# SMART DIALYSIS MONITORING SYSTEM WITH AUTOMATIC CUT-OFF FACILITY

1RAJARAJESWARI, 2MOHAMMED ASHIQ PP, 3MOHAMMED FASIL KV,

4MOHAMMED ASIF, 5NAEEM ABDUL SALAM

1Assistant Professor, 2,3,4,5 UG Scholar,

1, 2,3,4,5 Department of Biomedical Engineering,

Dhaanish Ahmed Institute of Technology, Coimbatore, TN, India

# Abstract

The main motto of this project is to remotely monitor the dialysis process of the patient who is in need. Due to the pandemic conditions like Covid-19, there exists a main drawback of tracking of patients as it involves one to one contact between patient and doctors. Moreover, when the doctor needs to watch closely the patient dialysis process, it forms nightmare to do so and hence we proposed this project in order to remotely monitor the patient dialysis process through IOT application. Through this application, the patient blood temperature, the volume of blood flow through the inlet chamber of dialysis, blood outflow from the dialysis chamber and finally the weight is monitored. Also the corresponding parameters are monitored locally though LCD display (16x2) for the physical monitoring of the dialysis process.

***Keywords*** *–* ***Dialysis, I-R Sensor, Global System for Mobile Communication (GSM), Patient Monitoring, IoT****.*

**1. INTRODUCTION**

As we know Haemodialysis is the process of purifying the blood of a person whose kidneys are not working normally. The smart Internet concept (IoT) which consists of connecting everything surrounding us to Internet and making it responsible of arranging and exchanging data. In healthcare, IoT represents a developed technology integrating all the smart resources, systems, and devices ease diagnosis of diseases, to find out cures, drugs and ensure a successful follow up in one unique system.

The main objective of IoT-based smart monitoring and controlling systems is to ensure a continuous control of all the crucial patient parameters such as the body temperature, the blood pressure, the volume of

blood flow during dialysis by use of a single system.

**Embedded System -** Embedded system is a combination of hardware and software use to achieve a single task within a given time frame, repeatedly and endlessly, with or without human interactions. Embedded system of a computer system which monitor and control the response of an external environment. Environment connected to system through sensors, actuators and other input output interfaces. Embedded system must meet timing and other constraints imposed on it by environment. An embedded system in general, incorporates hardware, operating system, peripheral devices and communication software to perform the predefined functions. In contrast to desktops that perform a variety of tasks, an embedded system performs a single, well-defined task.

The system has a processor, associated peripherals and software for a specific purpose. An embedded system is a computer system designed to perform one or a few dedicated functions often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. By contrast, a general- purpose computer, such as a personal computer (PC), is to be flexible and to meet a wide range of end-user needs. Embedded systems control many devices in common use today. Embedded systems are controlled by one or more main processing cores that are typically either microcontrollers or digital signal processors (DSP). The key characteristic, however, is being dedicated to handle a particular task, which may require very powerful processors. For example, air traffic control systems may usefully be viewed as embedded, even though they involve mainframe computers and dedicated regional and national networks between airports and radar sites.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. On a continuum from "general purpose" to "embedded", large application systems will have subcomponents at most points even if the system as a whole is "designed to perform one or a few dedicated functions", and is thus appropriate to call "embedded". In general, "embedded system" is not a strictly definable term, as most systems have some element of extensibility or programmability. For example, handheld computers share some elements with embedded systems such as the operating systems and microprocessors which power them, but they allow different applications to be loaded and peripherals to be connected. Moreover, even systems which do not expose programmability as a primary

feature generally need to support software updates. An embedded system is a computer system that cannot be programmed by the user because it is preprogrammed for a specific task and embedded within the equipment which it serves.

It has three main components:

1. It has hardware.
2. It has main application software. The application software may perform concurrently the series of tasks or multiple tasks.
3. It has a real time operating system (RTOS) that supervises the application software and provides to let the processor to run a process as per scheduling and do the context. RTOS defines the way of the system works.

**Microcontroller For Embedded Systems -** Microcontroller is a highly integrated chip that contains all the components comprising the controller. Typically, it includes the CPU, RAM some form of ROM, I/O ports and timers. A printer is an example for an embedded system since a processor inside the printer does any number of applications as word processor, print Server, video game player, network server or internet terminal software for variety of applications can be loaded. A PC can run a myriad task is that it has RAM memory and an operating system that loads the application software that is typically burned into ROM. Each embedded system has a microcontroller inside it that performs one task. One of the most critical needs of the microcontroller is to decrease the power consumption in space. This can be achieved by integrating more functions into the CPU chip. In high performance embedded processor, the trend is to integrate more and more function into the CPU chip and let the designer to decide which feature is

wanted to be used. A microcontroller is a computer-on-a-chip, or a single-chip computer. Micro suggests that the device is small, and controller tells you that the device might be used to control objects, processes, or events. Another term to describe a microcontroller is embedded controller, because the microcontroller and its support circuits are often built into, or embedded in, the devices they control. Any device that measures, stores, controls, calculates, or displays information is a candidate for putting a microcontroller inside.

**Internet Of Things -** The Internet of things (IoT) describes the network of physical object “things” that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet. The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Traditional fields of embedded systems, wireless sensor networks, control systems, automation, and others all contribute to enabling the Internet of things. In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", including devices and appliances that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smartphones and smart speakers. IoT implementations use different technical communications models, each with its own characteristics. Four common communications models described by the Internet Architecture Board include: Device- to-Device, Device-to-Cloud, Device-to- Gateway, and Back-End Data-Sharing. These models highlight the flexibility in the ways that IoT devices can connect and provide value to the user. There are a number of serious concerns about dangers in the growth

of IoT, especially in the areas of privacy and security, and consequently industry and governmental moves to address these concerns have begun including the development of international standards.

**Arduino IDE -** The Arduino Integrated Development Environment (IDE) is a cross platform application (for Windows, mac OS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User- written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main () into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program AVRDUDE to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. AVRDUDE is used as the uploading tool to flash the user code onto official Arduino boards.

# EXSISTING SYSTEM

In the existing system of methodology, continuous monitoring of crucial patient parameters like temperature, blood pressure, glycemic index, SpO2.

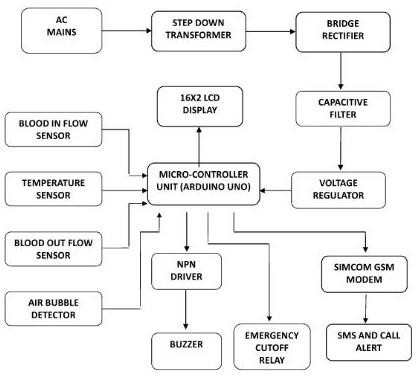
# Issues in existing system-

* Absence of the blood bubble detection system.
* Doesn’t have SMS notification and triggering alert.
* We can’t monitor from remote location.
* Automatic Cut-Off facility is available.

# PROPOSED SYSTEM

Due to the pandemic conditions like Covid-19, there exists a main drawback of tracking of patients as it involves one to one contact between patient and doctors. Moreover when the doctor needs to be closely watch the patient dialysis process, it forms nightmare to do so and hence we proposed this project in order to remotely monitor the patient dialysis process through IOT application. Through this application, the patient blood temperature, the volume of blood flows through the inlet chamber of dialysis, blood outflow from the dialysis chamber and finally the weight is monitored. Also the corresponding parameters are monitored locally though LCD display for the physical monitoring of the dialysis process. And in case of any abnormalities in the predefined parameters the relay system will cut off the dialysis procedure and in the meantime alerting the healthcare personnel to take necessary actions immediately.

**BLOCK DIAGRAM**



**Power Supply -** A regulated power supply is an embedded circuit; it converts unregulated Alternating Current (AC) into a constant DC. With the help of a rectifier it converts AC supply into DC. Its function is to supply a stable voltage, to a circuit or device that must be operated within certain power supply limits. The output from the regulated power supply may be alternating or unidirectional, but is nearly always Direct Current (DC). The type of stabilization used may be restricted to ensuring that the output remains within certain limits under various load conditions, or it may also include compensation for variations in its own supply source.

**Transformer -** The potential transformer will step down the power supply voltage (0- 230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output. It is a general purpose chassis mounting mains transformer. Transformer has 240V primary windings and center tapped secondary winding. The

transformer has flying colored insulated connecting leads Approx. 100 mm long. The Transformer act as step down transformer reducing AC - 240V to AC - 12V. Power supplies for all kinds of project & circuit boards. Step down 230 V AC to 12V with a maximum of 1Amp current. In AC circuits, AC voltage, current and waveform can be transformed with the help of transformers. Transformer plays an important role in electronic equipment. AC and DC voltage in Power supply equipment are almost achieved by transformer’s transformation and commutation.

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Electromagnetic induction produces an electromotive force within a conductor which is exposed to time varying magnetic fields. Transformers are used to increase or decrease the alternating voltages in electric power applications. It is a step down transformer in which the secondary winding is more than primary winding. Due to this windings it can able to step down the voltage. A Transformer changes electricity from high to low voltage or low to high voltage using two properties of electricity.

**Bridge Rectifier -** When four diodes are connected the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. The positive potential at point A will forward bias D3 and reverse bias D4. The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow. The path for current flow is from point B

through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage. Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier. One advantage of a bridge rectifier over a conventional full wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit. This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and Y is 1000 volts in both circuits. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts. The maximum voltage that appears across the load resistor is nearly-but never exceeds - 500 volts, as result of the small voltage drop across the diode. Current flows through the load during both half cycles of the applied voltage. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit. In the conventional full-wave circuit, the peak voltage from the center tap to either X or Y is 500 volts. The path for current flow is from point B through D1, up through RL, through

D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows.

The current flow through RL is always in the same direction.

**Voltage Regulator -** Regulator IC units contain the circuitry for reference source, comparator amplifier, and overload protection all in a single IC. The regulators can be selected for operation with load currents from hundreds of milliamperes to tens of amperes, corresponding to power ratings from milliwatts to tens of watts. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts.

The series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. For ICs microcontroller, LCD - 5 volts. For alarm circuit, op-amp, relay circuits -12 volts.

**Microcontroller Unit -** Arduino is an open- source project that created microcontroller based kits for building digital devices and interactive objects that can sense and control physical devices. The project is based on microcontroller board designs, produced by several vendors, using various

microcontrollers. These systems provide sets of digital and analog input/output (I/O) pins that can interface to various expansion boards (termed shields) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a programming language named Processing, which also supports the languages C and C++.

**Liquid Crystal Display** - LCD stands for liquid crystal display. They come in many sizes 8x1 , 8x2, 10x2 , 16x1 , 16x2 , 16x4 , 20x2 , 20x4 ,24x2 , 30x2 , 32x2 , 40x2 etc.

Many multinational companies like Philips Hitachi Panasonic make their own special kind of LCD'S to be used in their products. All the LCD'S performs the same functions. Their programming is also same and they all have same 14 pins (0-13) or 16 pins (0 to 15). Alphanumeric displays are used in a wide range of applications, including palmtop computers, word processors, photocopiers, point of sale terminals, medical instruments, cellular phones, etc.

**Simcom GSM Modem -** This GSM Modem can work with any GSM network operator SIM card just like a mobile phone with its own unique phone number. Advantage of using this modem will be that its RS232 port can be used to communicate and develop embedded applications. Applications like SMS Control, data transfer, remote control and logging can be developed easily using this. The modem can either be connected to PC serial port directly or to any microcontroller through MAX232. It can be used to send/receive SMS and make/receive voice calls. It can also be used in GPRS mode to connect to internet and run many applications for data logging and control. In GPRS mode you can also connect to any

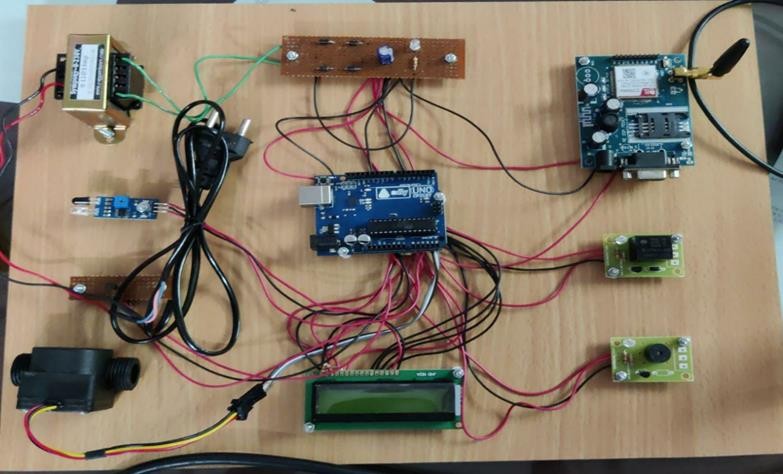
remote FTP server and upload files for data logging.

**Temperature Sensor (LM35) -** The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ˚ Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4˚C at room temperature and

±3⁄4˚C over a full −55 to +150˚C temperature range.

**I-R Sensor** - IR LED emits infrared radiation. This radiation illuminates the surface in front of LED. Depending on reflectivity of the surface, amount of light reflected varies. This reflected light is made incident on reverse biased IR sensor. The amount of electron-hole pairs generated depends on intensity of incident IR radiation. Thus as intensity of incident ray varies, voltage across resistor will vary accordingly.

**Flow Sensor -** Flow sensor consists of a plastic valve body, a rotor, and a hall-effect sensor. When liquid flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse signal. This one is suitable to detect flow of liquid in many applications. There is a comprehensive line of flow sensors in different diameters.



The above figure represents the overall hardware implementation of smart dialysis monitoring system. AC mains are described in order to fetch the power. Which is further step down transformer. Thus obtained AC signal is processed through bridge rectifier. Thus the obtained DC source is an unregulated and rippled DC power source, the capacitive filter and voltage regulator like 7805 are used to obtain regulated DC power source for the microcontroller operation. The LM35, I-R Sensor and flow sensor senses the parameters of the patient undergoing dialysis and the value fed to Arduino microcontroller unit. If the sensor values reaches the pre-determined value the dialysis procedure is cut-off and the alert alarm along with SMS notification is sent to the nurse station.

# SMS Notification Alert –

**CONCLUSION**

By using this project we can monitor the patients dialysis parameters like temperature and blood flow continuously and it will be logged in to the cloud platform. Additionally when these parameters move beyond the pre-determined value, the alarm will be activated and SMS notification will be sent to the nurse station, it helps to activate the care taker immediately. Also when air bubbles are detected by the I-R the dialysis procedure is paused and SMS alert is sent to nurse station for immediate action to be taken.

The system which have been developed in this research can make development of dialysis procedure risk free. Also we can make the procedure contactless between patients and healthcare providers. The system is also capable of producing notification when abnormal condition is detected.

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