

SMART PORTABLE KIDNEY DIALYSIS CONTROL AND MONITORING SYSTEM

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ABSTRACT

Hemodialysis is a procedure or therapy which is performed for patients who suffer from kidney or renal failure. This treatment helps to filter water and waste from the human body which in general is performed by the kidneys when they are healthy. Due to the kidney or renal failure a process called dialysis is performed on patients at regular intervals in order to maintain the blood pressure and with the help of hemodialysis the minerals like sodium, potassium and calcium can be balanced. Even though this treatment cannot act as a replacement for kidneys, it can make the patient feel comfortable and better. The currently available Hemodialert products will detect the blood leakage during the dialysis process only after sensing a leakage of a minimum of 100 ml of blood. Due to this, there are extremely high chances of a disease named 'Uremia' to possibly occur in patients. Also the sensing method is basically based on the changes of the voltage signal in the sensor. This device includes a detector having two electrodes spaced apart from each other which is connected to a signal generating source via a lead. This device also includes a signal processing unit that detects the change of state across the electrodes produced by the introduction of the fluid and an alarm actuated by the change of state. The proposed system is designed in such a way that the blood leakage condition can be detected within 1-2 seconds, which requires a sensing sensitivity of less than 1ml of blood. Photointerrupter is used as a sensor for detecting the blood leakage and it is connected to Wi-Fi for the function of wireless transmission of information.

Keyword: - Hemodialysis, Photo interrupter, Force Sensor, and Blood purifier.

1. INTRODUCTION

Kidney failure seems to be a most deadly disease in most of the countries in the recent years and the number of patients suffering from kidney renal failure is increasing every year. Kidney failure occurs due to the inability of the kidneys to filter the human blood efficiently. There are several types of kidney failure and they are Acute prerenal kidney failure, Acute intrinsic kidney failure, Chronic prerenal kidney failure, Chronic intrinsic kidney failure, Chronic post-renal kidney failure. Various therapy methods adopted for renal failure are Hemodialysis, Peritoneal dialysis and kidney transplantation.

The currently available Hemodialert products will detect the blood leakage during the dialysis process only after sensing a leakage of a minimum of 100 ml of blood. The changes in the voltage signal is the sensing method in the device and the changes in the voltage signal takes place within the sensor. This device includes a detector having two spaced apart electrodes, each electrode is connected to a signal generating source via a lead. The device also includes a signal processing unit that detects a change of state across the electrodes produced by the introduction of

a fluid and an alarm actuated by the change of state. The electrodes are encased in a flexible non conductive material and can be reused after cleaning.

The other commercial product for the detection of blood leakage is available from Red sense with a sensing sensitivity of approximately 1ml of blood. The detection of a blood leakage is by a change in electrical conductance in a circuit, which comprises two metal wires separated by a slit. When the blood flows into the slit, it creates an electrical connection between the two wires, and thus, the blood leakage can be detected.

1.1 Existing System

In the existing hemodialysis machines the amount of blood needed to detect the blood leakage during the dialysis process is high which is improved way too much in the proposed system. The price of the currently available hemodialysis products is high and cannot be afforded by poor people. The existing dialysis machine occupies a lots of space. Although these products have an alarm, the loudness of the alert is limited by the distance, causing healthcare workers to give more attention to whether the alarm is warned or not, which is an inconvenience.

1.2 Disadvantages

There is no monitoring for the blood leakage in the hospital for a patient. If the blood leakage is more the patient health will be more critical. If the dialysis process is not performed at regular intervals the formation of toxins in the blood happens leading to a disease called Uremia. The patient will receive whatever medications are necessary to manage the symptoms of uremia and other medical conditions. The speed of toxins build up in the blood corresponds to how fast the Uremia affects the patient.

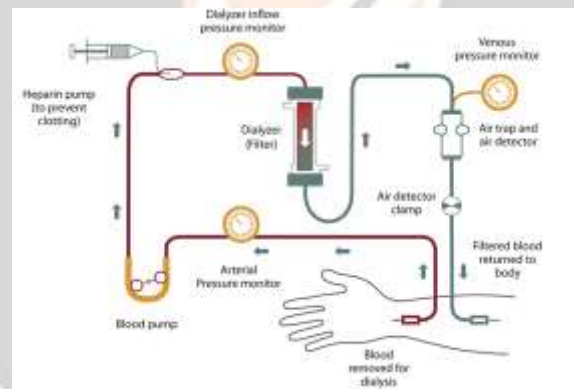


Fig -1: Hemodialysis process

2. PROPOSED SYSTEM

In the proposed system the patient's impure blood will be collected in a tank. Within that impure blood there might be certain diseases like Diabetes, high Blood Pressure etc. In order to remove those diseases a heating unit was connected to the device for heating the blood. For monitoring the blood condition while heating, the LM35 Temperature sensor is also connected to it. After heating the blood, the blood is now sent to the blood purifier unit for the purification process. After purifying the blood it will be sent back to the patient through a pumping motor. During this process there is a chance of blood leakage to happen which will be monitored by using Photo interrupter Tx and Rx in the device. Photo interrupter is used as a sensor for detecting the blood leakage and it is connected to the Wi-Fi for the function of wireless transmission of information.

If the detector senses a leakage of blood, the alert system will be activated immediately, such as sound along with a warning light. In addition, the progress of the patient will be sent to the nearest healthcare station for quick actions. At this point the blood quickly covers the entire absorbent material which makes a change in light penetration. The photo interrupter sensor notices the blockage of light due to the blood leakage in the absorbent material and notifies about the blood leakage. We are going to use the IOT for the transfer of information to the cloud. With the help of cloud we can analyse the patients entire process and for the analysis we are using DA tool.

2.1 Architectural Design

The process begins by collecting the impure blood from the patient’s body. The blood which is collected from the patient’s body is stored in a tank/container and its heated to remove the impurities like wastes and water. Here we have used LM35 as the Temperature sensor to monitor the blood temperature at which the blood is heated. After heating the blood, it is sent to the blood purification unit for the purification of the blood. After fully purified, it is sent to the patient through pumping motor. During this process, if the pressure at which the blood is sent pumped back to the patient and the patient’s blood pressure varies then and there which leads to the chances of blood leakage to occur. Hence a photo interrupter is used to detect the blood leakage.

Photo interrupter is a sensor used for detecting the blood leakage and it is combined with a Wi-Fi module for the function of wireless transmission. This photo interrupter consists of a light emitting sensor(Tx) and light receiving sensor(Rx) and an absorbent material. As a result, the light which is emitted will be absorbed and will never be received by the light receiving sensor(Rx). In this way, the leakage is detected and the alert system will be activated immediately such as sound and a warning light. The message will be passed to the nearest healthcare station through the IOT.

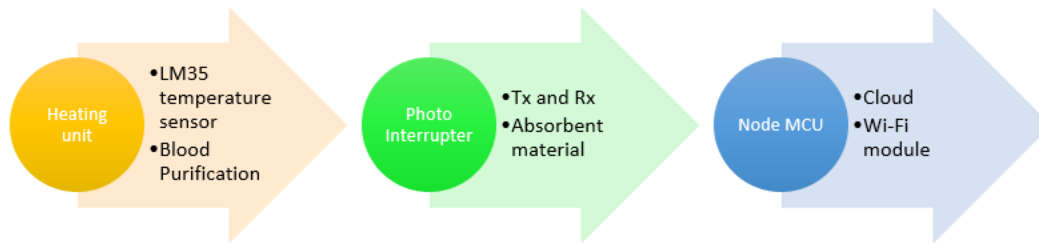
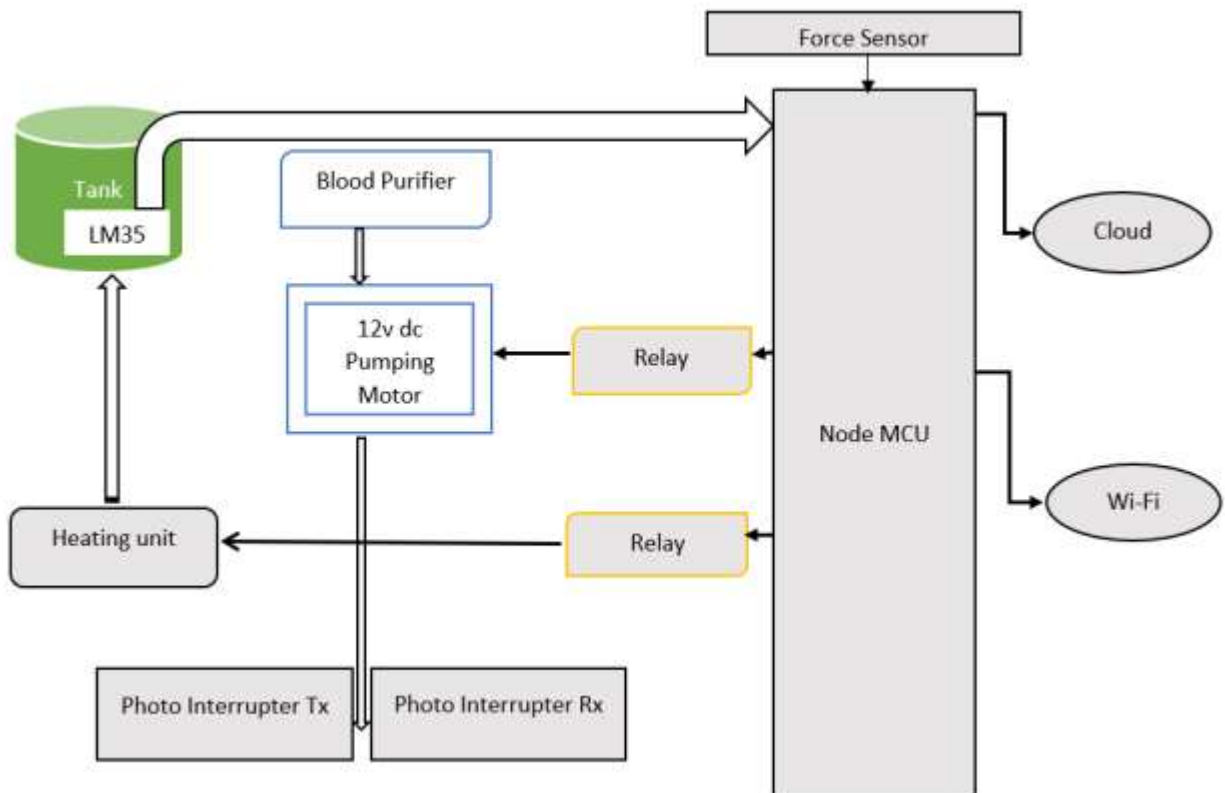
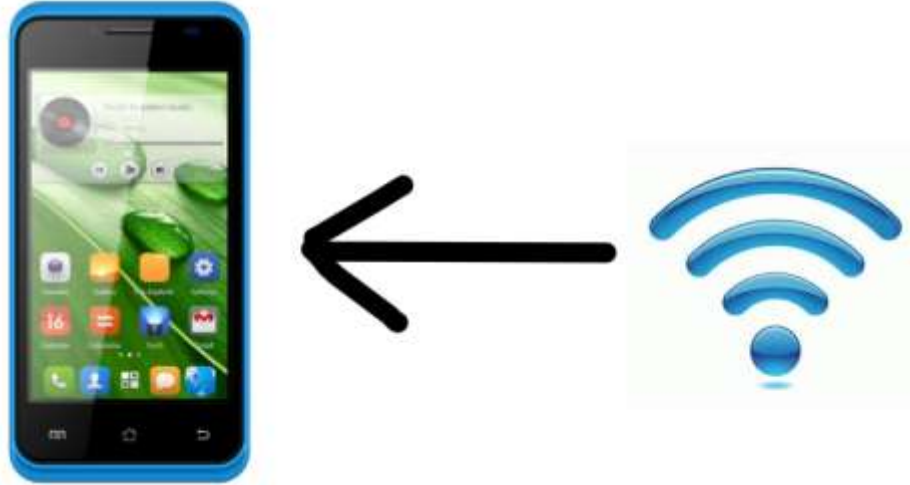


Fig -2: Process Flow Diagram

2.2 Transmitter Unit



2.3 Receiver unit



3. COMPONENT AND TECHNOLOGY STUDY

The hardware components used in this device are Node MCU, Photovoltaic Interrupter, Wi-Fi module, SPI Protocol, LM35 Temperature Sensor, Power Supply unit, Heating Unit, Force Sensor. Relay, 12V Pumping DC motor, Blood Tank Module, Blood Purifier. The technology used are Arduino IDE, Embedded C and JAVA.

3.1 Force sensor

The resistance in the force sensing resistor will change during the application of force or pressure. There is a conductive polymer in the force-sensing resistor, which is responsible for the changes in the resistance at the time of application of force. The conductive polymer is basically supplied in the form of a sheet or in the form of ink supplied by screen printing.



Fig -3: Force sensor

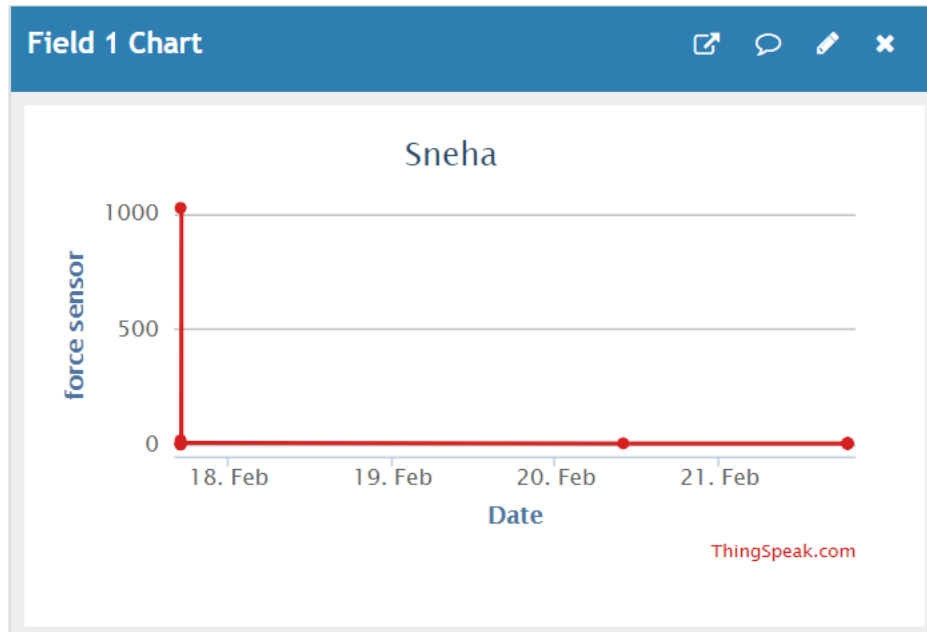


Chart -1: Study of force on force sensor

3.2 Power Supply

The power supply acts as the source of electrical energy. The Power Supply Unit is a device that supplies the electrical energy to the loads present in the system. The power supply unit consists of transformer, rectifier, filter and regulator which are connected in series. It will convert the AC input into stabilized DC output.

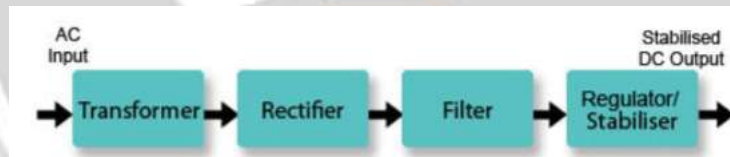


Fig -4: Power Supply

3.3 Photo Interrupter Sensor

The photo interrupter is a kind of sensor which consists of light emitting unit and light receiving unit. The process that happens inside the photo interrupter sensor is the detection of blockage of light because of the leakage of blood in the absorbent material. The important feature of photo interrupter sensor is that it combines both the transmitting and receiving unit in a single package.

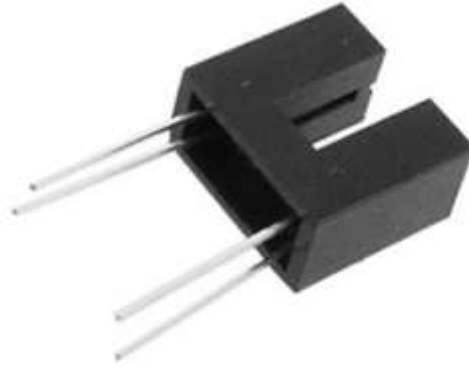


Fig -5: Photo interrupter

4. CONCLUSIONS

In this project we used Photo interrupter sensor to detect the blood leakage during the dialysis process. This will help people who could not afford hemodialysis instruments because this device is cost affordable. The disease such as Uremia can be avoided by using this device because of the high sensing sensitivity of blood leakage. As it is connected to Wi-Fi module, the progress of the patient can be analyzed from anywhere and can be reported to the hospital during emergency without delay.

5. REFERENCES

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