SYRINGE INFUSION SYSTEM

Project Report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology

Electronics and Communication

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SCHOLAR CERTIFICATE

We hereby certify that the work presented in this report entitled **" Syringe Infusion System"** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Information Technology** submitted in the department of **Electronics and Communication,** Jaypee University of Information Technology Waknaghat is an authentic record of our own work carried out over a period from August 2016 to May 2017 under the supervision of **Mr. Munish Sood** (Assistant Professor, ECE).

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

Signature of Candidates:

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This is to certify that the above statement made by the candidate is true to the best of my knowledge.

Supervisor Name: Mr. Munish Sood

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Dated: 30/04/2017

SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the B-Tech. thesis entitled "**Syringe Infusion Pump**" at Jaypee University of Information Technology, Waknaghat , India, is a bonafide record of his / her pioneering work carried out under my supervision. This work has not been deferred anywhere else for any other degree/diploma.

Mr. Munish Sood

Date : 30/04/2017

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LIST OF FIGURES

LIST OF ABBREVIATIONS

PCIP	Position Controlled Displacement Pump
IV	Intravenous Veins
LCD	Liquid Crystalline Display
RCDS	Roller Clamp Delivery System
FD	Forward Direction
RD	Reverse Direction

ABSTRACT

Directing medication to patients through the oral, intravenous means is a vital notion for the handling of sicknesses in medical field. Conventionally, medication to the patients is delivered by the System in which a drip to a patient's body is infused through a hanging bottle with a roller attached to the pipe. This is a popular means of transferring a fluid into a patient's body and is known as Roller Clamp Delivery System. Roller Clamp is used in almost every hospital for providing Glucose, Blood etc. While there is a drawback with this system that flow of liquid is controlled by the force of gravity. Although roller in pipe can be used to regulate the speed it does not tell about the flow rate of the fluid infusing into a patient's body. So, this system can cause serious health problems if flow rate is not set accordingly. An overcome to this system is Position Controlled Infusion Pump. PCIP is designed using a stepper motor, and by controlling the speed of stepper motor flow rate can easily be controlled. In this project, we include a syringe in it which is used for the transport of small amount of drug. It has a microcontroller set in it which controls the flow in these pumps. A stepper motor in it which gives a precise delivery of liquid. Stepper motor with greater resolution the less will be the drop size. Hence Syringe pumps are dependent on the stepper motor for their precision. It is also interfaced with an LCD in them which shows the flow rate of system. This can also be used with various sensors for their best use. They will be of great use soon after replacing Roller Clamp Delivery System.

CHAPTER-1

INTRODUCTION

INTRODUCTION

You must have seen nurses in hospital attaching a drip to a patient's body through a hanging bottle with a roller attached to the pipe. This is a popular means of transferring a fluid into a patient's body and is known as *Roller Clamp Delivery System.* Roller Clamp is used in almost every hospital for providing Glucose, Blood etc. While there is a drawback with this system that flow of liquid is controlled by the force of gravity. Although roller in pipe can be used to regulate the speed it does not tell about the flow rate of the fluid infusing into a patient's body. So, this system can cause serious health problems if flow rate is not set accordingly. An overcome to this system is Position Controlled Infusion Pump. Infusion Pumps use a stepper motor and by controlling the speed of stepper motor flow rate can easily be controlled.

1.1 What are Position Controlled Infusion Pumps?

PCIP are devices that are used to deliver different types of fluid, nutrients medicines into a patient's body. Infusion pump have a stepper motor attached to it which is programmed using a microcontroller. A microcontroller interfaced with a motor driver controls the speed, hence the flow rate of PCIP is set. Some infusion pumps also have a pressure and air bubble detector sensor.

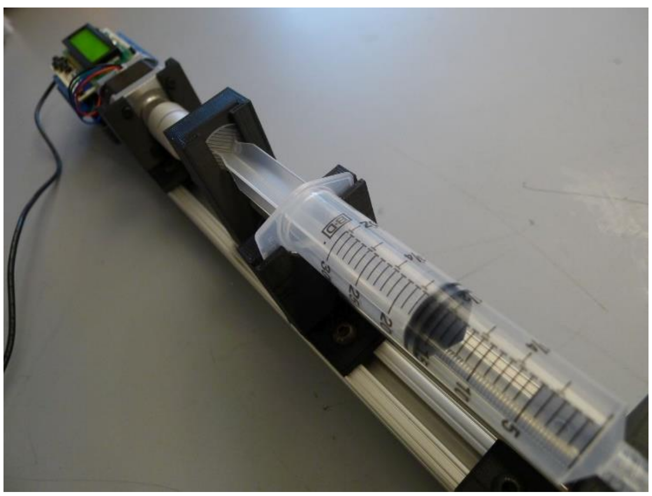

Figure 1.1 Syringe Infusion Pump

1.2 Why Position Controlled Infusion Pumps?

PCIP are better than the traditional Roller Clamp Delivery System. Their flow rate can be set and displayed on LCD. Infusion Pumps can also be interfaced with various sensors like heartbeat, respiratory, temperature etc. Changing parameters can be automatically evaluated and change in the flow rate be set accordingly by the microcontroller. It is very important to program the infusion pump carefully. Bad programming can lead to severe problems to a patient and whole system. With PCIP, there is no need of a nurse administering a patient regularly for drips etc. So, automatic infusion pump is a better medical device for administering drip drugs.

CHAPTER 2

LITERATURE REVIEW

LITERATURE REVIEW

2.1 Types of Infusion

There are two types of Infusion which are explained below :

2.1.1 Continuous Infusion – In continuous Infusion, small drops of liquid is delivered to a body controlled by the microcontroller. Liquid drops are of the size around 600 nanoliters to 1200 nanoliters depending on the design of infusion system.

2.1.2 Total Nutrition – In total nutrition infusion, a patient is delivered with liquid like meal hours. Usually this infusion is for people who cannot eat by themselves and hence they need an external supply for nutrition.

2.2 Types of Infusion Pumps

1. Gravity Controlled Pumps
2. Position Displacement Pumps

2.2.1 Gravity Controlled Pumps

This type of infusion system consists of drip rate expedients which are dependent on gravity for the rate of flow. There are systems which are transported with standard vein fluid administration sets which are named dial-a-flow or dose-flow. Rate of infusion is also dependent on pressure difference through the valve that is height of fluid or intravenous pressure obstruction. There is a roller which is dependent on force of gravity to provide the required pressure. A drop sensor is attached to the drip compartment which usually senses the drip rate and shows it on the display screen. This system uses a feedback mechanism that can change the drop rate to the present value and it doesn’t remove the error arisen due to changes or variation in drop size.

2.2.2 Position Displacements Pumps

As the name proposes it provide a positive displacement of liquid with the help of a motor. The mechanism is such that it avoids infusion of large amount of air or subcutaneous infiltration. These pumps are built on the concept of peristaltic or piston motion.

This pump uses linear or rotary methods. This type of rotator peristaltic pump consists rollers on a wheel, as a result it compresses the tubing and hence the liquid can move towards the patient in the tube. The linear mechanism of peristalsis include finger like projections which compresses the tubing against a fixed back plate sequentially and causes a unidirectional flow of liquid. Following are some of the types of position displacement pumps: -

Drip rate pumps- This type of pumps deliver pumping mechanism which makes them dissimilar from gravity dependent drip rate controllers. They replace gravity as the main force. These pumps use drip sensors which count the number of drops to control the infusion rate. These sensors are attaches to the infusion sets. The speed of fluid is dependent on the feedback control from drip sensor which actually counts the number of drops. In these types blocking pressure is important which is always set at 99mm Hg and sometimes over 210 mm of Hg. The high blocking pressure can dismantle the system causing the tube to burst. There is a disadvantage of these pumps which occurs when there is an extravagation as the pump keeps on pumping fluid into the tissues.

Volumetric pumps- This type of pumps eliminate the problem in drip rate pumps. Volumetric pumps use piston type action and peristaltic pumping type action. It uses infusion set which rises the cost of each infusion. It provides exact volume of infusion as it precisely regulates the set of flow rates. These pumps run on ml per hour.

Syringe pumps- These pumps include a syringe in it and are used for the transport of small amount of drug. Usually they have a microcontroller set in it which controls the flow in these pumps. Syringe pumps have a stepper motor in it which gives a precise delivery of liquid. Stepper motor with greater resolution the less will be the drop size. Hence Syringe pumps are dependent on the stepper motor for their precision. They also have a LCD in them which shows the flow rate of system. Syringe pump can also be used with various sensors for their best use. They will be of great use soon after replacing Roller Clamp Delivery System.

2.2.3 Specifications of Syringe Pump include

1. Microcontroller Meticulous Stepper motor must be used for precise delivery.
2. It should have competence of being operative with main power supply of 230 V.
3. It should have some switches to control the flow rate and ON/OFF.
4. It should have an LCD for displaying the speed of stepper motor/flow rate.
5. It should have switches for the microcontroller to decide the direction of flow.

2.2.4 Advantages of Syringe Pump

- Consistent and Moveable
- Low Priced
- Flow rate can be set.
- Easy Switches for ON/OFF
- Speed Control of Motor
- Used for small size drug delivery

2.2.5 Disadvantages of Syringe Pump

- Can’t be castoff for large size drug delivery

2.3 Requirements for Infusion System

A Syringe infusion system has mainly three key apparatuses:

Syringe: It contains the liquid to be transported to the patient’s body

Mechanical System: It contains Linear gears, component at which motor is fixed and syringe is fixed that control the flow.

Microcontroller: It is programmed to control every parameter in the system like stepper motor, flow rate etc.

2.3.1 Pump Mechanism

Stepper motor must be used in micro stepping mode for a Syringe Infusion Pump so that continuous Infusion take place. While if any other mode like half mode, full mode the infusion won't be continuous. Stepper motor will run on very small instants of time and that would be insensible if the infusion is not continuous which can cause excess pressure while infusing and may cause bubbles during infusion.

2.3.2 Power Supplies

Microcontroller needs a supply of 5V and Stepper motor needs a supply of around 12V. So, it's important to convert 230V to 12V using rectifier and then a voltage regulator to do it. Moreover, it can also be so that a separate rechargeable battery for both can be used separately. Whichever is feasible can be used.

2.3.3 Battery Management

Every so often we require transporting patients while they endure on the IV FLUIDS, so infusion must have a battery /rechargeable battery fixed on it. Therefore, if mains power is off patient don't have to suffer and battery backups the whole power supply.

2.3.4 Compactness

A good infusion system must be compact or portable. Patients can need infusion anywhere in ambulance, Hospitals, or their living apartments etc. So, Position Displacement Infusion pump must be portable in nature.

2.3.5 User Interface

The user Interface is to control the flow rate and to check various parameters displayed on LCD. Interface must be user friendly. It should be easy for the user to program it or control the flow rate. If the infusion pump is on battery then remaining time or how much it is charged should be displayed on LCD.

2.3.6 Alarms

Infusion Pumps requires some alerts in form of Indicators (LED’s), beep sound or a tuner showing if the infusion drug container is empty or for any other reason as per the requirements like drastic variation in temperature etc.

2.3.7 Time Keeping

As the health of patient is critical it is very important to track the time very carefully. So, a timer is must needed here. Moreover, if time is required between doses without time keeping it won’t be possible.

In this project, we have designed a Syringe Infusion Pump that automatically deliver fluids into patients body . Using Combination of linear gears and circular gears when stepper motor is rotated, it moves the piston in forward/backward direction and desired results are achieved.

CHAPTER 3

MATERIALS AND METHODS

MATERIALS AND METHODS

3.1 Components Used

Let us first learn about the various components used in making of position displacement Infusion pump and their purpose.

- Stepper Motor
- Stepper Motor Driver
- Microcontroller
- Linear Gears
- LCD
- Printer Fuser
- Push Buttons
- Mechanical Switches

3.1.1 Stepper Motor

Purpose: Stepper motor are used to precisely provide the flow of fluid.

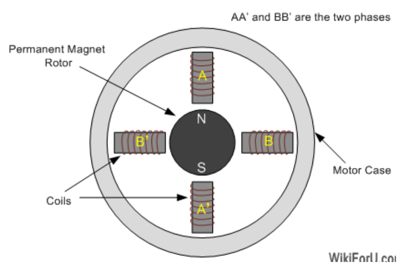

Figure 3.1: Stepper Motor Structure

Working: Stepper motor consist of a permanent magnetic part which rotates as per the coils excited. This part is called the rotor. And the stationary part on which coils are winded is stator. As per in the above figure AA` and BB` are two different phases. When AA` phase is energized, the rotor remains in direction which is shown in above figure. When another phase BB` is, energized rotor moves into anticlockwise direction. This angle of 90 can also be expurgated into half by energizing two coils concurrently.

Another type of mode is micro stepping mode used in this project. In which a continuous (sine wave) is sent as a signal to stepper motor and it runs smoothly. So it is not a step wise rotation here. The stepper motor runs smoothly as needed.

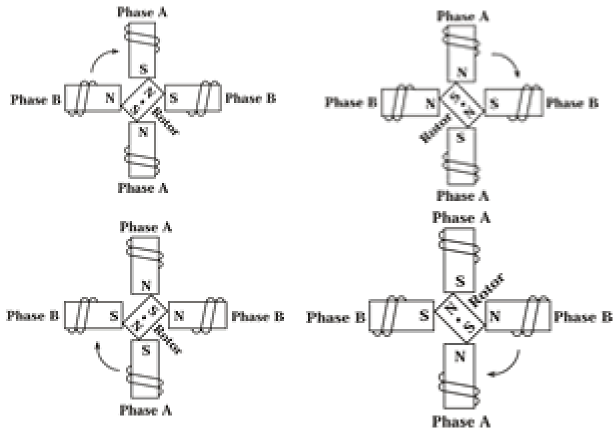

Figure 3.2: Stepper Motor Working

3.1.2 Stepper Motor Driver

Purpose: Driver are used to interface the stepper motor with microcontroller.

Working: Mainly two pins Step Pin and Direction Pin in DRV8825 is used to control the step size and direction of the stepper motor. Whenever a pulse is input on Step pin stepper motor takes a step and this step can be reduced to around 800 micro steps per revolutions as per the pulse to its inputs. While the DIR pin is used to set the direction if no input is given it works in clockwise direction else in anticlockwise direction. All the other pins are explained in the below figure.

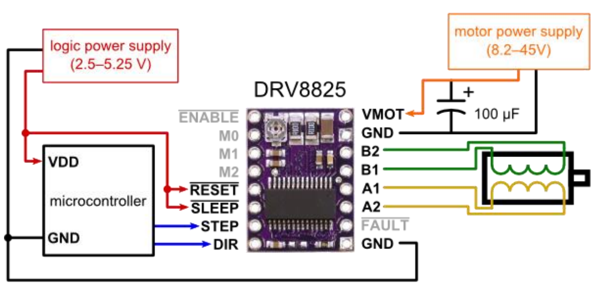

Fig 3.3 Interfacing of Stepper Motor with Driver

3.1.3 Microcontroller

Purpose: Purpose of using this microcontroller is to control the speed of motor which will consequently decide the flow rate of fluid.

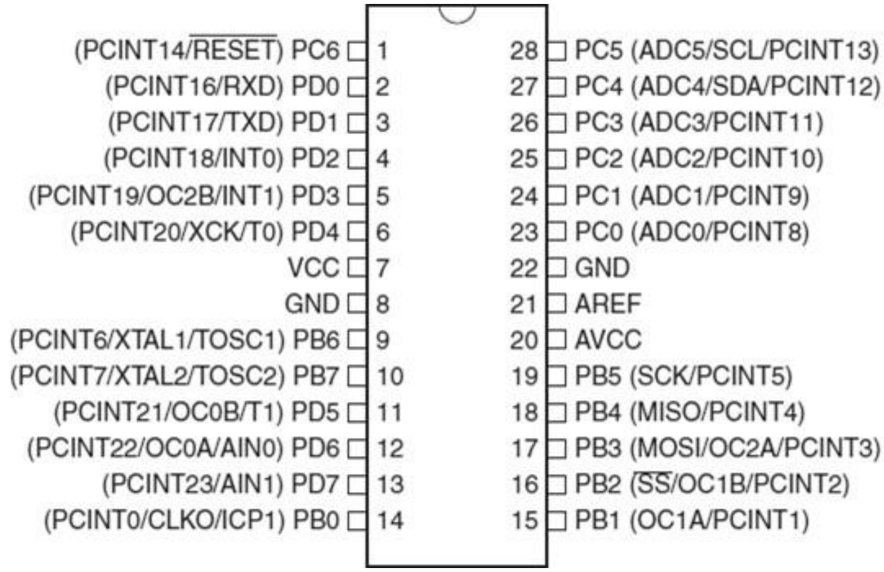

Figure 3.4: Pin Diagram of ATMEGA 328

About: Pin Diagram of the microcontroller ATMEGA328 is given above. This microcontroller has 28 pins. This microcontroller needs a V_{CC} of 5V. This microcontroller is one of the best present in market right now. It has pins that can take both Analog and digital inputs. From PC_0 to PC_5 all the pins can take digital and analog inputs. Also, it has pins that can be used for Serial Interfacing with different devices. It also has pins to be interfaced with external clock. It has two 8 bit timers and one 16 bit timers. It's flash memory is about 32KB. This microcontroller has around six PWM channels. So, if we need a PWM pulse we can connect pin to the channel and there it is.

3.1.4 LCD

Purpose: LCD is used to display the speed of motor.

Liquid Crystalline Display used here is 16×2, i.e. 16 horizontal characters and 2 vertical characters.

Working: 16×2 LCD contains 16 pins . Pin 1 is Ground. Pin 2 is VCC which is again 5V here and hence can be given directly from the microcontroller supply which is also

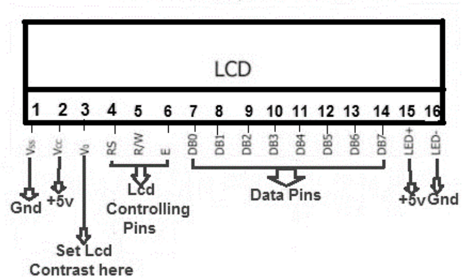

Figure 3.5: LCD Pin Diagram

5V. Pin 7 to 14 are for the purpose of Data which is to be PRINTED. And hence it will use 7 data pins of the microcontroller. LED+ (Pin 15) is for the purpose of backlight, and it needs 5V and pin 16 is again ground of the backlight.

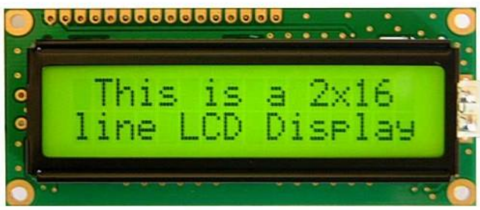

Figure 3.6: LCD

3.1.5 Linear Gears

Purpose: Linear Gears are used for the forward/backward movement of syringe.

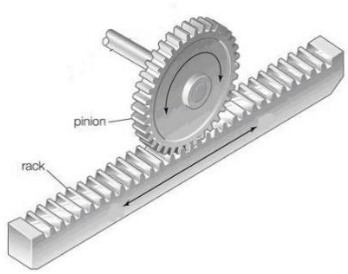

Figure 3.7: Linear Gear System

Working: The pinion of linear gear is attached to the stepper motor and consequently the rack is connected with the syringe hence when the stepper motor moves in forward direction the rack moves in backward direction and the syringe is filled. Now if the rack moves in forward direction the syringe will infuse the liquid in it into the patient’s body.

3.1.6 Printer Fuser

Purpose: Printer Fuser is used to set the linear gears syringe and stepper motor over it.

Figure 3.8: Printer Fuser

About: In this project printer fuser is used to set up all the component on it. Usually linear gears are not readily available in market. One have to design them through 3D printing. But in printer fuser linear gears are present. We have used it for better results.

3.1.7 Switches

Purpose: To set the speed of the stepper motor and to notify microcontroller in which direction syringe should move.

Figure 3.9: Push Button Switch

Working : One leg of the push button is connected with the power (VCC) and the other leg is connected to the component whose switching is to be controlled.

3.1.8 Software

Purpose: This software is used to program the microcontroller**.**

About: Software used for the project is ARDUINO IDE. Arduino IDE is simple to use and is user friendly. It provides C language environment to write the program. Creating own libraries and directories in this software is quite easy.

Sometimes it is quite difficult to connect the microcontroller with this software. As the driver is not updated in windows. So it has to be manually installed. Procedure for connecting the microcontroller with the desktop is easily available on web.

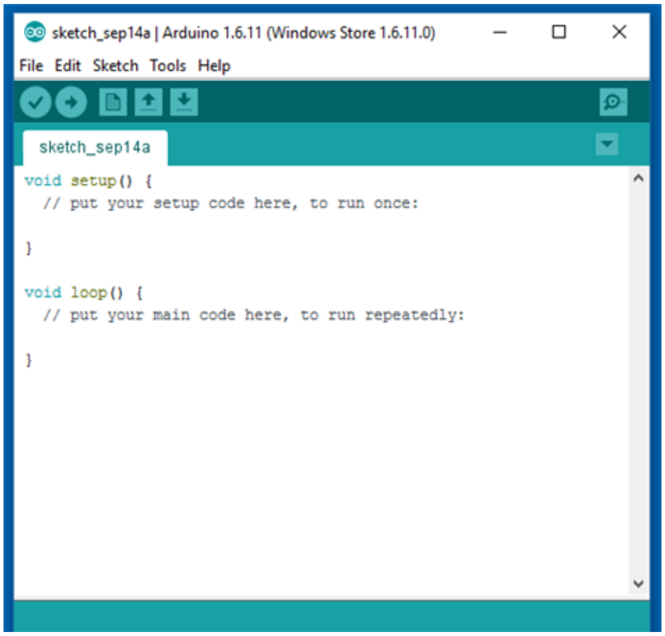

Figure 3.10: Arduino IDE

3.2 Procedure for designing PCIP

1. Fix all the linear gears on printer fuser. In case linear gears are present on printer fuser go to step 2.

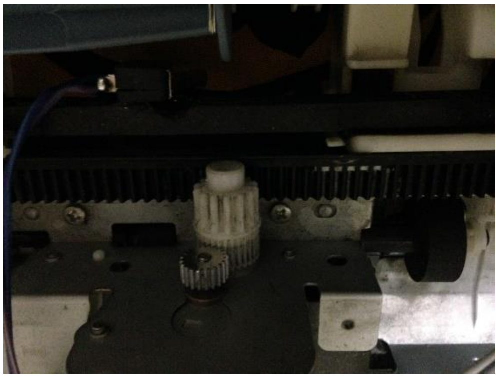

Figure 3.11: Linear Gears Fixing

2. Take the stepper motor and fix it over the linear gears with pinion on it that can make the linear gear to move in a required direction**.**

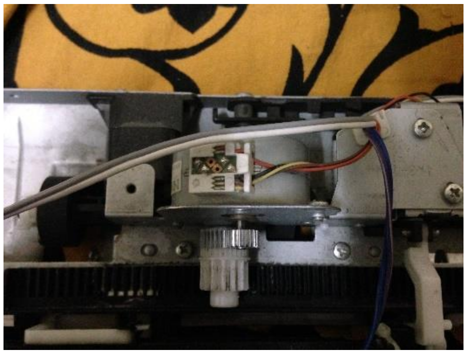

Figure 3.12: Stepper Motor Fixing

3. After this attach, mechanical switches to the fuser so that the microcontroller can be notified about the change in direction.

Figure 3.13: Mechanical Switches Fixing

4. Now take a wire and fix syringe on linear gear and fuser for infusion.

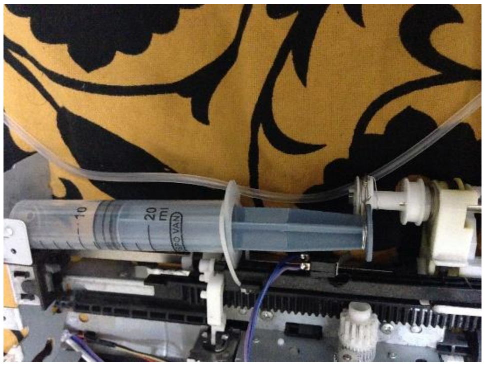

Figure 3.14: Syringe Fixing

5. After this we need to program every part using ATMEGA 328p, we will interface stepper motor using DRV8825 with microcontroller first. Microcontroller interfacing with driver is shown below.

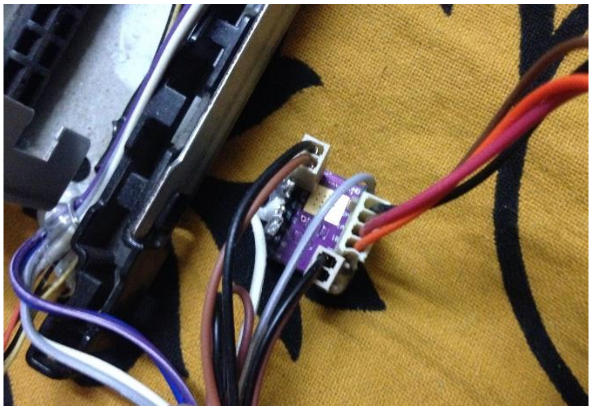

Figure 3.15: DRV8825 Interfacing

6. Now we need to program switches and connect them to data pins of ATMEGA328 so that they can be used to control the speed of stepper motor.

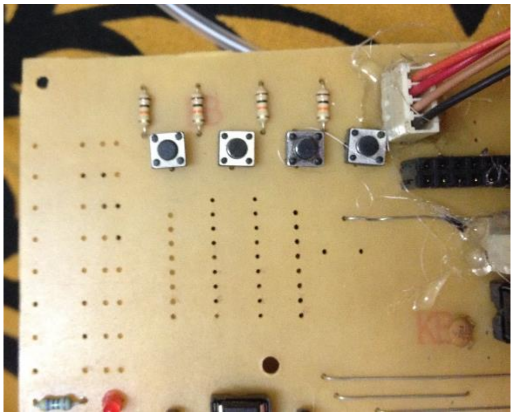

Figure 3.16: Switch Interfacing

7. After all this is completed, then we need to interface LCD with the microcontroller which will display the speed/ Flow Rate etc. of the INFSUION.

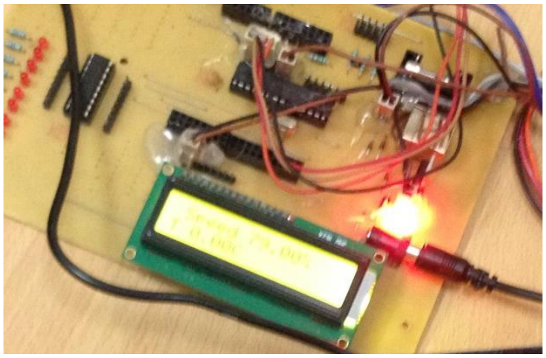

Figure 3.17: LCD Interfacing

8. Syringe Infusion System is ready to be operated.

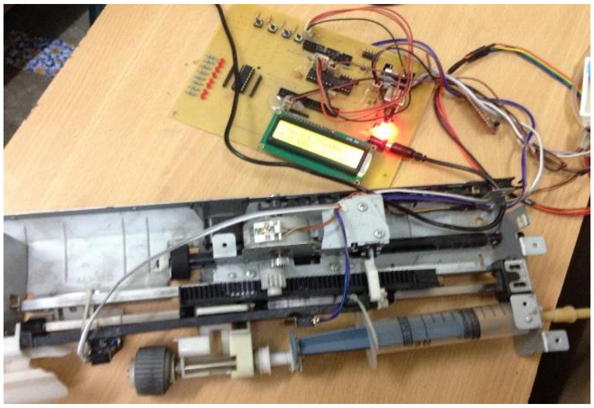

Figure 3.18: Syringe Infusion System

CHAPTER 4

WORKING OF POSITION CONTROLLED INFUSION PUMP

WORKING OF POSITION CONTROLLED INFUSION PUMP

4.1 Block Diagram of Infusion Pump

As the name proposes it provide a positive displacement of liquid with the help of a motor. The mechanism is such that it avoids infusion of large amount of air or subcutaneous infiltration. These pumps are built on the concept of peristaltic or piston motion.

This pump uses linear or rotary methods. This type of rotator peristaltic pump consists rollers on a wheel, as a result it compresses the tubing and hence the liquid can move towards the patient in the tube. The linear mechanism of peristalsis include finger like projections which compresses the tubing against a fixed back plate sequentially and causes a unidirectional flow of liquid.

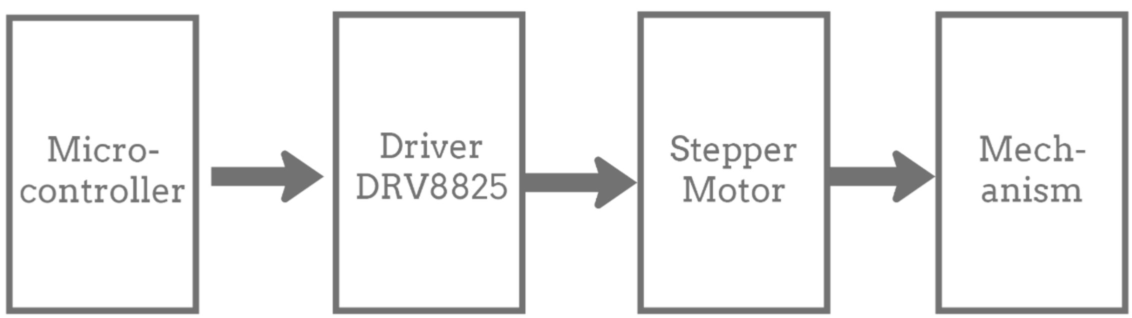

Figure 4.1: Block diagram Of PCIP

Here as we can see in the above figure that microcontroller controls the stepper motor driver which subsequently controls the stepper motor and hence the mechanism is performed. In the mechanism a syringe is moving in both forward and backward direction, as per the control of microcontroller.

4.2 Flow Chart of Infusion Pump

In the Position Controlled Infusion Pump as soon as the power is supplied to the microcontroller, stepper motor shows some movement. This movement depends on mechanical switches which decides the direction of stepper motor. Two other push buttons are interfaced with the microcontroller which sets the flow rate of the infusion system. As discussed earlier it is the speed of stepper motor that decides the flow rate, let us understand the working of Position Controlled Infusion Pump using a simple flow chart :

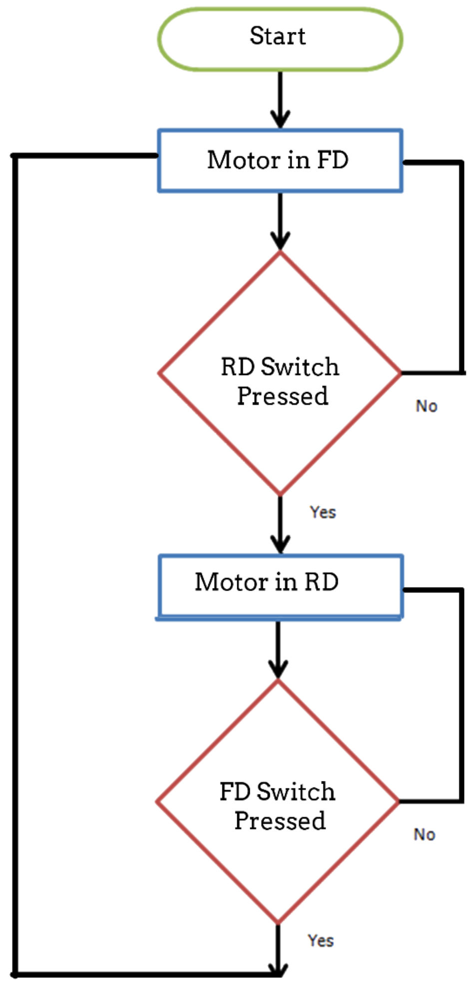

Figure 4.2: Flow Chart of PCIP

FD- Forward Direction
RD- Reverse Direction

CHAPTER 5

RESULTS AND DISCUSSIONS

RESULTS AND DISCUSSIONS

5.1 Future Enhancement

Many types of sensors can be interfaced with Infusion system to regulate the flow. These can be Heart Beat Sensors, Respiratory Sensor, Air Bubble Detector. We can have the whole system to control via a remote control/ mobile using IOT. Also, if the patient relatives need to know the report they can be sent the report through the device.

Figure 5.1: Air Bubble Detector Sensor

Figure 5.2: Heart Beat Sensor

Figure 5.3: Respiratory Thorax

5.1.1 Air Bubble Detector – Air bubble detector can be used for detecting any bubble in the pipe through which fluid is being transported.

5.1.2 Heart Beat Sensor – Heart Beat sensor can be used with a microcontroller to set the flow rate as per the variations in heart beat.

5.1.3 Respiratory Sensor – Respiratory sensor can be used with a microcontroller to set the flow rate as per the variations in breath.

These various types of sensors can be used as a parameter to change the flow rate of the infusion system. Once microcontroller evaluates the variation in heart beat etc. it will set whether to increase or decrease the flow rate.

5.2 Conclusion

Microcontroller has been successfully used to program the stepper motor driver and consequently the stepper motor by which rate of flow of medicine is controlled. In this project, a microcontroller is programmed to control the speed of the stepper motor by its driver. If the speed of stepper motor is increased using the switches connected to ATMEGA 328 the flow rate will increase and if the speed of the stepper motor is decreased, again using the switches the flow rate will be decreased. Also, there is an LED interfaced with this microcontroller which displays the flow rate, speed of the stepper motor and the temperature of the patient. Not only Syringe Infusion pump can be used for providing fluids to body but also it can be used for Anesthesia. Anesthesia is required during long operations to rest the patient. During an operation if a person comes to consciousness, it can lead to his/her death. So, continuous Infusion method can be used here for providing Anesthesia to a patient. Syringe Infusion Pump can have many applications where flow rate is to be administered. Moreover, future enhancement of this project will make this microcontroller based position controlled infusion pump universally acceptable.

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APPENDIX

APPENDIX A

Atmel®

8-bit AVR Microcontrollers

ATmega328/P

DATASHEET COMPLETE

Introduction

The Atmel® picoPower® ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR® enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/P achieves throughputs close to 1MIPS per MHz. This empowers system designer to optimize the device for power consumption versus processing speed.

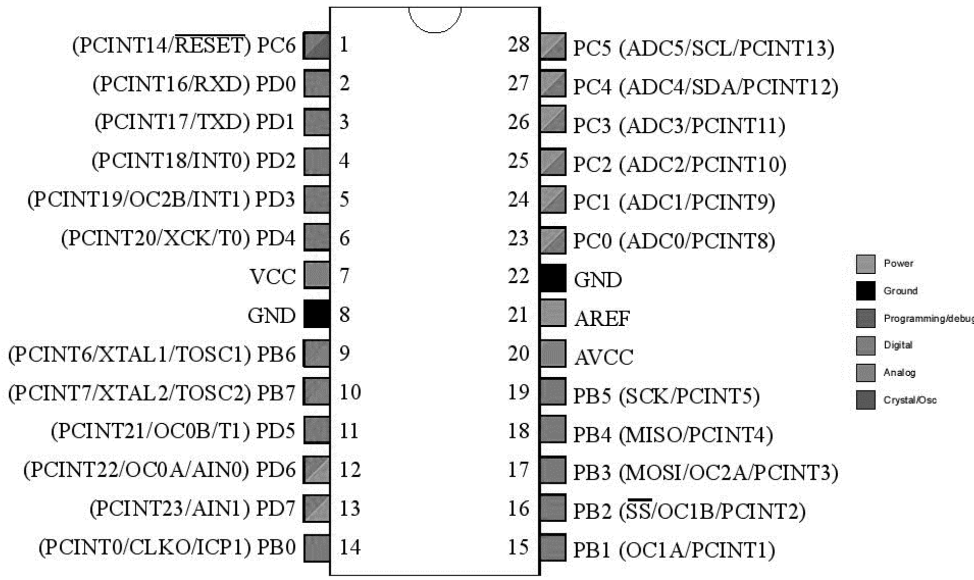
Feature

High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family

- Advanced RISC Architecture
  - 131 Powerful Instructions
  - Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 32KBytes of In-System Self-Programmable Flash program Memory
  - 1KBytes EEPROM
  - 2KBytes Internal SRAM
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data Retention: 20 years at 85°C/100 years at 25°C[1]
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - Programming Lock for Software Security
- Atmel® QTouch® Library Support
  - Capacitive Touch Buttons, Sliders and Wheels
  - QTouch and QMatrix® Acquisition
  - Up to 64 sense channels

- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel 10-bit ADC in TQFP and QFN/MLF package
    - Temperature Measurement
  - 6-channel 10-bit ADC in PDIP Package
    - Temperature Measurement
  - Two Master/Slave SPI Serial Interface
  - One Programmable Serial USART
  - One Byte-oriented 2-wire Serial Interface (Philips I^2C compatible)
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - One On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage:
  - 1.8 - 5.5V
- Temperature Range:
  - -40°C to 105°C
- Speed Grade:
  - 0 - 4MHz @ 1.8 - 5.5V
  - 0 - 10MHz @ 2.7 - 5.5V
  - 0 - 20MHz @ 4.5 - 5.5V
- Power Consumption at 1MHz, 1.8V, 25°C
  - Active Mode: 0.2mA
  - Power-down Mode: 0.1µA
  - Power-save Mode: 0.75µA (Including 32kHz RTC)

\


(PCINT14/RESET) PC6 1
(PCINT16/RXD) PD0 2
(PCINT17/TXD) PD1 3
(PCINT18/INT0) PD2 4
(PCINT19/OC2B/INT1) PD3 5
(PCINT20/XCK/T0) PD4 6
VCC 7
GND 8
(PCINT6/XTAL1/TOSC1) PB6 9
(PCINT7/XTAL2/TOSC2) PB7 10
(PCINT21/OC0B/T1) PD5 11
(PCINT22/OC0A/AIN0) PD6 12
(PCINT23/AIN1) PD7 13
(PCINT0/CLKO/ICP1) PB0 14
28 PC5 (ADC5/SCL/PCINT13)
27 PC4 (ADC4/SDA/PCINT12)
26 PC3 (ADC3/PCINT11)
25 PC2 (ADC2/PCINT10)
24 PC1 (ADC1/PCINT9)
23 PC0 (ADC0/PCINT8)
22 GND
21 AREF
20 AVCC
19 PB5 (SCK/PCINT5)
18 PB4 (MISO/PCINT4)
17 PB3 (MOSI/OC2A/PCINT3)
16 PB2 (SS/OC1B/PCINT2)
15 PB1 (OC1A/PCINT1)
Power
Ground
Programming/debug
Digital
Analog
Crystal/Osc

APPENDIX B

DRV8825 Stepper Motor Controller IC

1 Features

- PWM Microstepping Stepper Motor Driver
  - Built-In Microstepping Indexer
  - Up to 1/32 Microstepping
- Multiple Decay Modes
  - Mixed Decay
  - Slow Decay
  - Fast Decay
- 8.2-V to 45-V Operating Supply Voltage Range
- 2.5-A Maximum Drive Current at 24 V and T_A = 25°C
- Simple STEP/DIR Interface
- Low Current Sleep Mode
- Built-In 3.3-V Reference Output
- Small Package and Footprint
- Protection Features
  - Overcurrent Protection (OCP)
  - Thermal Shutdown (TSD)
  - VM Undervoltage Lockout (UVLO)
  - Fault Condition Indication Pin (nFAULT)

2 Applications

- Automatic Teller Machines
- Money Handling Machines
- Video Security Cameras
- Printers
- Scanners
- Office Automation Machines
- Gaming Machines
- Factory Automation
- Robotics

3 Description

The DRV8825 provides an integrated motor driver solution for printers, scanners, and other automated equipment applications. The device has two H-bridge drivers and a microstepping indexer, and is intended to drive a bipolar stepper motor. The output driver block consists of N-channel power MOSFET's configured as full H-bridges to drive the motor windings. The DRV8825 is capable of driving up to 2.5 A of current from each output (with proper heat sinking, at 24 V and 25°C).

A simple STEP/DIR interface allows easy interfacing to controller circuits. Mode pins allow for configuration of the motor in full-step up to 1/32-step modes. Decay mode is configurable so that slow decay, fast decay, or mixed decay can be used. A low-power sleep mode is provided which shuts down internal circuitry to achieve very low quiescent current draw. This sleep mode can be set using a dedicated nSLEEP pin.

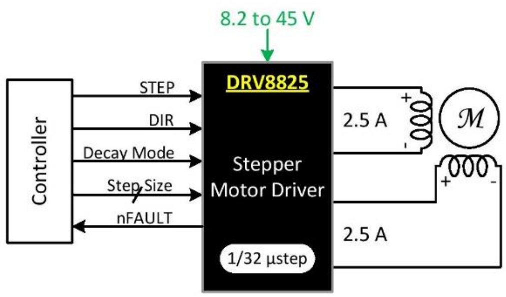
Internal shutdown functions are provided for overcurrent, short circuit, under voltage lockout and over temperature. Fault conditions are indicated via the nFAULT pin.

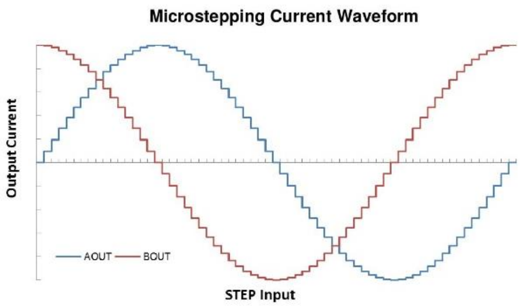
Device Information(1)

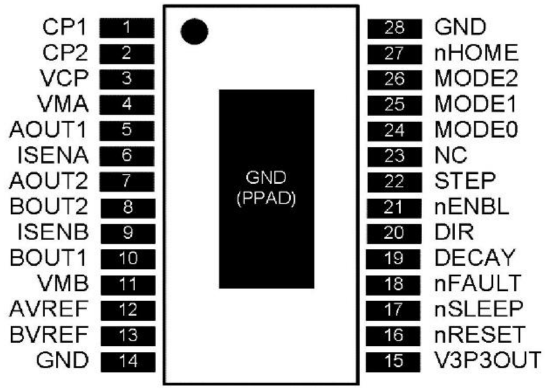
PART NUMBER	PACKAGE	BODY SIZE (NOM)
DRV8825	HTSSOP (28)	9.70 mm × 6.40 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

4 Simplified Schematic







Pin Functions

PIN		I/O(1)	DESCRIPTION	EXTERNAL COMPONENTS OR CONNECTIONS
NAME	**NO.**			
POWER AND GROUND				
CP1	1	I/O	Charge pump flying capacitor	Connect a 0.01-μF 50-V capacitor between CP1 and CP2.
CP2	2	I/O	Charge pump flying capacitor	
GND	14, 28	—	Device ground	
VCP	3	I/O	High-side gate drive voltage	Connect a 0.1-μF 16-V ceramic capacitor and a 1-MΩ resistor to VM.
VMA	4	—	Bridge A power supply	Connect to motor supply (8.2 to 45 V). Both pins must be connected to the same supply, bypassed with a 0.1-μF capacitor to GND, and connected to appropriate bulk capacitance.
VMB	11	—	Bridge B power supply	
V3P3OUT	15	O	3.3-V regulator output	Bypass to GND with a 0.47-μF 6.3-V ceramic capacitor. Can be used to supply VREF.
CONTROL				
AVREF	12	I	Bridge A current set reference input	Reference voltage for winding current set. Normally AVREF and BVREF are connected to the same voltage. Can be connected to V3P3OUT.
BVREF	13	I	Bridge B current set reference input	
DECAY	19	I	Decay mode	Low = slow decay, open = mixed decay, high = fast decay. Internal pulldown and pullup.
DIR	20	I	Direction input	Level sets the direction of stepping. Internal pulldown.
MODE0	24	I	Microstep mode 0	MODE0 through MODE2 set the step mode - full, 1/2, 1/4, 1/8/ 1/16, or 1/32 step. Internal pulldown.
MODE1	25	I	Microstep mode 1	
MODE2	26	I	Microstep mode 2	
NC	23	—	No connect	Leave this pin unconnected.
nENBL	21	I	Enable input	Logic high to disable device outputs and indexer operation, logic low to enable. Internal pulldown.
nRESET	16	I	Reset input	Active-low reset input initializes the indexer logic and disables the H-bridge outputs. Internal pulldown.
nSLEEP	17	I	Sleep mode input	Logic high to enable device, logic low to enter low-power sleep mode. Internal pulldown.
STEP	22	I	Step input	Rising edge causes the indexer to move one step. Internal pulldown.
STATUS				
nFAULT	18	OD	Fault	Logic low when in fault condition (overtemp, overcurrent)

APPENDIX C

Code on ATMEGA328p

```
#include <EEPROM.h>
#include <LiquidCrystal.h>
LiquidCrystal lcd(4, 5, 6, 7, 8, 9);
const int stepPin = 1;
const int dirPin = 0;
float sp,temp;
boolean pulse;
int tdelay=0;
void swCheck()
{
if(digitalRead(19)==0 && sp<100)
{
sp=sp+0.1;
EEPROM.write(0, sp);
delay(10);
}
else if(digitalRead(18)==0 && sp>0)
{
sp=sp-0.1;
EEPROM.write(0, sp);
delay(10);
}
else if(digitalRead(17)==0)
{
digitalWrite(dirPin,1);
while(digitalRead(16)==1)
{
digitalWrite(stepPin,pulse);
pulse=!pulse;
delay(2);
}
}
else if(digitalRead(16)==0)
{
digitalWrite(dirPin,0);
delay(200);
while(digitalRead(16)==0)
{
digitalWrite(stepPin,pulse);
pulse=!pulse;
delay(1);
}
}
}
```

```
void setup() {
lcd.begin(16, 2);
pinMode(stepPin,OUTPUT);
pinMode(dirPin,OUTPUT);
pinMode(19,INPUT);
pinMode(18,INPUT);
lcd.print("Test Proj");
sp = EEPROM.read(0);
delay(1000);
if(sp>100)
{ sp=20;}
lcd.clear();
lcd.print(" Speed ");
lcd.setCursor(0,1);
lcd.print("T ");
}

void loop() {
digitalWrite(stepPin,pulse);
pulse=!pulse;
delay(sp);
lcd.setCursor(7,0);
lcd.print(100-sp);
lcd.print("%");
temp=analogRead(A0);
temp=(temp*4.88)/10;
lcd.setCursor(2,1);
if(tdelay>15)
{
lcd.print(temp);
lcd.print("C    ");
tdelay=0;
}
swCheck();
tdelay++;
}
```