EMI.

[3] Paul Pankhurst and Zahra McGuiness Abdollahi have developed a new portable micro-pump which solves the defects of current pumps. It is user-friendly and cost efficient. It has very high performance, accuracy and small erring size which can be used in wider medical applications. It provides controlled dosing and timing in drug delivery.

[4] XialiHei, Xiaojiang Du, Shan Lin et.al, have personalized a patient infusion pattern (PIP) for wireless insulin pumps. It detects the dosage amount, rate, and time of infusion, and prevents the lives of people from being given overdosed. It prevents from the attack. They concluded the performance was good and can also be generalized to other infusion systems.

[5] J. P. Silva, B. A. Rodrigues, J. C. S. Casado, and S. S. R. F. Rosa tried to obtain the output they have done the mathematical modeling process of Systolic and Diastolic Blood Pressures for controlling the blood pressure of the patient. Specifications of the infusion pump and the mathematical model did not diverge. Infusion pump can also be interface with devices like biosensors or applications.

[6] Pooja Rajendra Prasad et.al, have designed a secure software for infusion pump on considering the security. It is controlled by including security with the design of the Wireless infusion pump software. It gives the information when there is lack of security. But the network is not secured.

[7] Luiz E. G. Martins, Hanniere de Faria et.al, have planned to develop a low-cost insulin infusion pump for the treatment of diabetes, since the existing pumps are not at a reasonable cost. It has some drawbacks as not accuracy, non-reliability and some parameters. It is useful for blood glucose and overcome the risk factors of diabetics.

[8] M. Deepalakshmi and Dr. R. Jayaparvathy have proposed small size and cost-efficient integrated infusion pump system which is not available at low cost so far in the Indian market. It keeps the blood glucose at the limited range and provides the correct dosage of insulin. They concluded that, continuous monitoring is essential which may be considered as a drawback of this system.

CHAPTER 3

DESIGN AND IMPLEMENTATION

3.1 Circuit Diagram:

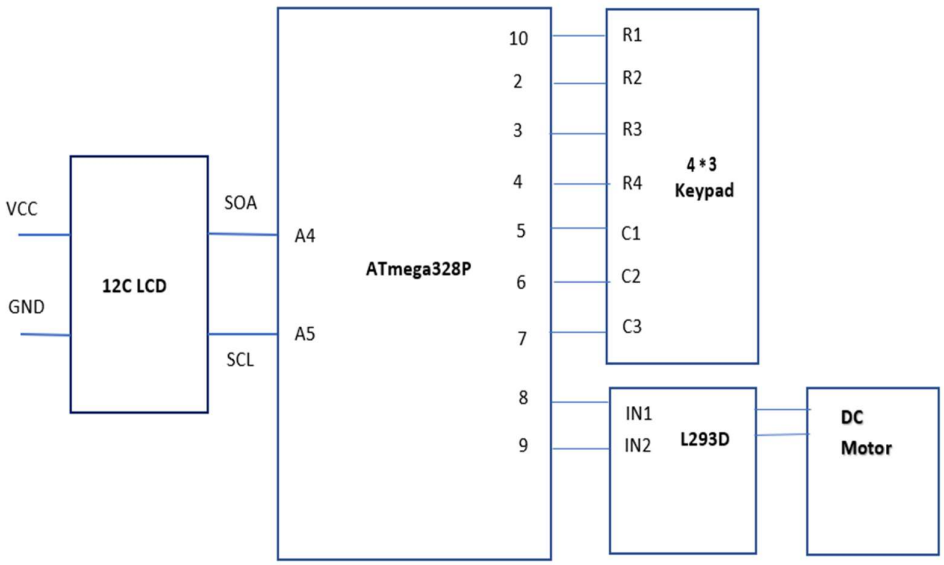

Fig3.1: Circuit diagram of the project

3.2 Working Principle:

- 12V adapter is connected to the electrical socket and the circuit.
- Arduino is connected with the laptop.
- When switched ON, 256V from the socket will be taken by the adapter, which will transfer it to DC voltage of 12V and will send to the circuit driver.
- Will wire L293D motor driver IC with Arduino Uno.
- Connect Vcc1 pin to 5V output on Arduino.
- Now, the input and enable pins (ENA, IN1, IN2, IN3, IN4 and ENB) of the L293D IC are connected to six Arduino digital output pins (9, 8, 7, 5, 4 and 3). Note that the Arduino output pins 9 and 3 are both PWM-enabled.
- Hooking up an Arduino Uno to an I2C LCD display

- We need to connect 4 pins instead of 12. Start by connecting Vin pin to the 5V output on the Arduino and connect GND to ground.

- On the Arduino boards with the R3 layout, the SDA (data line) and SCL (clock line) are on the pin headers close to the AREF pin. They are also known as A5 (SCL) and A4 (SDA).

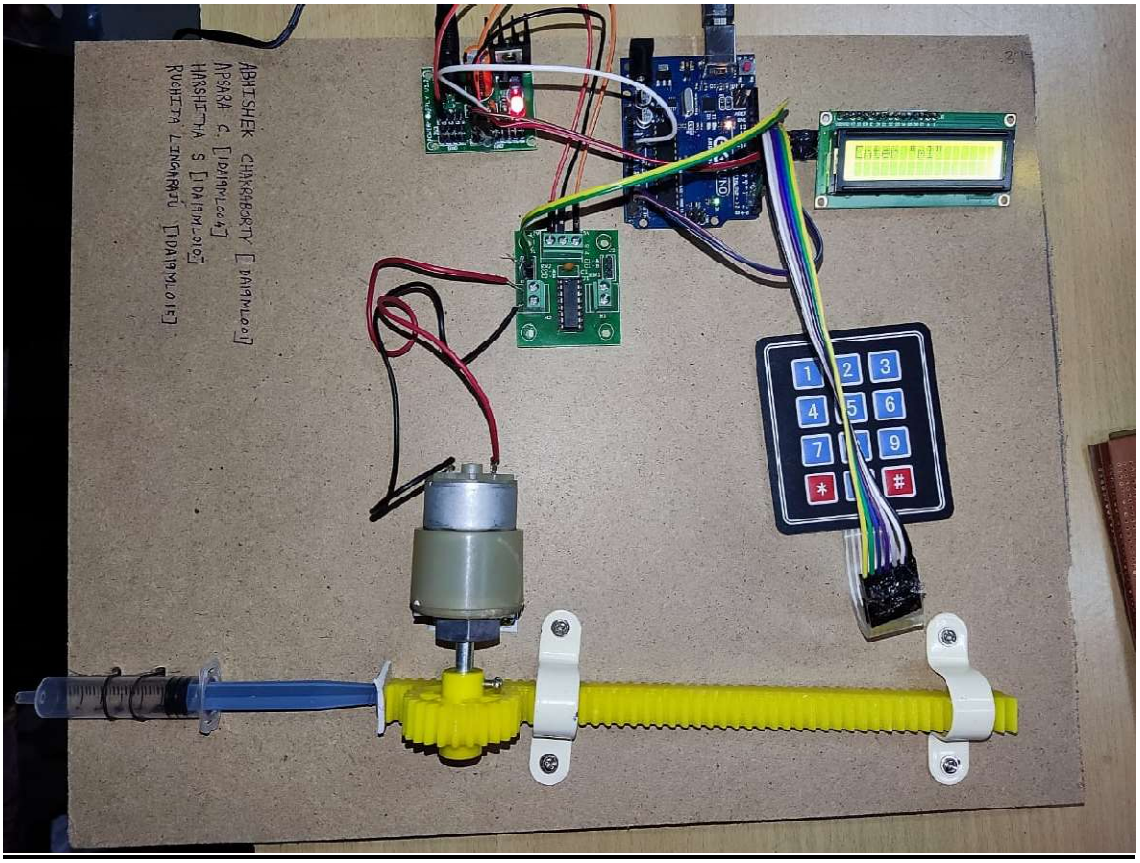

Fig3.2: Full working circuit

3.3 Components Required:

Name	No.
Arduino Uno	1
DC Motor	1

LCD Display	1
DC Motor Driver L293D	1
Keypad	1
12V Adapter	1
Syringe	1
Rack and Pinion	1
Connecting Wires	Many

Table3.1: Components table

3.4 Components Description:

3.4.1 Arduino Uno

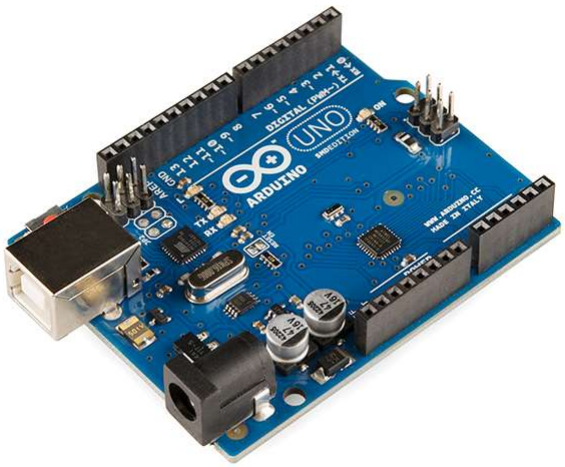

Fig3.3: Arduino Uno Board

An Arduino board is a one type of microcontroller-based kit. The first Arduino technology was developed in the year 2005 by David Cuartielles and Massimo Banzi. The designers thought to provide easy and low-cost board for students, hobbyists and professionals to build devices. Arduino board can be purchased from the seller or directly we can make at home using various basic components. The best examples of Arduino for beginners and hobbyists includes motor

detectors and thermostats and simple robots. In the year 2011, Adafruit industries expected that over 3 lakhs Arduino boards had been produced.

3.4.1.1 Arduino Technology

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operates at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- **External Interrupt 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 Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.
- **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
- **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e., 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analogReference() function.

- Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

- **AREF:** Used to provide reference voltage for analog inputs with analogReference() function.
- **Reset Pin:** Making this pin LOW, resets the microcontroller.

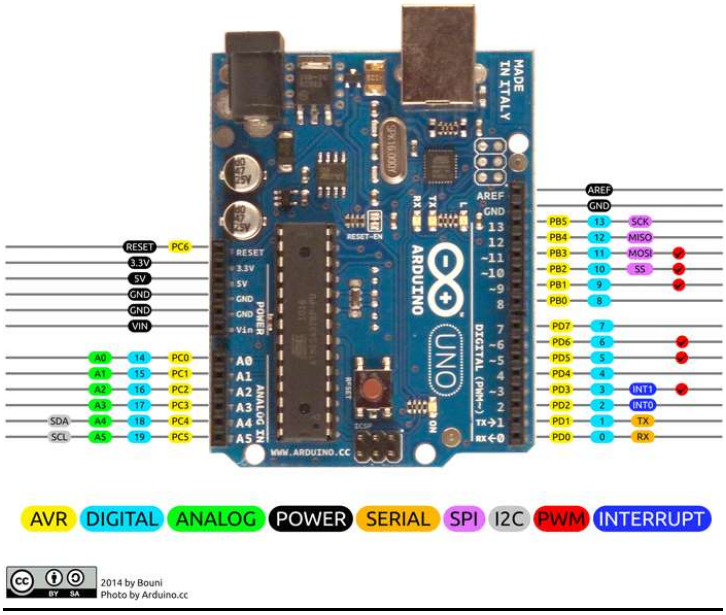

Fig3.4: Arduino Pin Diagram

3.4.1.2 Arduino Architecture

Arduino's processor basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories- Program memory and the data memory. The code is stored in the flash program memory, whereas the data is stored in the data memory. The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader), 2 KB of SRAM and 1 KB of EEPROM and operates with a clock speed of 16MHz.

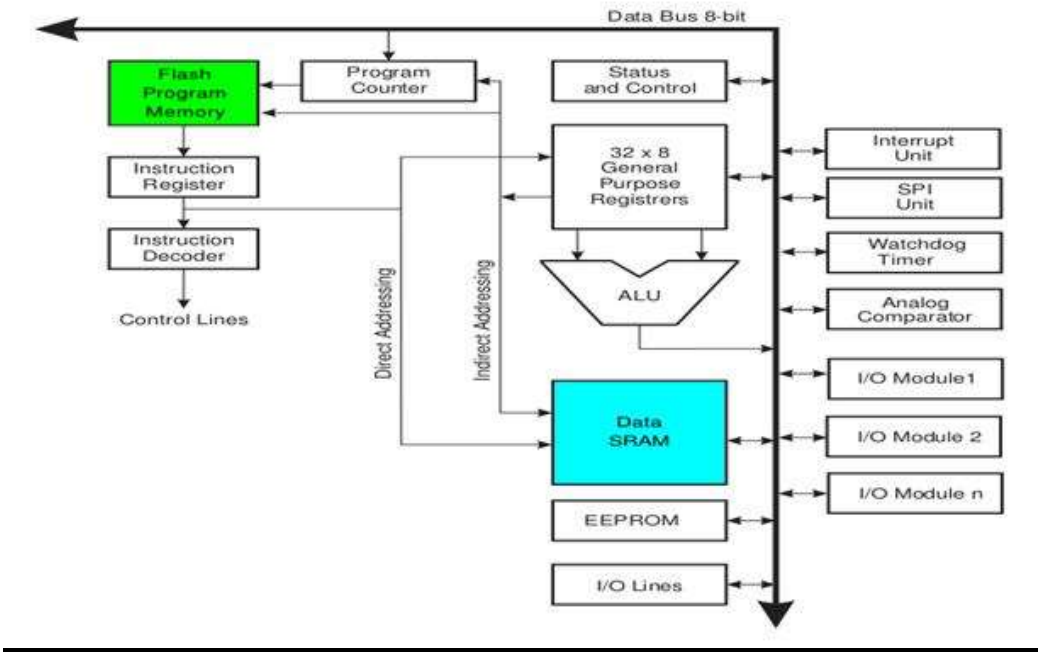

Fig3.5: Arduino Architecture

3.4.1.3 Programming Arduino

The most important advantage with Arduino is the programs can be directly loaded to the device without requiring any hardware programmer to burn the program. This is done because of the presence of the 0.5KB of Bootloader which allows the program to be burned into the circuit. All we have to do is to download the Arduino software and writing the code.

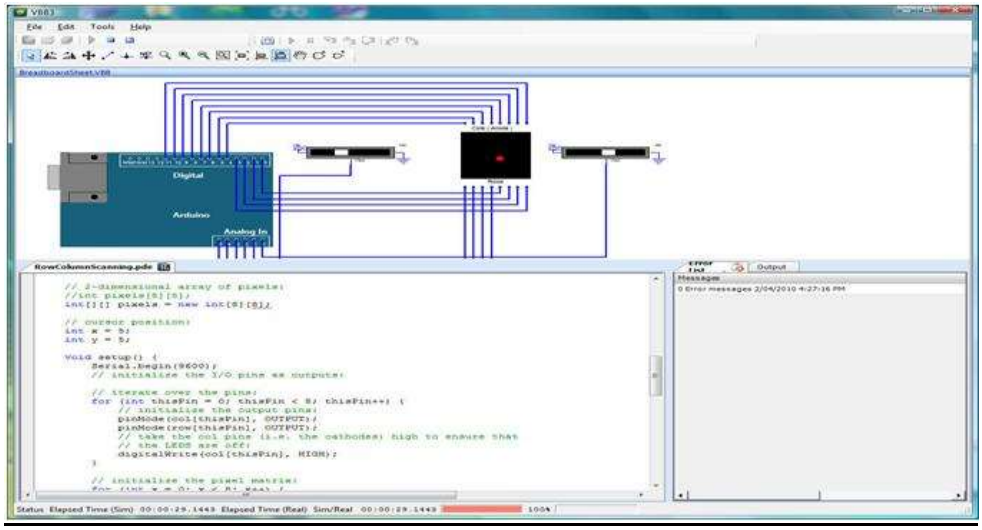

Fig3.6: Arduino Program

3.4.1.4 Programming Steps

- Programs written in Arduino are known as sketches. A basic sketch consists of 3 parts

    1. Declaration of Variables
    2. Initialization: It is written in the setup () function.
    3. Control code: It is written in the loop () function.

- The sketch is saved with.ino extension. Any operations like verifying, opening a sketch, saving a sketch can be done using the buttons on the toolbar or using the tool menu.
- The sketch should be stored in the sketchbook directory.
- Chose the proper board from the tools menu and the serial port numbers.
- Click on the upload button or chose upload from the tools menu. Thus, the code is uploaded by the bootloader onto the microcontroller.

3.4.1.5 Advantages of Arduino Board

1. It is inexpensive
2. It comes with an open-source hardware feature which enables users to develop their own kit using already available one as a reference source.
3. The Arduino software is compatible with all types of operating systems like Windows, Linux, and Macintosh etc.
4. It also comes with open-source software feature which enables experienced software developers to use the Arduino code to merge with the existing programming language libraries and can be extended and modified.
5. It is easy to use for beginners.
6. We can develop an Arduino based project which can be completely stand alone or projects which involve direct communication with the software loaded in the computer.
7. It comes with an easy provision of connecting with the CPU of the computer using serial communication over USB as it contains built in power and reset circuitry.

3.4.2 DC Motor

A DC motor is one of the first electric motors designed to convert direct current electrical energy to mechanical energy. It is one of the greatest devices that humans invented and since then, it has amazingly revolutionized our lives. This rotary electrical machine occupied different types, all of them contain almost the same components that cooperate based on either the mechanism of electronic or the mechanism of electromechanical that is responsible for changing the direction of current in the motor.

A DC motor is made up of a stator, an armature or a rotor, and a commutator with brushes. These are main components and are included in all the DC motors. If we want to explain very briefly how this type of engine works, we must say that the polarity opposition between the two magnetic fields of the motor causes it to turn. These motors may be the simplest motors available in terms of construction and performance, but they have a wide range of uses, including those used in home appliances such as electric razors and those used in a variety of industries.

Fig3.7: DC Motor

3.4.2.1 Types of DC Motor

- **Permanent Magnet Motors** - Permanent Magnet Motors, also known as PMDC motors, are one the DC motors that use a permanent magnet to make a field flux. This

type of DC motors possesses a great starting torque with good speed regulation. With limited torque it has, typically appliances with low horsepower use permanent magnet motors

- **Shunt Motors** - the field of shunt motors is connected in parallel with the armature windings. This type of motors provides a great speed regulation due to the fact that the shunt field can be excited separately from the armature windings. additionally, shunt motors also provide simplified reversing controls.
- **Series Motors** - A series motor is made up of a field wound with some turns of a wire which carries the current of the armature. Just like permanent motors, series motors offer a large amount of starting torque. But unlike permanent motors, series motors cannot regulate speed. Besides, if series motors run with no load, it can be so hazardous. These limitations make series motors unsuitable for variable speed drive applications.
- **Compound Motors** - Compound motors have a shunt field which is separately excited, just like shunt DC motors. compound DC motors are alike permanent and series motors, in terms of offering good starting torque but they have some problems in speed regulation in variable speed drive applications.

3.4.2.2 Working Principle of DC Motor

DC motors work on the principle of electromagnetism that for the first time Faraday introduced. Faraday's principle of electromagnetism says that a current-carrying conductor faces a force when it is placed in a magnetic field. On the other hand, and according to Fleming's Left-hand rule, the motion of the conductor is always in a direction that is perpendicular to the current and the magnetic field.

a better understanding of the working of DC motor needs us to know about all the details in the construction. The armature is the rotating part that is placed between the north and south pole of the permanent or electromagnet and the stator is their stationary part whose magnetic fields are in interaction with the magnetic field of the rotor or the armature.

The armature coil consisting of the commutator and brushes is connected to the DC supply. The commutator turns the AC induced in the armature into DC and the brushes move this current from the rotating part of the motor to the stationary external load.

The stator of a DC motor enjoys a stationary set of magnets and a coil of wire with a current running through it to produce an electromagnetic field aligned with the center of the coil. To

concentrate the magnetic field One or more windings of insulated wire are wrapped around the core of the motor.

he windings of insulated wire are connected to a rotary electrical switch that is called a commutator, applying an electrical current to the windings. The commutator allows each armature coil to be energized in turn, creating a steady rotating force.

To create this steady rotating force called also torque the coils of the armature are turned on and off in a sequence that consequently a rotating magnetic field is generated that interacts with the different fields of the stationary magnets in the stator.

This interaction between the rotating magnetic field and field of stationary magnets in the stator finally causes it to rotate. These key operating principles of DC motors allow them to convert the electrical energy from direct current into mechanical energy through the rotating movement, which can then be used for the propulsion of objects.

3.4.2.3 Advantages of DC Motor

- They are suitable for low-speed torque
- They have adjustable speed
- They offer a wide range of speed control both below and above the rated speed
- They have a very high and strong starting torque
- They are used in appliances such as electric trains and cranes having overwhelming burdens in the beginning conditions
- They are more affordable
- Their maintenance is easy and takes little to no time

3.4.3 LCD Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

Fig3.8: LCD 16X2

3.4.3.1 LCD 16X2 Pin Diagram

The 16×2 LCD pinout is shown below.

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V

- Pin 16 (-ve pin of the LED): This pin is connected to GND.

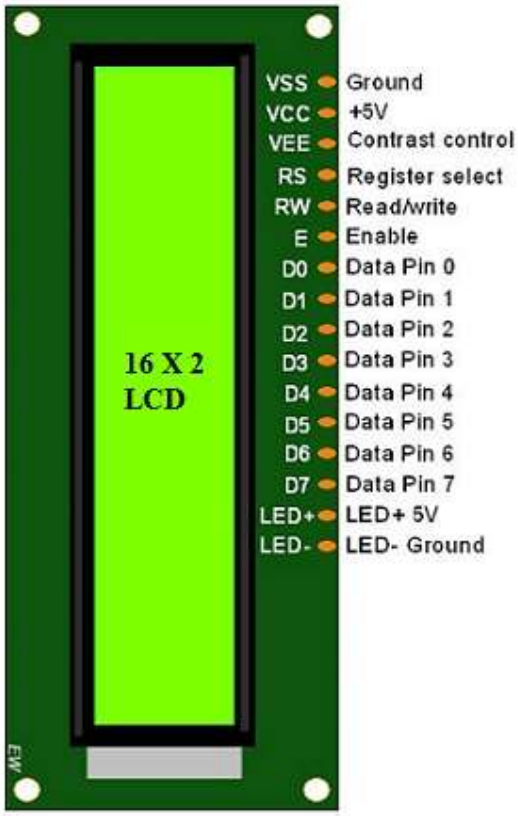

Fig3.9: Pin outs of LCD

3.4.3.2 Features of LCD 16X2

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8-pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters.

3.4.3.3 Registers of LCD

A 16×2 LCD has two registers like data register and command register. The RS (register select) is mainly used to change from one register to another. When the register set is '0', then it is

known as command register. Similarly, when the register set is '1', then it is known as data register.

3.4.3.4 Command Register

The main function of the command register is to store the instructions of command which are given to the display. So that predefined tasks can be performed such as clearing the display, initializing, set the cursor place, and display control. Here commands processing can occur within the register.

3.4.3.5 Data Register

The main function of the data register is to store the information which is to be exhibited on the LCD screen. Here, the ASCII value of the character is the information which is to be exhibited on the screen of LCD. Whenever we send the information to LCD, it transmits to the data register, and then the process will be starting there. When register set =1, then the data register will be selected.

3.4.4 DC Motor Driver L239D

L293D IC is a typical Motor Driver IC which allows the DC motor to drive on any direction. This IC consists of 16-pins which are used to control a set of two DC motors instantaneously in any direction. It means, by using a L293D IC we can control two DC motors. As well, this IC can drive small and quiet big motors.

This L293D IC works on the basic principle of H-bridge, this motor control circuit allows the voltage to be flowing in any direction. As we know that the voltage must be change the direction of being able to rotate the DC motor in both the directions. Hence, H-bridge circuit using L293D ICs are perfect for driving a motor. Single L293D IC consists of two H-bridge circuits inside which can rotate two DC motors separately. Generally, these circuits are used in robotics due to its size for controlling DC motors.

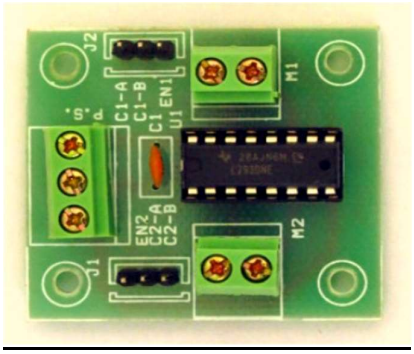

Fig3.10: L293D

3.4.4.1 Pin Diagram

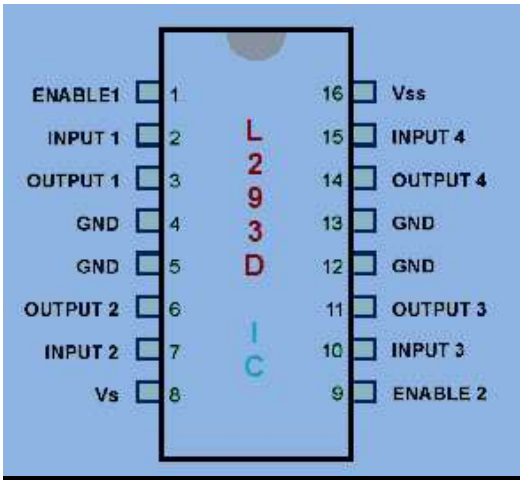

Fig3.11: Pin Diagram of L293D

- Pin-1 (Enable 1-2): When the enable pin is high, then the left part of the IC will work otherwise it won't work. This pin is also called as a master control pin.
- Pin-2 (Input-1): When the input pin is high, then the flow of current will be through output 1
- Pin-3 (Output-1): This output-1 pin must be connected to one of the terminals of the motor
- Pin4 &5: These pins are ground pins
- Pin-6 (Output-2): This pin must be connected to one of the terminals of the motor.
- Pin-7 (Input-2): When this pin is HIGH then the flow of current will be though output 2
- Pin-8 (Vcc2): This is the voltage pin which is used to supply the voltage to the motor.
- Pin-16 (Vss): This pin is the power source to the integrated circuit.
- Pin-15 (Input-4): When this pin is high, then the flow of current will be through output-4.
- Pin-14 (Output-4): This pin must be connected to one of the terminals of the motor
- Pin-12 & 13: These pins are ground pins
- Pin-11 (Output-3): This pin must be connected to one of the terminals of the motor.
- Pin-10 (Input-3): When this pin is high, then the flow of current will through output-3
- Pin-9 (Enable3-4): When this pin is high, then the right part of the IC will work & when it is low the right part of the IC won't work. This pin is also called as a master control pin for the right part of the IC.

3.4.5 Keypad

Keypad/Keyboard is most widely used as an input device. Generally Used with microcontroller and microprocessor-based devices. In this section, we will discuss the "4×3" matrix keypad, its basic understanding is important. Here basic refers to its construction and working mechanism of key detection.

Here R1, R2, R3 & R4 refers to row 1, row 2, row 3 & row 4 respectively and C1, C2 & C3 refers to column 1, column 2 & column 3 respectively.

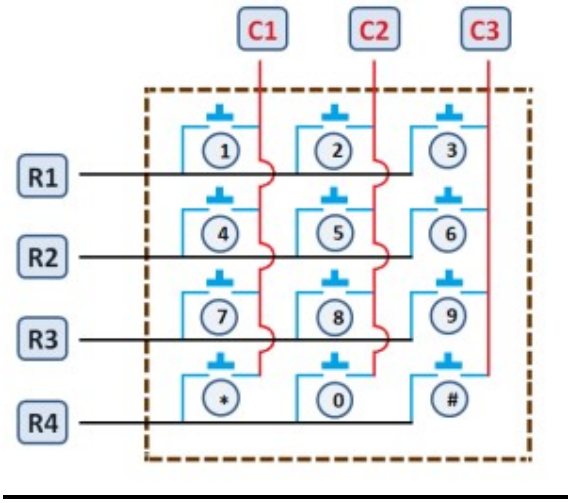

Fig3.12: 4*3 Keypad

3.4.5.1 Operation Mechanism

There are 12 numbers and/or characters and 12 push-buttons (switch). Each push-button is associated with each number or character.

All the columns are set to HIGH i.e., + 5V and rows to LOW i.e., ground (we can interchange columns to LOW and rows to HIGH according to our convenience, but then we need to change the programming model accordingly).

So, if no key has been pressed then all columns will remain HIGH and if the key has been pressed then its corresponding column will give a LOW signal (because it shorted to ground via row). Just suppose we press '2', it is in column 2 and row 1 so as we pressed '2' column 2 will become from HIGH to LOW (because signal directs to the ground without any resistance) but as we release the key 2 it will again become high because of pull-up resistor, we read about the concept of pull-up in the previous chapter, here we used pullup resistor of 4.7 K ohm.

Fig3.13: 4*3 Keypad

3.4.5.2 Logic Used

If column 1 key has been pressed, as row R1 is output type and C1 is input to Arduino, then Arduino will read the logic (state HIGH or LOW) of Row 1 passes through C1 line (same logic we used in reading input from a switch (interface of the switch as input)).

Row 1 should be LOW, so that the microcontroller can detect logic (as we know from both sides HIGH logic will not lead to a potential difference). But if we have multiple rows then we should give logic HIGH to them (R2, R3, R4) to distinguish between R1 and other rows. In short for Row 1 keys

Arduino will continuously read input pin signals, if C1 is LOW means key 1 is pressed, if C2 is LOW means key 2 is pressed and if C3 is LOW means key 3 is pressed.

3.4.6 Rack and Pinion

With rack and pinion steering, the rotation of the pinion causes linear motion of the rack, which turns the vehicle's wheels left or right. Rack and pinion systems are a common component in railways. In between train rails are racks that interact with pinions attached to locomotives and train cars to assist trains with moving up steep inclines.

While a rack and pinion system might seem complicated, according to Advance Autoparts, it is simply a gear attached to a toothed bar. The bar attaches to a set of tie rods. A generating rack is a rack outline used in the design of a generating tool, such as a hob or a gear shaper cutter, to indicate the details and dimensions of the teeth. Simple linear actuators often consist of some combination of rack and pinion. The shaft rotation of the pinion is powered by hand or by a motor to create linear movement.

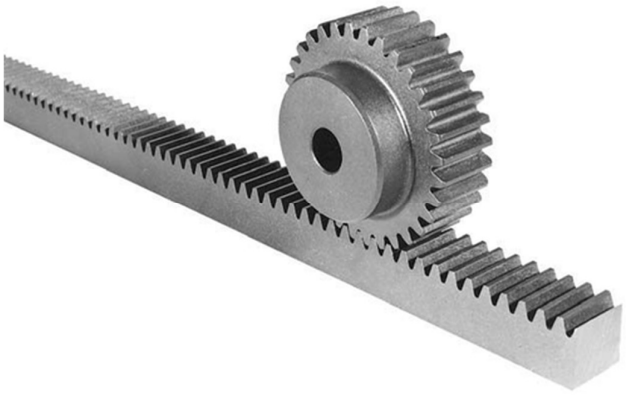

Fig3.14: Rack and Pinion

3.4.6.1 Working

According to an article by Moog Parts, rack and pinion steering works by using a gear system to translate the steering wheel's circular motion into the linear motion needed to turn the wheels. A metal tube houses the gearset. The tube has openings on each end to allow the rack to attach to an axial rod. The pinion gear connects to the steering shaft so that the gear will spin and

move the rack when the steering wheel turns. The axial rods connect to a tie rod end, which attaches to the spindle.

3.4.7 Syringe

6 mL Oral Syringe provide patients with liquid medications. These Oral Syringes have clear barrels that allow easy inspection of the contents. Graduated markings on the barrel of these Oral Medication Syringes provide more accurate measurements of medical dosages. These Oral Medication Syringes are made with polypropylene. Syringes come with a Catheter Tip that will not accept a hypodermic needle for added safety. Syringes are designed for single use and come with separate ribbed tip caps. Dual graduations in millilitres and teaspoons provided measurements in the standard most people are accustomed to using.

Fig3.15: 6ml Syringe

CHAPTER 4

FLOWCHART

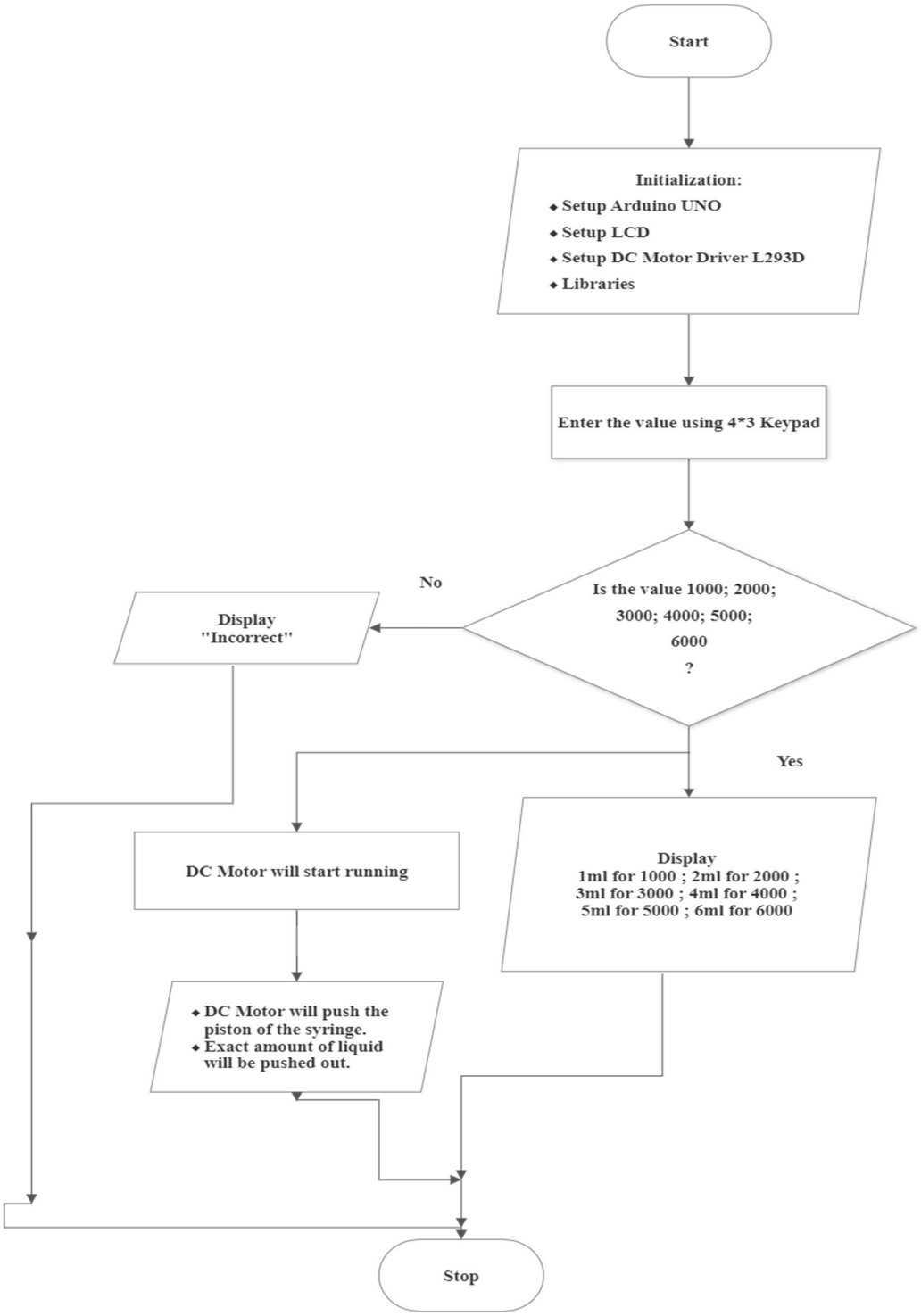

Fig4.1: Flowchart

CHAPTER 5

RESULT

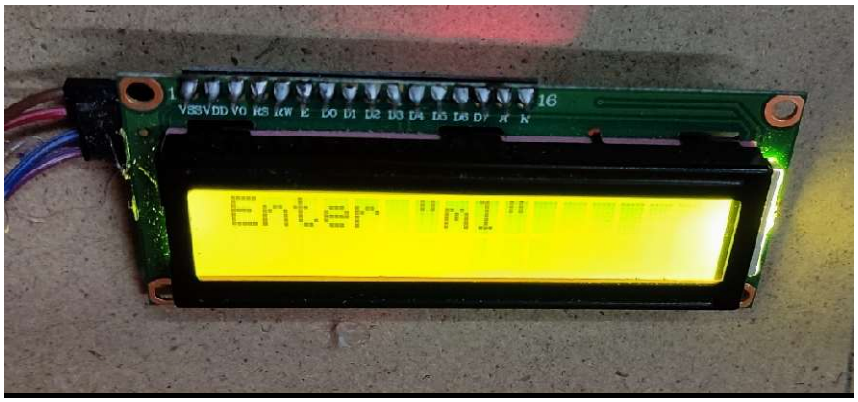

Fig5.1: LCD screen showing ‘Enter “ml”’

Fig5.2: Number is displayed

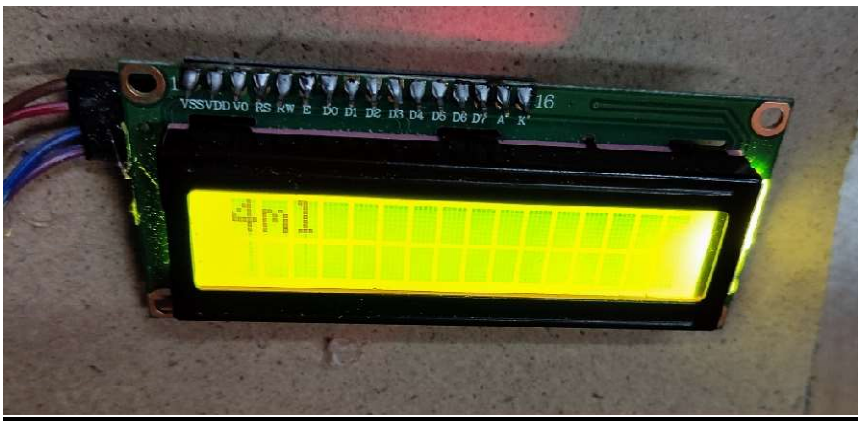

Fig5.3: LCD screen displays 4ml output

In this project, we have built an Arduino based Syringe Pump Infusion which will push the same amount of liquid to be pushed as instructed by the doctors or nurses. Once Arduino is connected to laptop and 12V adapter is connected to the circuit, LCD will start glowing and will display at first “Welcome”. Then ‘Enter “ml”’ will be displayed. That time we will type the amount according to the need of ml to be pushed from the syringe. If we type 1000 using keypad, then 1ml will be pushed by the piston of the syringe.

We took few readings of the result:

Sl.No.	Number Entered by Keypad	Piston Will Be Pushed (ml)
1	1000	1
2	2000	2
3	3000	3
4	4000	4
5	5000	5
6	6000	6

Table5.1: Observation Table

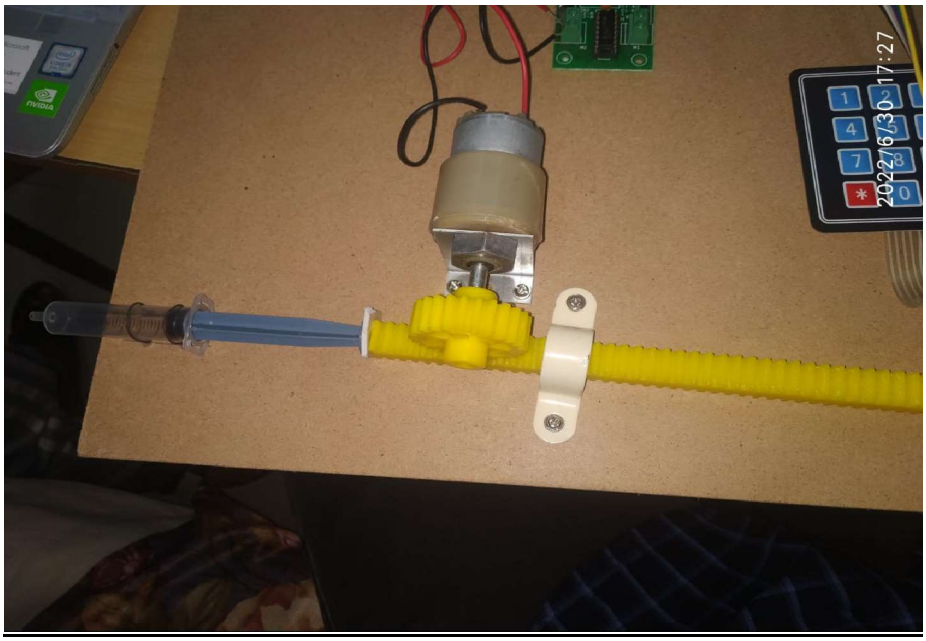

Fig5.4: Piston moving

CHAPTER 6

CONCLUSION

The technique of syringe pump infusion has demonstrated its great potential for use in a wide range/ clinical measurements. A main focus has been the precision delivery of medication. DC Motor will help the pinion to rotate and push the piston to give exact amount of liquid to the patient as instructed or given as input by the doctors and nurses. In future, IOT can be used which will give remote access for the doctors to use the syringe pump infusion machine easily.

REFERENCE

1. Erin Quattromani, Margaret Hassler, Nikki Rogers, Jennifer Fitzgerald and Paula Buchanan" Smart Pump App for Infusion Pump Training" Clinical Simulation in Nursing, Volume 17, pp 28-37, Doi:org/10.1016/ j.ecns.2017.11.004.

2. C. Luca, D.Andritoi, C.Corciova, R.Ciorap, " Study on the influence of wireless communication Technology on infusion pumps 2016 International Conference and Exposition on Electrical and Power Engineering (EPE 2016), 20-22 October, Iasi, Romania.

3. HasnaaElKheshen , Ibrahim Deni , AlaaBaalbaky , Mohamad Dib , Lara Hamawy , Mohamad Abou Ali, "Semi-Automated Self-Monitored Syringe Infusion Pump", 2018 International Conference on Computer and Applications (ICCA) Doi: 10.1109/COMAPP.2018.8460462

4. Isabella L. Grassetti, Samantha L. Curran, Anita M. Petrilli, James O'Brien, Douglas E. Dowand Joseph M. Martel, "Application of Polymer Composite Material for Radiation Protection of Infusion Pumps", Doi:10.1109/HealthCom.2015.7454541

5. Moret, E.; Muntané, E.; Ricart, P.; Andreu, A.; Bonafont, "Infusion pump audit for continuous drug administration in a university hospital: 17AP2-6", X European Journal of Anesthesiology: June 2011 – Volume 28 – Issue- p 218

6. Frank Doesburg ,Fokie Cnossen, Willem Dieperink, Wouter Bult, Anne Marie de Smet, Daan J . Touw, Maarten W. Nijsten, "Improved usability of a multi-infusion setup using a centralized control interface" Doi: 10.1371/journal.pone.0183104.

7. Jennifer Biltoft and Lonnye Finneman, "Clinical and financial effects of smart pump–electronic medical record Andrei Drumea, AlexandruVasile, 2006 29th International Spring Seminar on Electronics Technology. Doi: 10.1109/ISSE.2006.365134.

8. Interoperability at a hospital in a regional health system", Doi: 10.2146/ajhp161058.

9. Jeffrey M. Rothschild, Carol A. Keohane, E. Francis Cook, E. John Orav, Elisabeth Burdick, Sarah Thompson, Judy Hayes and David W. Bates, "A controlled trial of smart infusion pumps to improve medication safety in critically ill patients", Doi: 10.1097/01.ccm.0000155912.73313.cd.

10. ThorunnOskarsdottir, David Harris, Adam Sutherland, Andrew Wignell and Nanna Christiansen, “A national scoping survey of standard infusions in paediatric and neonatal intensive care units in the United Kingdom”, 10.1111/jphp.12992

11. Andrei Drumea, AlexandruVasile, 2006 29th International Spring Seminar on Electronics Technology. Doi: 10.1109/ISSE.2006.365134.