LABORATORY MODEL OF LOW COST DIALYSIS MACHINE

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **"LABORATORY MODEL OF LOW COST DIALYSIS MACHINE"** is the bonafide work of **"Gopi Chandran R (312213121011), Surya Prakash D(312213121054) and Vaibhav M (312213121059)"** who carried out the project work under my supervision. Certified further that to the best of my knowledge, the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or an award was conferred on an earlier occasion on these or any other candidates.

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ABSTRACT:

We propose a new idea for haemodialysis machine which is affordable and can reach the hands of poor and needy. The proposed prototype can be used in hospitals for dialysis. The prototype consists of following components: Temperature detector, Bubble detector, Blood Pressure detector, Blood warmer.

The temperature detector consist of temperature sensor (DS18B20) coupled to arduino nano. The bubble detector consist of Opto Isolator Module (MOC 7811) coupled to arduino nano. The blood pressure detector consists of Contact Level sensor coupled to arduino nano from which flow rate is obtained. Using the Hagen-Poiseuille equation pressure is obtained. Blood warmer consist of a specially etched Aluminium plate through which the dialysis tube passes through, the plate is heated by a 12V DC heater and this keeps the blood warm at 37 degree celsius throughout the dialysis process. Temperature sensor is also coupled to this in order to monitor the temperature rise. Two peristaltic pumps are used which facilitate in the circulation of blood and dialysate. All the 4 modules are connected to Arduino Mega which is the central controller. From the modules feedback is provided to the controller. On any abnormal condition the controller triggers the ALARM circuit which provides indications to the technician. Relay switch is used to cut off the power supply during abnormal condition. One of the inputs to the relay is from the controller, during the abnormal condition the input from the controller becomes high and it turns off the relay switch there by cutting off the power supply to the modules.

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CHAPTER 1

INTRODUCTION

1.1 MOTIVATION

Kidney failure is one of the most common problems among humans. The treatments for kidney failure most commonly include kidney transplantation and dialysis procedure. Kidney transplantation is very expensive for common man and there is also the problem of graft rejection. Another method is dialysis but the expensive equipment that is used for this procedure makes it very costly. The cost of getting hemodialysis is 12-15,000 rupees per month and for peritoneal dialysis is 18-20,000 rupees per month. The expensive nature of the dialysis procedure makes it not available for poor patients. The machine used for hemodialysis makes the procedure expensive. Simplification of the hardware components reduces the cost of the machine which in turn reduces the cost of the dialysis procedure thereby many poor people can get access to dialysis procedure.

1.2 PRIOR ART

We got inspired from the device “ARTIFICIAL KIDNEY”. It is made in the University of California and will hit the market by end of the year 2017. It is approved by FDA. It can be implanted in the abdomen. It uses bio-hybrid approach where bioreactor cells are coupled with the kidney cells. It uses bio-membrane that performs excellent filtration compared to existing dialysis machine. It can also stimulate hormones similar to the kidney. It will also be economical compared to the existing machine. Dr. SHUVO ROY is the co-inventor of this device. This device gets automatically powered by the heart so there is no need of any batteries or external power supply.

1.3 NEED FOR DIALYSIS

Kidney performs functions that are very essential for human body. It removes unwanted substances from the body by purifying blood and also retains minerals like sodium, potassium etc. Unwanted substances are removed in the form of urine. Nephron is the functional unit of kidney there are about millions of nephrons in the kidney. Nephron consists of Glomerulus and Bowman's capsule. Inside the glomerulus the ultra-filtration of blood takes place. Then the filtered part goes through the proximal and distal convoluted tubules where important salts are absorbed and the waste and toxic products are removed. These waste products then get collected as urine in the collecting duct. From the collecting duct urine goes to the ureter. In patients with kidney failure the nephron gets damaged so the kidney cannot perform purification process. For those people dialysis performs the purification process artificially.

1.4 DIALYSIS AND TYPES

Dialysis is also known as "ARTIFICIAL KIDNEY". It is the procedure that performs the purification function of the kidney for patients with kidney failure. Generally there are two types of dialysis

- Hemodialysis
- Peritoneal dialysis

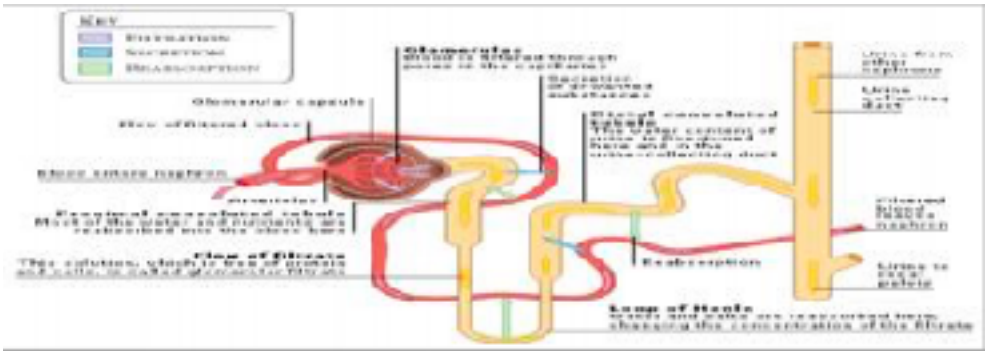

Figure 1.3.1 Purification of blood by kidney

1.4.1 HAEMODIALYSIS

It is the medical procedure to remove fluid and waste products from the blood and to correct the electrolyte imbalances. It is accomplished using a machine and a filter called DIALYZER also referred as artificial kidney. It is used to treat both acute and chronic kidney failure.

1.4.2 PERITONEAL DIALYSIS

It is the way to remove the waste products from blood when the kidney fails to do the job adequately. A cleansing fluid flows through the catheter to the part of the abdomen and removes the waste products from the blood.

1.5 HEMODIALYSIS PROCEDURE

Hemodialysis uses the machine to perform the dialysis procedure. The machine consists of blood pump that sucks the blood from the arteries of the patient. The impure blood passes through the warmer to keep the blood temperature at 37 degree celsius. There is also a heparin pump which provides heparin to prevent the clotting of blood. Throughout the process temperature of 37 degree celsius is maintained. The arterial and venous blood pressure are monitored regularly by the machine. There is a solution Dialysate which is obtained by mixing acid and bicarbonate in 1:2 ratio. Both impure blood and dialysate are brought inside the dialysis filter called the “DIALYZER”. Filter consist of the semi-permeable membrane that separates the impurities from the blood by “counter current flow mechanism” in which the dialysate and impure blood moves in the opposite direction resulting in purification. The purified blood is sent back to the patients through veins. Here the venous pressure is monitored regularly. Formation of bubble during the flow of blood is a main threat to the dialysis process. Quality bubble detection sensors are used that detects even minute of bubbles. When the bubble is detected the alarm sounds and flow is stopped as the bubble formation

can cause severe damage to the patients. The machine also has alarm systems that give quick indications to the technicians. The machine also has rinsing facilities by which the machine cleans automatically. It also has self-diagnosing facilities before performing the procedure the machine performs the self- diagnosis test. The entire hemodialysis procedure depends upon the machine Dialyzer which performs the procedure in about 8-12hours with high accuracy and safety.

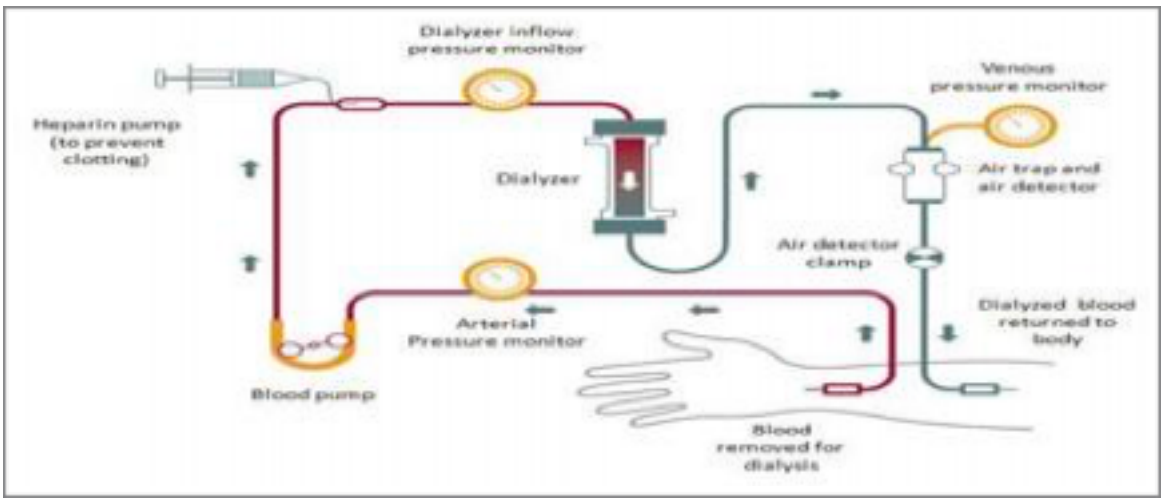

Figure 1.5.1 Hemodialysis procedure block diagram

Figure 1.5.2 Hemodialysis machine

1.6 PROJECT OBJECTIVE

➢ The main objective of our project is to simplify the hemodialysis Ma- chine which reduces the cost of it, which in turn reduces the cost of the dialysis procedure. So thereby rural and poor people can afford the dialysis procedure.

➢ To reduce the size of the machine and make it portable

➢ To make the machine user-friendly thereby patients can use the machine easily and can perform the dialysis procedure at their home.

Arduino Mega (Microcontroller) **Arduino Nano (Microcontroller)** **12V DC Heater** **Temperature Sensor(DS18b20)** **Opto Isolator/Photo Interrupter (MOC7811) SS Contact Type Water Level Sensor** **LCD 16x2** **LED** **DC Buzzer** **24V Relay Aluminium Plate AC Socket** **12V DC Charger**

Table 1.6.1 List of Components

1.7 ORGANISATION OF THESIS

This dissertation shows how a this model can help people to have dialysis at low cost. The organization of this thesis is as follows. Chapter 2 shows our literature study in detail. We have discussed about the various papers that were studied by us for working on this project and developing a laboratory model of a low cost dialysis machine.

Chapter 3 talks about the temperature module used in this project. We have also talked about the other methods used in temperature detection and how it had failed. This chapter talks about the sensor used, its connection and the output. In Chapter 4, we talk about the air bubble detection circuit used in the project. MOC7811 sensor and its pin configuration have been explained in this chapter.

Chapter 5 and 6 highlight the flow of liquid through peristaltic pump and maintaining the temperature using blood warmer. In Chapter 5, we discuss an efficient algorithm, for calculating the pressure of flowing liquid. We have also discussed about level sensors, how they work and how pressure can be calculated indirectly from flow rate calculated from the level of flowing liquid based on Reynold's number.

In Chapter 6, we talk about peristaltic pumps, their working and how they are able to create negative pressure for sucking the blood. The blood warmer uses simple heater connected to 12V supply to maintain the temperature of flowing liquid. Chapter 7 talks about the controller and relay circuit. This chapter gives details about a relay buzzer and light emitting diode and how they are used in this project to provide audio and visual feedback. Last but not the least, Chapter 8 gives summary of this dissertation as well as discusses on directions for future work.

CHAPTER 2

LITERATURE SURVEY

S.NO	TITLE	AUTHOR	RESULT
1	Effect of dialysis membrane in treatment of patients with acute renal failure	Raymond M.Hakim; Robert A.Parker	Comparison of cuprophane and polymethylmetha acrylate membranes and cuprophane is more effective when compared to polymethylmetha acrylate.
2	A New Procedure for the Removal of protein Drugs and Toxins.	J. Stange S. Mitzner W. Ramlor T. Cliesche	Double sided albumin attached high flux silicon analyzer with albumin contained dialysate solutionis effective in removal of protein bound toxins and drugs.
3	Blood Flow Measured by Doppler Frequency Shift of Back-Scattered Ultrasound	Dean L. Franklin, William Schlegel, Robert F. Rushmer	Blood flow measured from the reflected ultrasound echo

4	Fiber optic pH probe for physiological use	John.I.Peterson, Seth.R.Goldstein	Fiber optic probes using phenol red dye provides accurate measurement of blood ph
5	Ultrasonic detection of bubbles using Doppler flow transducer	R.Y.Nishi	The capabilities and limitations of the transducers for the detection of bubbles were investigated by studying the scattering from both solid objects and air bubbles moving through the acoustic field. In vivo experiments indicate that it would be difficult to obtain any correlation between the output of these transducers and bubble size.
6	Theory and validation of access flow measurement by dilution technique during hemodialysis	Nikolai M.Krivitski	Changing the size of needles and distance at which the needle is inserted, the dilution Method by considering these changes is more effective than using the expensive color coded duplex sonography Which has access failure.

CHAPTER 3
TEMPERATURE MODULE

Previous Works

LM35 is an analog temperature sensor. This means the output of LM35 is an analog signal. Microcontrollers don't accept analog signals as their input directly. We convert this analog output signal to digital before we can feed it to a microcontroller's input. Our arduino has in built 10 bit ADC. We can make use of this in built ADC of arduino to convert the analog output of LM35 to digital output. We connect analog out of LM35 to the analog input pins of arduino.

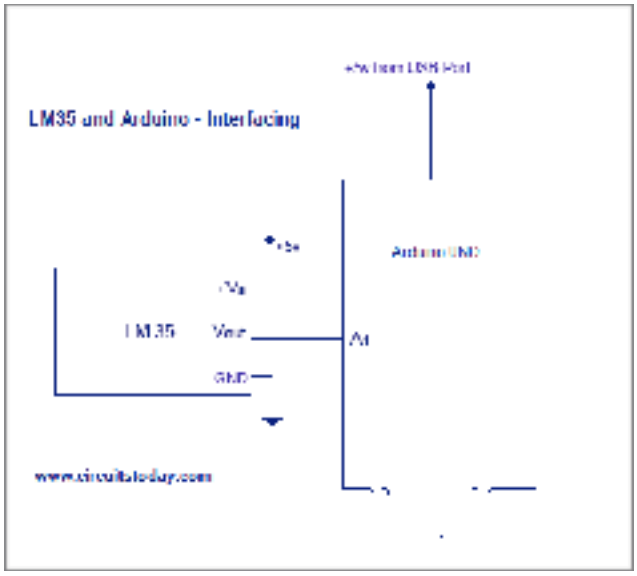

Figure 3.1.1 LM35 Connection

The +5v for LM35 is taken from the +5v out pin of arduino.The ground pin of LM35 is connected to GND pin of arduino. We connect V_{out} (the analog out of LM35) to any of the analog input pin of arduino. In this circuit, we have connected Vout of LM35 to A1 of arduino.

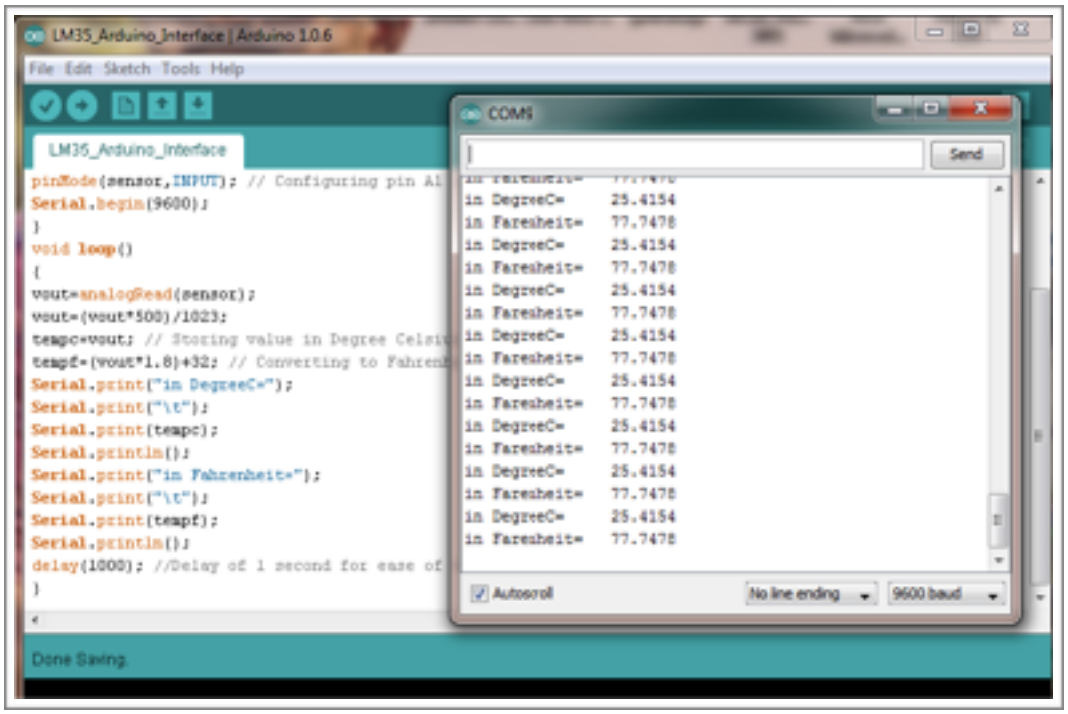

Figure 3.1.2 Arduino Serial Output

However the problem with using LM35 was that the conversion of signal into digital one created additional noises as a result the output wasn't stable. They were constantly changing.

Present Work

Digital temperature sensor DS18B20 has 3 pin configuration **ground, data** and **VCC**. The ground pin is connected to ground of nano, the data pin is connected to the D2 pin of nano and the VCC pin is connected to the 5V pin of nano. The sensor is made liquid proof by encapsulating it inside aluminium cap. The nano is connected to a 16*2 LCD which displays the detected temperature in both Celsius and Fahrenheit. This sensor has high accuracy and precision in detecting temperature as each reading provided by the sensor matches exactly with the temperature reading provided by high quality thermometers.

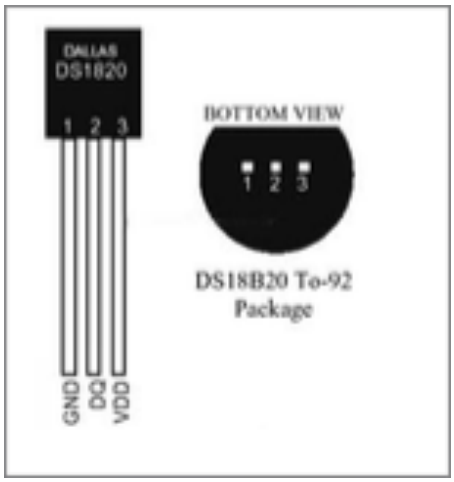

Figure 3.1.3 DS18b20 Pinout

The DS18B20-PAR digital thermometer provides 9 to 12–bit centigrade tile user-programmable upper and lower trigger points. The DS18B20-PAR does not need an external power supply because it derives power directly from the data line (“parasite power”). The DS18B20-PAR communicates over a 1- Wire bus, which by definition requires only one data line (and ground) for communication with a central

microprocessor. It has an operating temperature range of –55°C to +100°C and is accurate to ±0.5°C over a range of –10°C to +85°C.

Figure 3.1.4 DS18b20 Temperature Sensor

Features:

- Unique 1-Wire® interface requires only one port pin for communication
- Each device has a unique 64-bit serial code stored in an onboard ROM
- Requires no external components
- Can be powered from data line. Power supply range is 3.0V to 5.5V
- Measures temperatures from –55°C to +125°C (–67°F to +257°F)
- ±0.5°C accuracy from –10°C to +85°C
- Thermometer resolution is user-selectable from 9 to 12 bits
- Converts temperature to 12-bit digital word in 750ms (max.)
- User-definable nonvolatile (NV) alarm settings
- Alarm search command identifies and addresses devices whose temperature is outside of programmed limits (temperature alarm condition)
- Applications include thermostatic controls, industrial systems, consumer products, thermometers, or any thermally sensitive system

Connection:

Sensor has three wires - Red connects to 3-5V, Black connects to ground and Yellow is data.

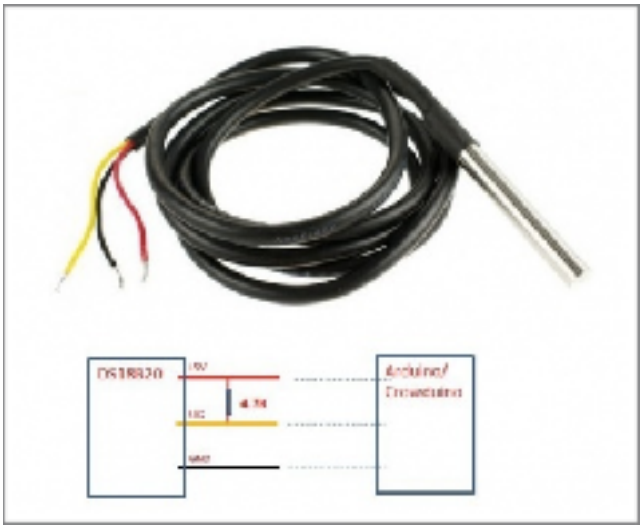

Figure 3.1.5 DS18b20 Connection

Algorithm

Step1: Connect the sensor to arduino mega

Step 2: Upload the code

Step 3: Setup the circuit for temperature sensor

Step 4: Burn the code

Step 5: View the result on LCD

Result:

Temperature sensor (DS18b20) was able to detect the temperature of liquid and the measured value was matching with the values recorded by a standard thermometer.

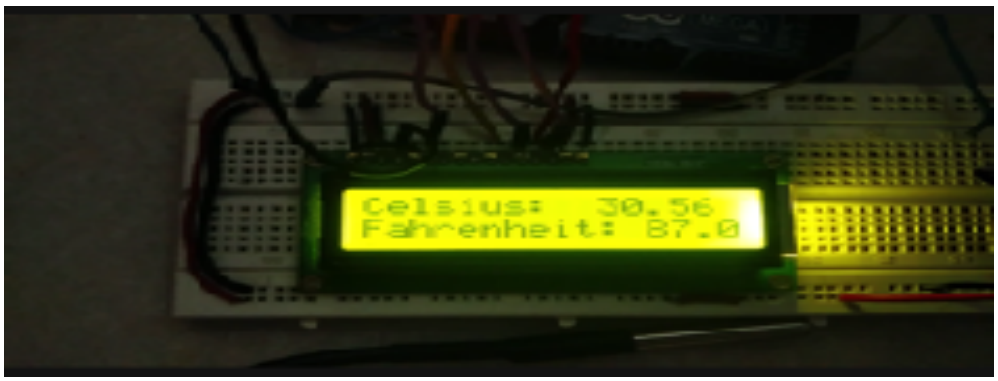

Figure 3.1.6 Temperature indication using DS18b20

CHAPTER 4
AIR BUBBLE DETECTOR

MOC7811 sensor was previously used to detect air bubbles in the flowing liquid. However the output was fluctuating due to weak legs of the sensor. As a result it was replaced with a module where the sensor was soldered into a PCB along with other electronic components of the circuit. Opto Isolator module MOC 7811 has 4 pin configuration **5V, ground, digital output** and **analog output**. 5V and ground pin of MOC 7811 is connected to the 5V and ground pin of nano respectively. The analog pin of the module is connected to the A0 pin of nano. Dialysis tube is positioned accurately inside the opto isolator. When the fluid flows through the tube there occurs a constant range of values, when there is an occurrence of bubble inside the tube the output value changes drastically. This change in values triggers an alarm circuit which alerts the user.

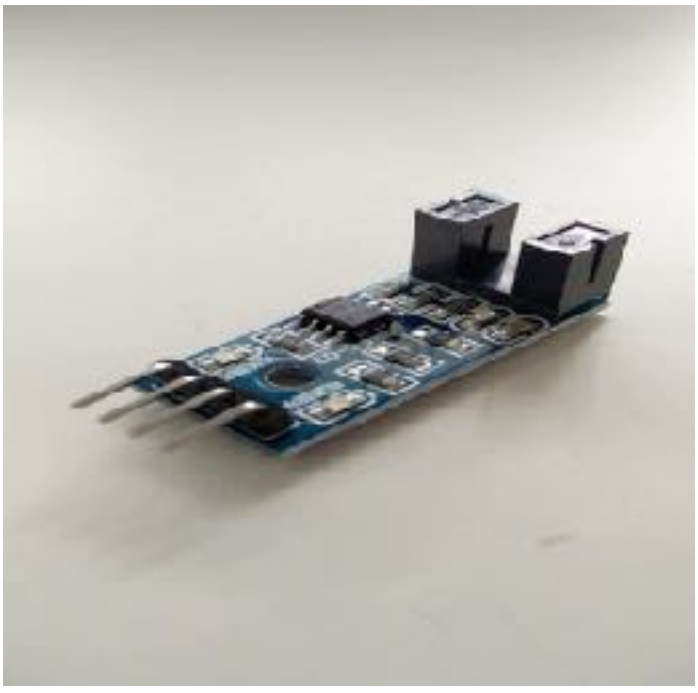

Figure 4.1.1 MOC7811 Module

General Description

MOC7811 is a slotted Opto isolator module, with an IR transmitter & a photodiode mounted on it. Performs Non-Contact Object Sensing. This is normally used as positional sensor switch (limit switch) or as Position Encoder sensors used to find position of the wheel. It consists of IR LED and Photodiode mounted facing each other enclosed in plastic body.

Specifications

- Size: Refer to the image below
- Mounting hole diameter: 3mm

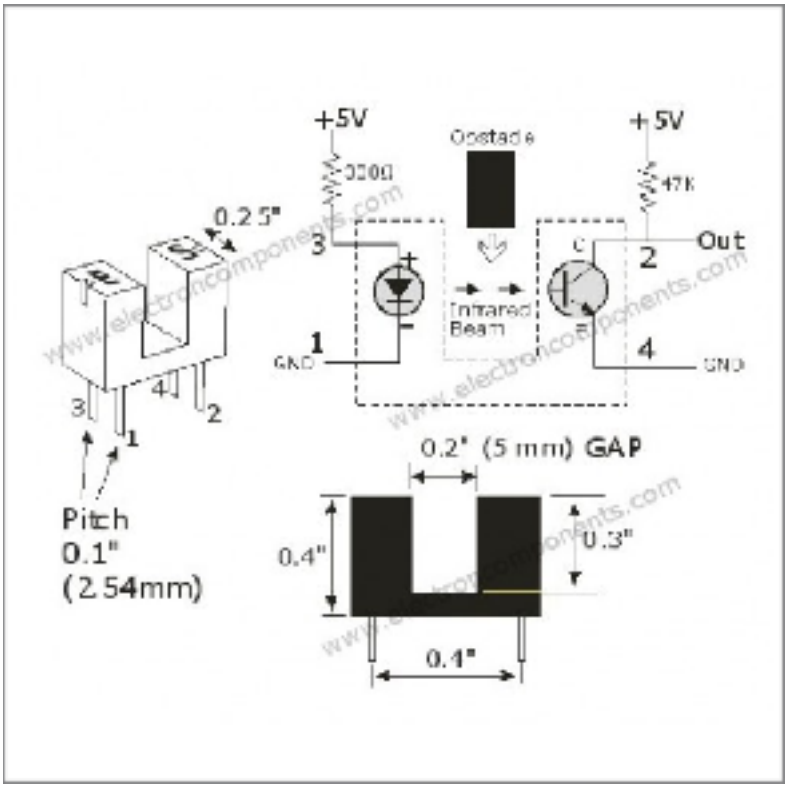

Figure 4.1.2 MOC7811 Pinout

- Mounting hole spacing: 19mm
- Slot width: 3mm
- Slot depth: 7mm

Applications

- DC motor position / velocity control
- Position and velocity servomechanisms
- Factory automation robots
- Numerically controlled machinery
- Computer printers and plotters

Details

When light emitted by the IR LED is blocked because of alternating slots of the encoder disc, logic level of the photo diode changes. This change in the logic level can be sensed by the microcontroller or by discrete hardware. This sensor is used to give position feedback to the robot or as Limit switches.

Algorithm

Step1: Connect the sensor to arduino mega

Step 2: Upload the code

Step 3: Setup the circuit for MOC7811 Module

Step 4: Burn the code

Step 5: View the result on the arduino serial monitor

Step 5: If voltage value greater a threshold make buzz pin HIGH

Step 6: If voltage value lesser a threshold make buzz pin LOW

Result:

Opto Isolator/ Photo Interrupter (MOC7811) was able to detect air bubbles present in the flowing liquid with high accuracy.

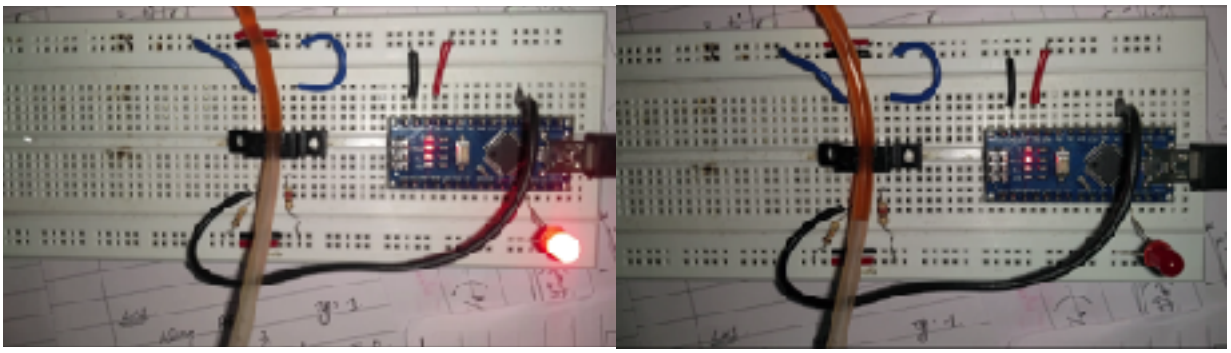

Figure 4.1.3 LED indication of air bubble using MOC7811

CHAPTER 5
BLOOD PRESSURE DETECTOR

3 SS Contact type level sensors are used in the module. One sensor is used to provide 5V power supply while the remaining two sensors act as start sensor and finish sensor. The first sensor is connected to 5V pin of nano, the second sensor is connected to A1 pin and the third sensor is connected to A0 pin of nano respectively. Start sensor triggers the start time and then the finish sensor triggers the finish time of liquid to fill the given volume. The difference between the start and finish time gives the elapsed time from which the flow rate is obtained by dividing capacity of the container by the elapsed time. Then the velocity is calculated by dividing the flow rate by area of the container. From velocity the Reynolds's number is calculated which determines the type of flow whether it is laminar or turbulent. If Reynolds's number is greater than 2000 then it is turbulent and if it is lesser than 2000 then it is laminar. In our project the flow is laminar so by using Hagen-Poiseuille relationship the pressure drop is calculated, from which the pressure head is calculated in terms of millimetres of water.

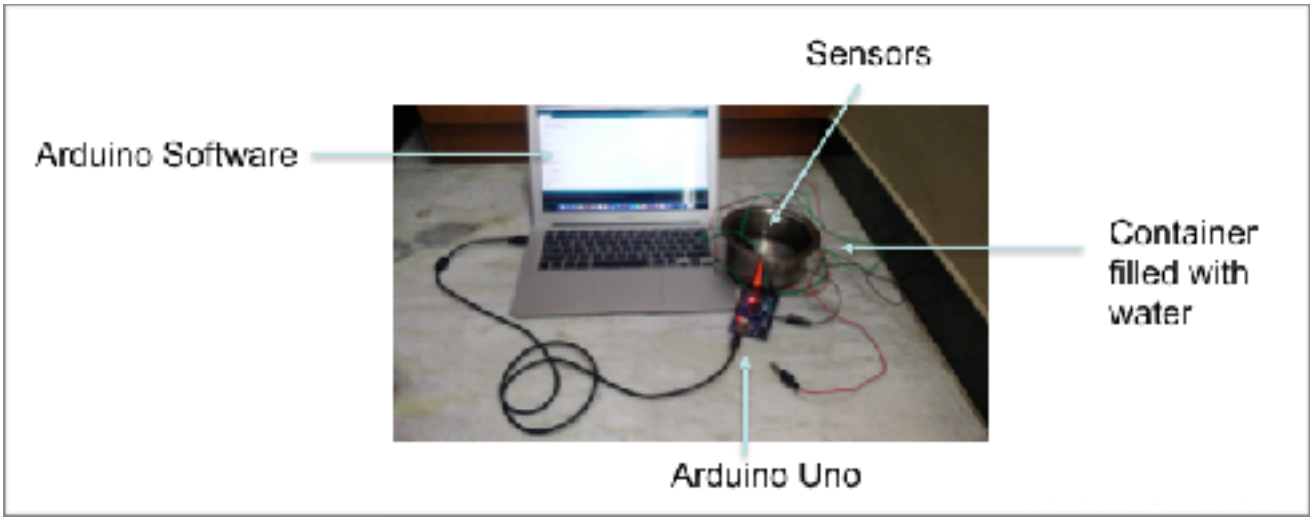

Figure 5.1.1 Pressure Calculation Setup

Formulas Used:

Flow Rate (Q)= Capacity / Time

Velocity(v)= Flow Rate(Q) / Area

Reynold's Number (R_e)= Density(ρ) Velocity(v)*Length(L)/Viscosity (μ)

$$\mathrm{Re} = \frac{\rho v L}{\mu}$$

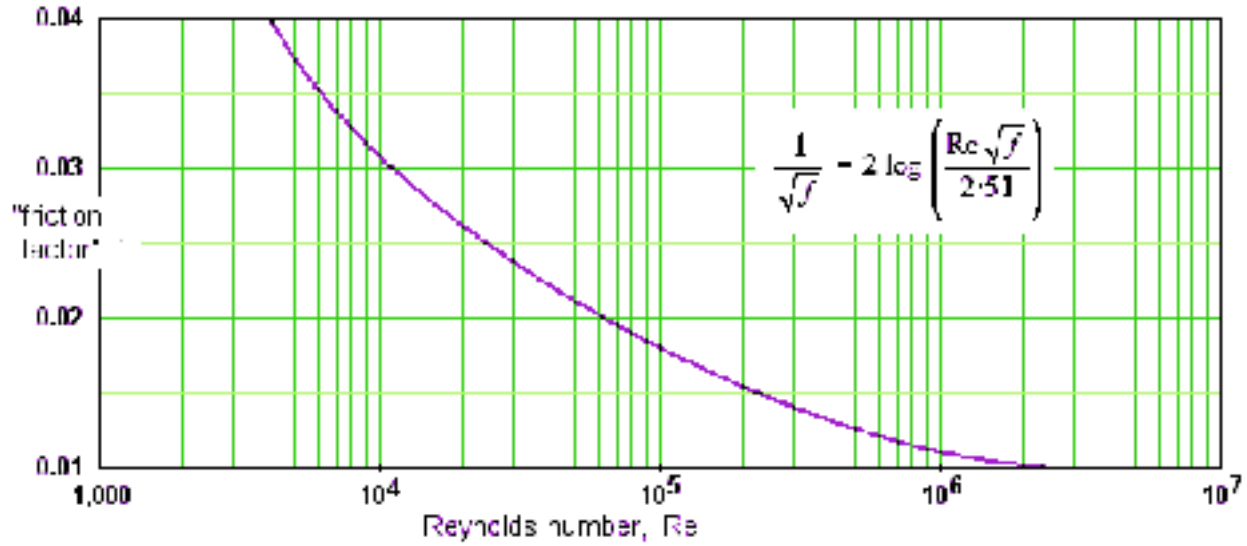

Figure 5.1.2 Calculating friction factor for Darcy's Equation

$$\text{Flow rate} = \frac{\pi r^4 (P - P_0)}{8\eta l}$$

$$P - P_0 = f_D \frac{l}{2r} \frac{\rho V^2}{2}$$

where
r - radius of the tube
η-viscosity of fluid
V-flow velocity
P- outlet pressure
l-length of tube
P_0- inlet pressure
f_D- Darcy friction factor

SS Contact Type Level Sensor

Contact type sensors work on principle of conduction. These level sensors are made out of stainless steel. Three sensors are used here. First sensor gets its input from 5V pin of arduino nano. This is placed inside a beaker which has other two sensors attached inside it at 100mL and 250mL respectively. The two sensors are attached to A0 and A1 pin of arduino nano and act as start and finish. As the liquid enters the beaker, it touches the sensor having 5V as a result the liquid inside the beaker conducts the voltage. When the liquid level rises and touches the other sensors, it gets powered and this activates the corresponding nano pins. Based on the time taken by the two sensors, elapsed time is calculated from which the flow and pressure is finally calculated.

Figure 5.1.3 SS Contact Type Level Sensor

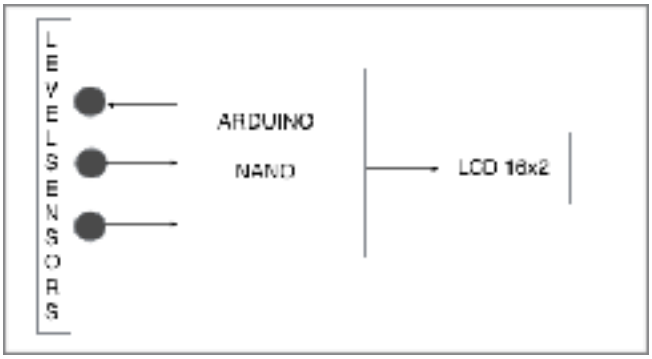

Figure 5.1.4 Level Sensor Block Diagram

Result:

Level Sensors were able to detect the level of liquid from which the pressure was calculated indirectly .

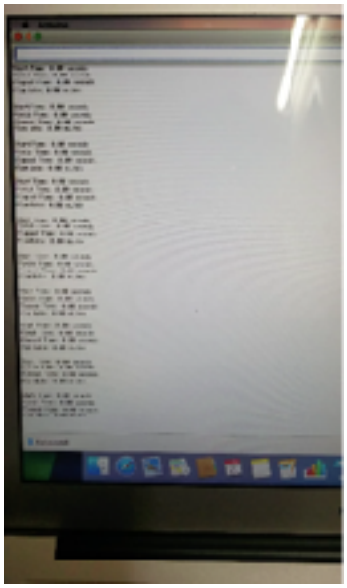

Figure 5.1.5 Pressure detection seen on arduino serial monitor

CHAPTER 6
BLOOD WARMER AND PERISTALTIC PUMP

A blood warmer is used to warm blood or fluids prior to transfusion to a patient. Often used in emergency settings, operating rooms, and intensive care units to prevent hypothermia, the instrument warms blood to a temperature that is safe for infusion. Salient features include automatic adjustment of temperature to flow rate, an audible alarm system, and portability.

Blood Warmer is used to maintain the temperature of blood between 37˚ - 40˚C. It is heated indirectly as direct contact of heating coil with the blood damages it. We have used a 12V DC heater that in turn heats an aluminium plate with grooves for tubings. This heater is capable of producing power up to 120W. The temperature of this aluminium plate is monitored using a temperature sensor (DS18b20) and this acts as a feedback to control the heating process. Arduino Nano is used to power the DC heater when the temperature exceeds the upper limit, a pin is used as a feedback to turn off the machine. An LED glows when something goes wrong.

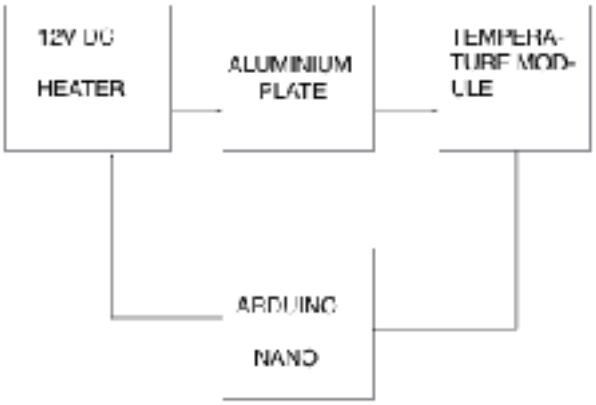

Figure 6.1.1 Blood Warmer Block Diagram

Aluminium Heating Plate

Aluminium plates have the second highest thermal conductivity, next to copper, and are available at much lower cost. Aluminium is non-toxic and non-reactive, and also light weight. Anodised aluminium has a thin coating of aluminium oxide (Al203) on the surface. Aluminium oxide forms as a result of aluminium reacting with oxygen at high temperature, and is a very hard ceramic suitable for protection from scratches. The thermal conductivity of aluminium is about three times greater than that of steel. This makes aluminium an important material for both cooling and heating applications such as heat-exchangers. Combined with it being non-toxic, this property means aluminium is used extensively in cooking utensils and kitchenware. Along with copper, aluminium has an electrical conductivity high enough for use as an electric conductor. Although the conductivity of the commonly used conducting alloy (1350) is only around 62% of annealed copper, it is only one third the weight and can therefore conduct twice as much electricity when compared with copper of the same weight.

Figure 6.1.2 Aluminium Plate with grooves

Design of aluminium plate

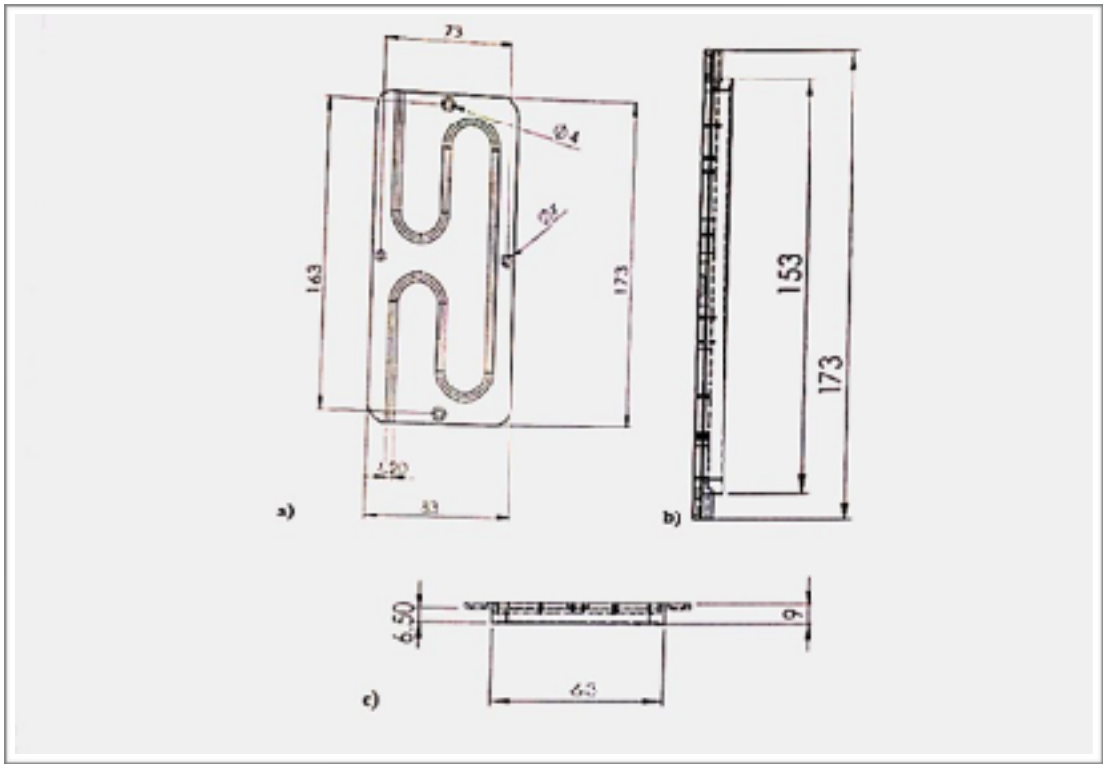

Figure 6.1.3 Aluminium Plate design

Height of the plate: 173mm

Length of the groove: 480mm

Size of the groove: 3.2mm

Width of the plate: 83mm

Peristaltic Pump

The peristaltic pump is based on alternating compression and relaxation of the hose or tube drawing the contents into the hose or tube, operating in a similar way to our throat and intestines.A rotating shoe or roller passes along the length of the hose or tube totally compressing it and creating a seal between suction & discharge side of the pump, eliminating product slip.Upon restitution of the hose or tube a strong vacuum is formed drawing product into the pump.The medium to be pumped does not come into contact with any moving parts and is totally contained within a robust, heavy-duty hose or a precision extruded tube.This pumping action makes the pump suitable for accurate dosing applications and has a pressure rating up to 16 bar (hose) and 2 bar (tube).The high pressure hose has inner layer of 2-6 reinforcement layers and an outer layer, which allow higher working pressures and generate higher suction lifts than non re-enforced tubing.

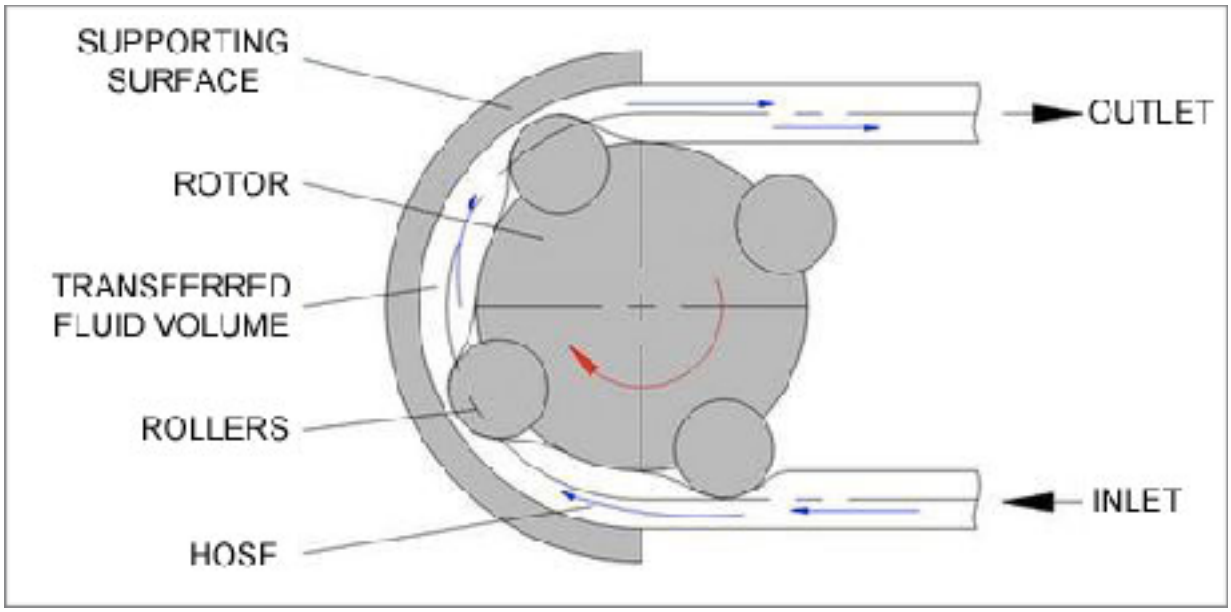

Figure 6.1.4 Peristaltic Pump Inside View

The Peristaltic pump used here has a flow rate of about 5-40ml/min. Two pumps are used one to take the blood from the patient's body and the other one is used to circulate the dialysate. The pump has an operating voltage of about 12V and it plays a significant role in circulating the fluid through the DIALYZER for filtering. It creates a significant negative pressure that sucks the blood form the patient body, it creates the negative pressure by squeezing the tube against a strong support.

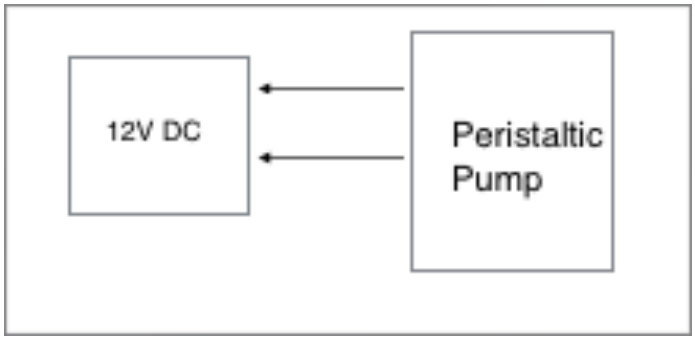

Figure 6.1.5 Peristaltic Pump Block Diagram

Previous Works

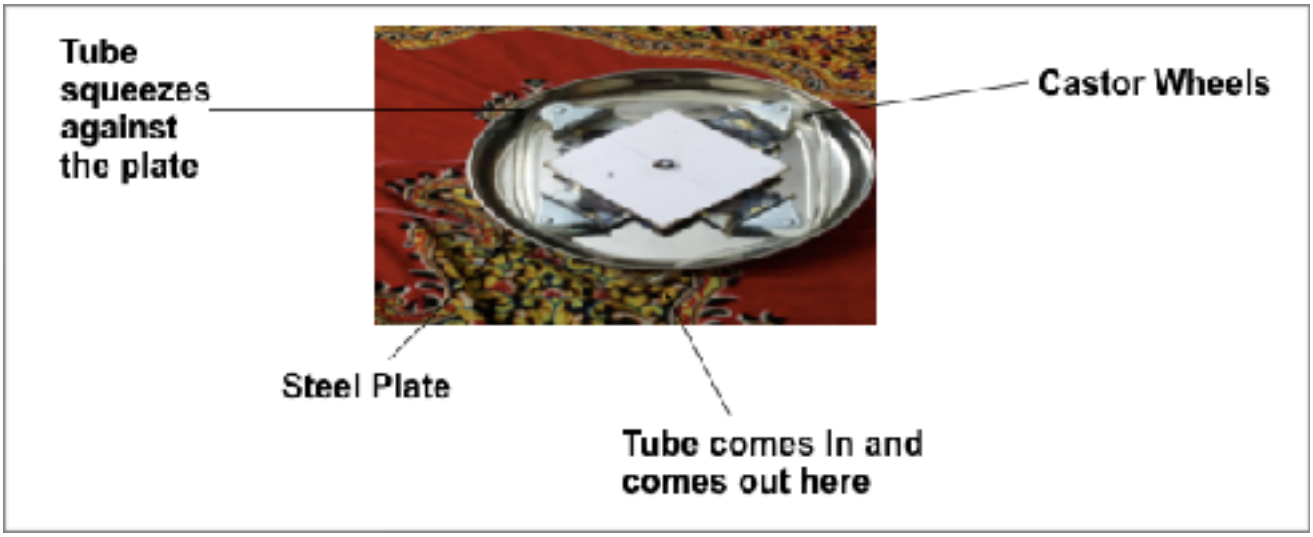

Figure 6.1.6 Peristaltic Pump using steel plate

We developed a peristaltic pump using a steel plate. 2 holes were cut at one end. We used a tube of 6 millimetre diameter and they were enclosed around the circumference of the plate. A DC motor was used and was attached at the plate's centre which was attached to a wooden block, Castor wheels were attached to this block. These wheels squeeze the tube to create a negative pressure for the liquid inside the tube to flow.

Figure 6.1.7 Peristaltic Pump's DC motor

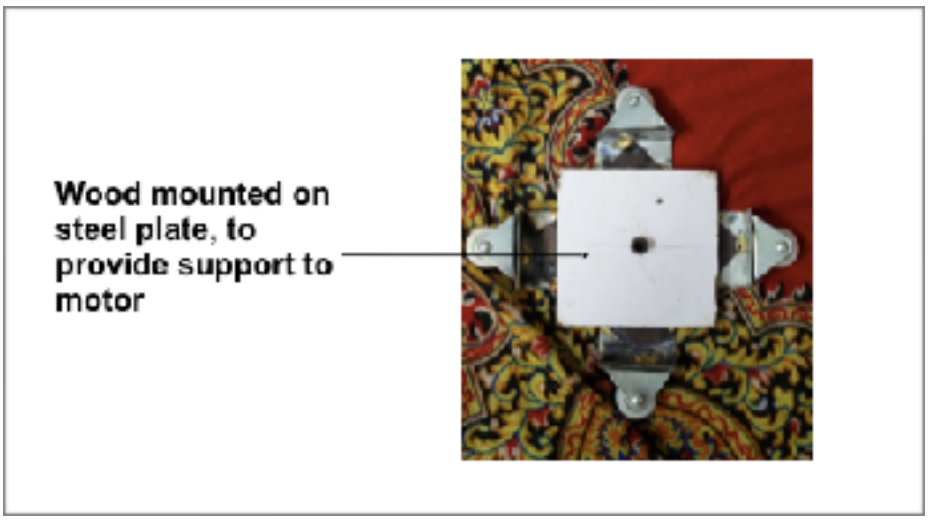

Figure 6.1.8 Wooden block with castor wheels

This pump was unable to create the adequate negative pressure for liquid to be sucked and was creating too much sound.

Result:

Blood warmer was able to heat the liquid and maintain the temperature while the peristaltic pump was able to create adequate negative pressure to suck the liquid.

Figure 6.1.9 Peristaltic Pump circulating the liquid

CHAPTER 7

CONTROLLER AND RELAY CIRCUIT

Relay

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet ,a coil of wire that becomes a temporary magnet when electricity flows through it. As the name suggests, many sensors are incredibly sensitive pieces of electronic equipment and produce only small electric currents. But often we need them to drive bigger pieces of apparatus that use bigger currents. Relays bridge the gap, making it possible for small currents to activate larger ones. That means relays can work either as switches (turning things on and off) or as amplifiers (converting small currents into larger ones).

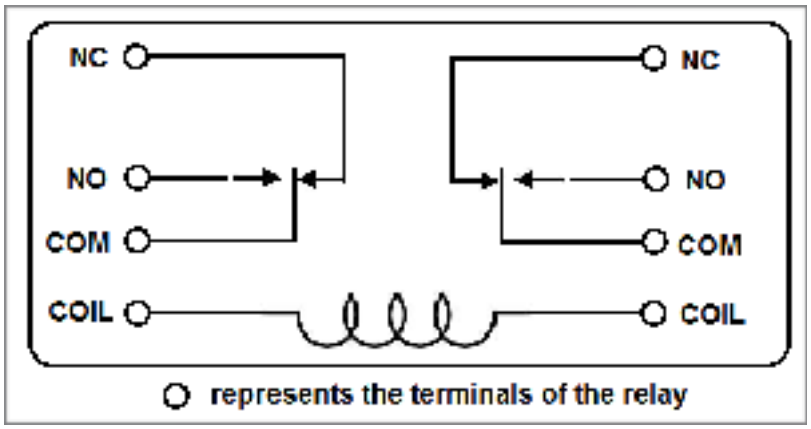

Figure 7.1.1 Relay Pin Diagram

Terminal Connections

- COIL- This the is the COIL terminal. These are the terminals where you apply voltage to in order to give power to the coils (which then will close the switch). Polarity does not matter. One side gets positive voltage and the other side gets negative voltage. It doesn't matter which order. Polarity only matters if a diode is used.

- NO- This is Normally Open switch. This is the terminal where you connect the device that you want the relay to power, when the relay is powered, meaning when the COIL receives sufficient voltage. The device connected to NO will be off when the relay has no power and will turn on when the relay receives power.
- NC- This is the Normally Closed Switch. This is the terminal where you connect the device that you want powered when the relay receives no power. The device connected to NC will be on when the relay has no power and will turn off when the relay receives power.
- COM- This is the common of the relay. If the relay is powered and the switch is closed, COM and NO have continuity. If the relay isn't powered and the switch is open, COM and NC have continuity. This is the terminal of the relay where you connect the first part of your circuit to.

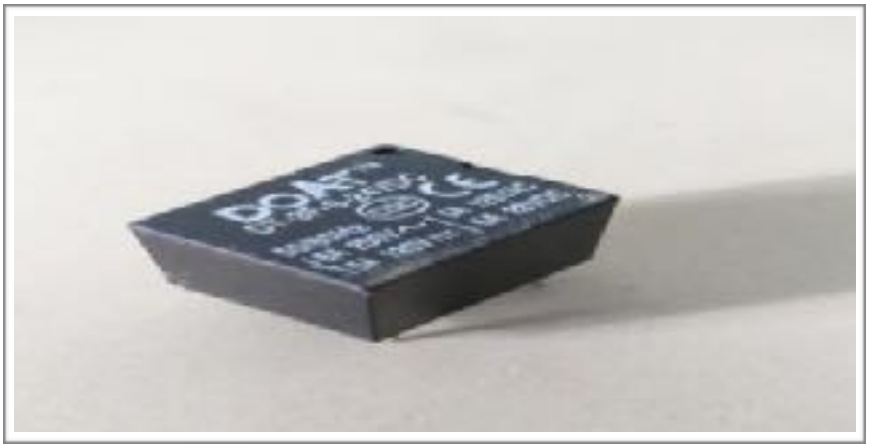

Figure 7.1.2 24V Relay

DC Buzzer

It is an electronic component which works on 5V DC. It produces sound of constant frequency when powered. We've used one DC buzzer for audio feedback.

Figure 7.1.3 DC Buzzer

Light Emitting Diode (LED)

LEDs work with DC less than five volts. These produce light when powered and can be used as an indicator which provides visual feedback.

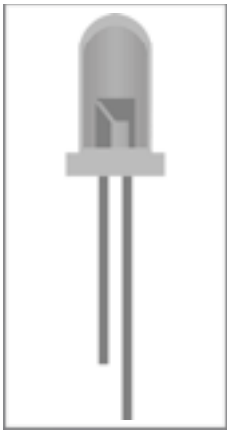

Figure 7.1.4 LED

Working

The arduino mega is used as the main controller which receive feedbacks from D10 pin of each arduino nano. The feedback pins from each module is connected to Pin 8, 9, 10, 11 of arduino mega respectively. The D4 and the ground pin of mega are connected to the coil of relay switch. The common pin of the relay switch is connected to 12V power supply. Initially the D6 pin of mega is kept low, so the relay

remains in its original position without switching. When there is any abnormal situation the subsequent feedback pin becomes high which makes the D4 pin of mega high. This makes the relay to switch from its normal position which cut's off the power supply to the pump so that the liquid doesn't flow until the abnormality is rectified. The abnormal situation is indicated to the technician by buzzer alarm and LED light.

System Block Diagram

The entire machine works on 12V DC power supply which is provided by a socket inside that is controlled by a relay. Though the machine runs on AC, the power is converted into DC so that the components inside the machine namely the microcontroller, pump and the sensors run on DC either 5V or 12V which is provided with help of an voltage regulator. Here we have used IC7805 voltage regulator to give 5V from 12V DC

IC 7805 is a 5V Voltage Regulator that restricts the voltage output to 5V and draws 5V regulated power supply. It comes with provision to add heatsink. The maximum value for input to the voltage regulator is 35V. It can provide a constant steady voltage flow of 5V for higher voltage input till the threshold limit of 35V. If the voltage is near to 7.5V then it does not produce any heat and hence no need for heatsink. If the voltage input is more, then excess electricity is liberated as heat from 7805.

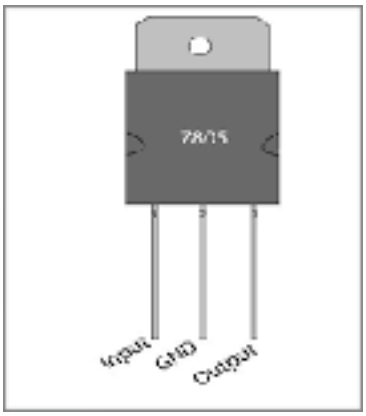

Figure 7.1.5 IC7805

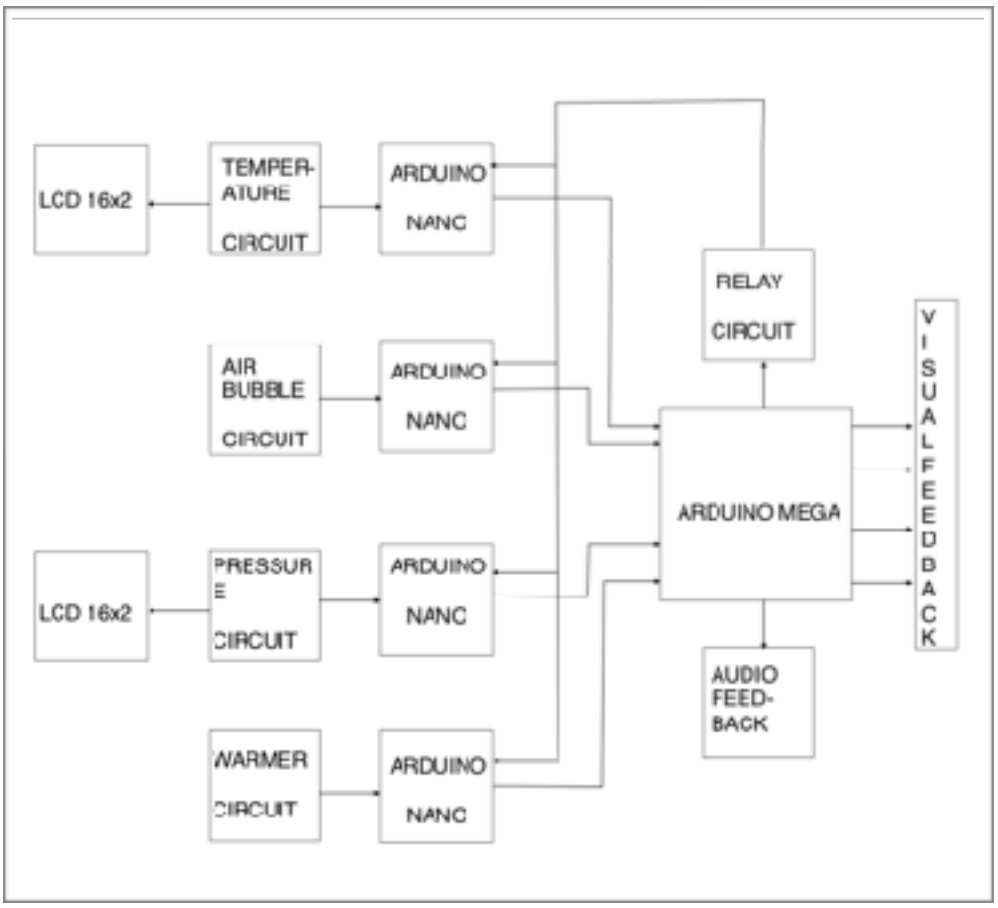

Figure 7.1.6 System Block Diagram

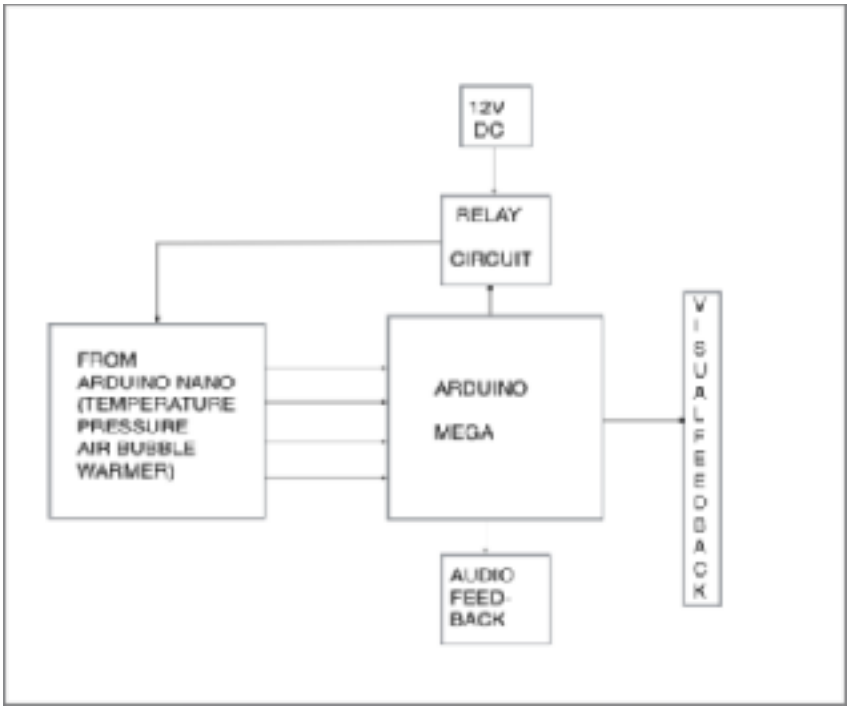

Figure 7.1.7 Relay and controller circuit

Result:

Relays were successful in turning off the machine in case of any abnormality and the nature of abnormality was indicated by a LED. Also a buzzer is used to indicate abnormality along with a LED. It buzzes for any type of abnormality.

CHAPTER 8

CONCLUSION & FUTURE WORK

Hence, the Laboratory Model of Low Cost Dialysis Machine is developed to cut down the cost of dialysis procedure and make it more portable so that it is feasible everyone. By using our model, the complex electronic circuitries can be simplified. This experiment is tested using several liquids namely water, oil, ketchup and dye. Hence this model can be further developed into a dialysis ma- chine which would be really beneficial and advantageous for everyone.

Figure 8.1.1 Model Dialysis Machine from outside

Figure 8.1.2 Model Dialysis Machine from inside

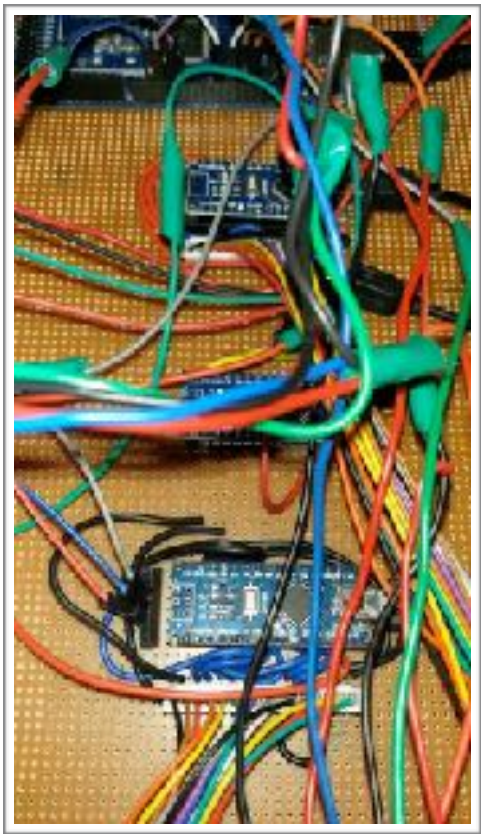

Figure 8.1.3 PCB of the individual modules

Figure 8.1.4 LCD Indicators for Temperature and Pressure

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