Blood Leakage analysis during Haemodialysis treatment using Image processing

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Abstract: Blood leakage is a critical problem during Haemodialysis therapy. One of the preventive methods to stop the accident associated with the blood leakage is it can be done by using the sensor. This paper describes the application of Sensor installed in a blood leakage monitoring system to detect blood leakage during haemodialysis treatment. This paper describes the application of Image processing installed in a blood leakage monitoring system to detect blood leakage during haemodialysis treatment. Here proposed system consists of PC, Bluetooth module, LED, Blood leak detector and Buzzer. The Image captured by the camera is calibrated for the output which sensing the blood's color only. The red color sensing algorithm is simply evaluated on the system based on the developed algorithm by python and Open CV. The goal of this system is to give an alarm when the red color blood leakage is detected. So if blood leak occurs on the Arterio-venous fistula, which can be detected during haemodialysis treatment. This system alerts by playing sound appropriate alerts are taken immediately by the healthcare workers to prevent any risk happen to the patient during haemodialysis therapy.

Keywords: Haemodialysis, Arterio-venous fistula, Blood leakage, Bluetooth Module.

I. INTRODUCTION

The kidneys play important roles in maintaining health. In healthy condition, the kidneys maintain the body's internal equilibrium of water and minerals. Those acidic metabolism end-products that the body cannot get rid of via respiration are also excreted through the kidneys. The kidneys also function as a part of the endocrine system, producing erythropoietin. Erythropoietin is involved in the production of red blood cells plays a role in bone formation. When you are diagnosed with kidney failure, you need some sort of renal replacement therapy - some sort of therapy that replaces your kidney function. There are plenty of options. In an effort to help those people, we have come up with an idea of DIALYSIS. You need dialysis when you develop end stage kidney failure usually by the time you lose about 85 to 90 percent of your kidney function.

In recent years, kidney renal failure is found to be a major disease in developed and developing countries. Various therapy methods adopted for renal failure are haemodialysis, Peritoneal dialysis, and kidney transplantation [1].In the above three methods, the haemodialysis therapy method is accepted to be the best treatment method by most countries for renal failure. Haemodialysis working [2]

• A Haemodialysis machine has a dialyzer filter which cleans the blood

• The doctor makes access to our blood vessels. This is done with minor surgery on the Arterio-venous fistula, usually to our arm. Then blood is taken into the dialyzer.

• The dialyzer has two parts one part for our blood and the other part for a fluid called Dialysate. These two parts are separated by a thin semi-permeable membrane.

• Smaller waste products such as urea and extra fluid pass through the membrane and are removed.

• Blood cells, protein, and other important things remain in our blood because they are too big to pass through it.

Haemodialysis is the method to access the blood via two thin needles or a central venous catheter, and then it is connected to the dialysis lines. High blood flow circulates the blood to the dialyzer, for cleansing. Haemodialysis carries a risk of blood spillage, whether, it is done at home or in the hospital [3]. This may occur because of:

• Accidental dislodgement of the needles (the venous needles creates the greatest blood loss)

• Disconnection of the needles or catheter from the dialysis lines.

• Disconnection of the lines from the dialyzer.

An unfortunate blood leakage during haemodialysis therapy is at least inconvenient and messy, but at worst it could be fatal. Even though Haemodialysis is the best treatment method for kidney renal failure the various technical problems associated with haemodialysis are venous needle Dislodgement (VND), blood clotting, power failure, the air in bloodlines, dialyzer reaction. Out of the above listed technical problems in haemodialysis, VND is found to be a potentially serious complication and as a result of VND there will be the blood leak occurs during haemodialysis process. Thus blood leakage due to VND in haemodialysis is the most complicated problem and should be avoided

during the haemodialysis process [4]. So it is considered to be important to monitor the blood leaking condition during the haemodialysis treatment.

In this study, Open CV is used with Python for detecting the blood leakage, it captures the frames from the camera and it compares with threshold value so the color value is more than the threshold value then considers it as red color then it plays an alert sound.

II. RELATED WORK

A. Blood Leak Monitoring System to detect blood leakage:

The Hardware components used in the proposed detector mainly include an optical sensor, Bluetooth module, and alert components. The detector senses the light changes due to the absorbent material which absorbs the blood and thus the voltage signal of the sensor varies accordingly. The obtained voltage change values are converted into a digital signal using a microcontroller and give alert sound and warning light when blood leakage occurs.
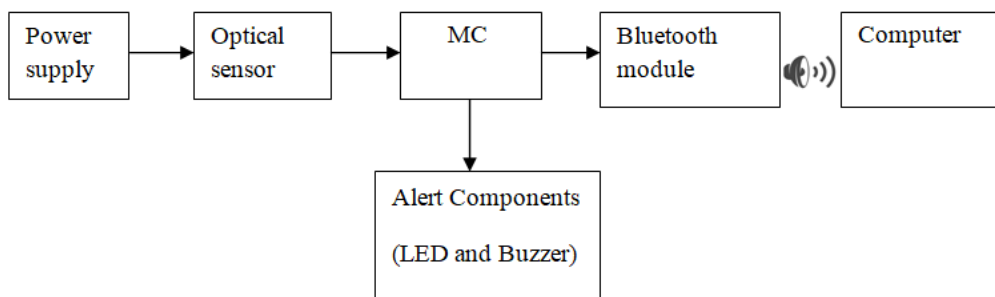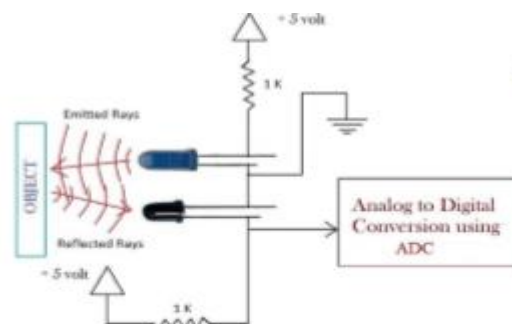

Figure1: Block Diagram of Blood Leakage Monitoring System

Finally, the digital signal is sent to the computer. so the blood leakage monitoring system gives a warning indication to the health care worker if the blood leakage occurs and they can take proper action immediately to prevent the blood loss. This product detects the blood leakage during haemodialysis and 5V power supply is used to give the power of this system.

B. Optical Sensor Module:

This optical sensor module includes LED and photodiode. LED emits light radiation. This radiation illuminates the surface of absorbent material which is placed in front of the LED and the surface reflects the light as shown in Figure 2. Generally, the intensity of light reflected from the surface is varied depends on the reflectivity of the surface. This reflected light is made to an incident on photodiode where it is in reverse biased [5]. Thus based on the intensity of the reflected light from the surface, it gives the sensor output.

Haemodialysis is a process of purifying the blood of a person whose kidneys are not working normally. This type of dialysis achieves the extracorporeal removal of waste products such as creatinine and urea and free water from the blood when the kidneys are in a state of kidney failure. Blood leak is one of the major concern in this therapy,

Figure2: Optical Sensor Circuit Diagram

To keep away from the reflections of nearby objects both the transmitter and the receiver must be enclosed properly with black color plastic cover. The sensor module output is connected to the ADC input of a microcontroller.

C. Dialysate Blood Leak Detection in Haemodialysis

during the therapy Blood leak can happen in two ways, one is due to Venous Needle Dislodgement [VND], which occurs when a venous needle dislodges from patient vascular access during hemodialysis treatment. And another is Dialysate blood leak, it occurs inside the dialyzer when

the membrane which filters out blood ruptures, which leads to blood leak on the dialysate.

For detecting Dialysate Blood leak, dialysate outflow is checked continuously for any traces of blood, the detector sends a beam of light through used dialysate into the photocell, the amount of blood detected can vary greatly, with some that cannot be seen by the human eye. This Optical Sensor Blood Leak Detector which monitors the dialysate triggers an alarm as soon as the smallest amount of blood runs into the dialysate. In this type of Blood Leak Sensor, the transmittance of liquids is monitored, wherein non-invasive detector of blood in clear liquids is developed which must be capable of detecting the smallest amount of blood in dialysate running at a flow rate of up to 800ml/min and clamps on to the transparent tubes.
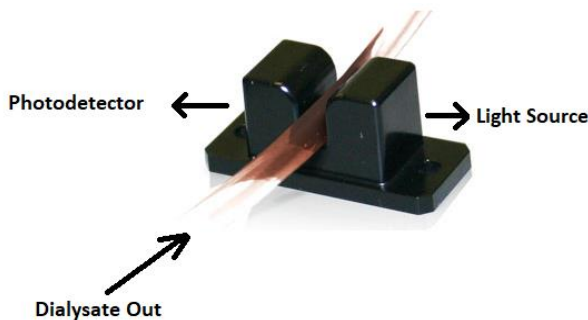

Figure 3: Conceptual Dialysate Blood Leak detector

D. Venous Needle Dislodgement:

In Patients on haemodialysis It is described that even though Haemodialysis is the best method for Kidney Renal failure the various technical problems associated with Haemodialysis are Venous Needle Dislodgement(VND), blood clotting, power failure, the air in bloodlines, dialyzer reaction. Out of the above listed technical problems in Haemodialysis, VND has been reported to be a potentially serious complication and as a result of VND, there will be blood leakage during Haemodialysis process. Thus blood leakage due to VND in haemodialysis is the most complicated problem and should be avoided during the Haemodialysis process. It describes the problems associated with VND, the prevention methods, provides practice recommendations to prevent it, and reduces the risk during HD.

III. Proposed Methodology:

The Venous Needle Dislodgement (VND) is a most important and complicated problem associated with Haemodialysis treatment so a continuous monitoring of blood leakage has to be done during haemodialysis. When any blood leakage monitoring device is used, an alert component (such as sound and or a warning light) shall be present in the monitoring device can give a warning indication to the health care worker about the blood leakage

and they can take the necessary action immediately to prevent the blood leakage. So this product detects the blood leakage during HD.

The electronic components used in our proposed detector include Bluetooth, alert components. The sensing part of the sensor will sense the lights changes due to the colored absorbent material and the original voltage signal of the sensor alerts accordingly. The obtained voltage change value is sent to the alert components through an operational amplifier in the Bluetooth module and is converted into digital signals. Finally, the digital signals can be sent to a monitoring computer via Bluetooth wireless transmission. The block diagram of the blood leak monitor is shown in above figure 4.
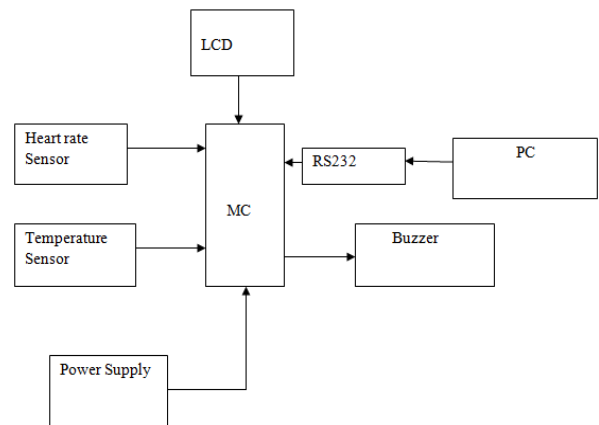

Figure4: Block Diagram of Blood leak monitor
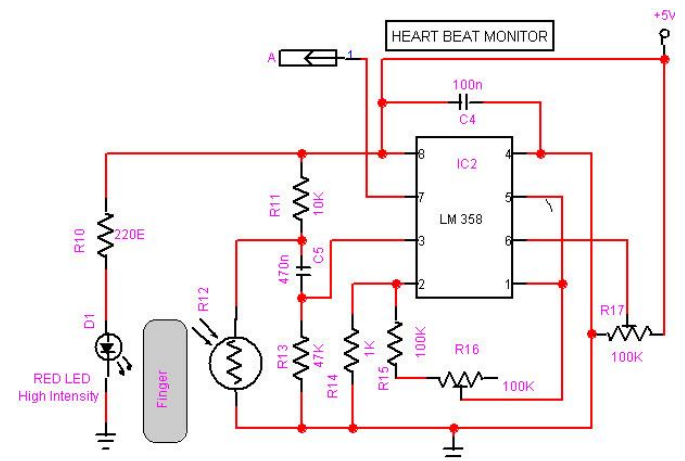
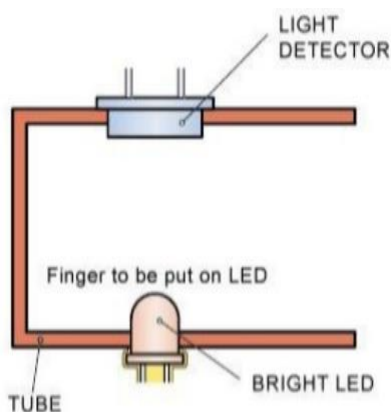**HEARTBEAT SENSOR:**

Figure 5:HeartBeat circuit Daigram

Figure 6:HeartBeat block Daigram

The heart beat sensor circuit diagram comprises a light detector and a bright red LED. The LED needs to be of super bright intensity because maximum light passes and spreads if a finger placed on the LED is detected by the detector. Now, when the heart pumps blood through the blood vessels, the finger becomes slightly more opaque; due to this, less amount of light reaches from the LED to the detector. With every heart pulse generated, the detector signal gets varied. The varied detector signal is converted into an electrical pulse. This electrical signal gets amplified and triggered through an amplifier which gives an output of +5V logic level signal. The output signal is also directed by a LED display which blinks on each heartbeat rate. The main purpose of this automatic health system is to monitor the body temperature, heart rate and pulse rate of a patient and display the same to the doctor by using RF technology. In hospitals, patients' body temperatures and heartbeat rates need to be monitored regularly, which is usually done by doctors or other paramedical staff. They observe the body temperature and heartbeat rates (whether 72 times per minute). The doctors and other hospital management staff keep a record of the body temperature and heartbeats of every patient. This health monitoring system project includes various components such as an 8051 microcontroller, a 5V regulated power supply unit, a temperature sensor, a heartbeat sensor, an RF transmitter, a receiver module and a LCD display. The microcontroller is used as the brain of the entire project for monitoring the heartbeat, pulse rate, and body temperature of patients. The working of this monitoring system project is illustrated with the help of a block diagram, which includes various blocks such as a power-supply block that supplies power to the whole circuit, a sensor that calculates patients' body temperature, and a heartbeat sensor for monitoring heartbeats of the patients.

ALERT COMPONENTS:

A. BUZZER: A buzzer is an audio signaling component that can be mechanical, electromechanical or piezoelectric. Typical uses of buzzers and beepers are giving an alarm to

the devices. These devices are the output transducers which converting electrical energy. The piezo buzzer produces sound based on the inverse principle of the piezoelectricity. The pressure variation or strain which is produced by the application of an electric potential across a piezoelectric material is the basic phenomena of the buzzer [6]. The alert signal can be generated by these buzzers and thus it alerts a user of a particular event corresponding to a switching action, counter signal or sensor input. Piezo-buzzers consumes less current (less than 30 mA) than the magnetic buzzer. Most of the buzzers produce sounds in the range of 2 to 4 kHz.

B. Light Emitting Diode (LED): A light-emitting diode (LED) is a semiconductor light source. It emits visible light when an electric current passes through it.   LEDs are used as indicator lamps in many devices and are widely used for other lighting purposes. Many newly designed LEDs are available across the visible, ultraviolet, and infrared wavelengths, which gives very high brightness. When a light-emitting diode is forward-biased (switched on), electrons are recombined with electron holes within the device and release the energy in the form of photons. This effect is called electroluminescence and the color of the light is determined by the energy gap of the semiconductor. Current LEDs have many advantages over incandescent light sources that including lower energy consumption, longer lifetime, improved robustness, smaller size, and faster switching [7]. LEDs are more powerful for room lighting and require more precise current and heat management than compact fluorescent lamp sources of comparable output.

BLOOD LEAK MONITOR OPERATION:

First, as shown in Figure 7 the process is started and acquire the still image and then analyze the still image. If blood leakage is detected then we have to set the alarm that gives light warning that blood leak is detected. If blood leakage is not detected then wait for N seconds and then the process is repeated. After the blood leakage detected, we have set the alarm that produces the sound and waits for corrective actions taken by the healthcare[8].
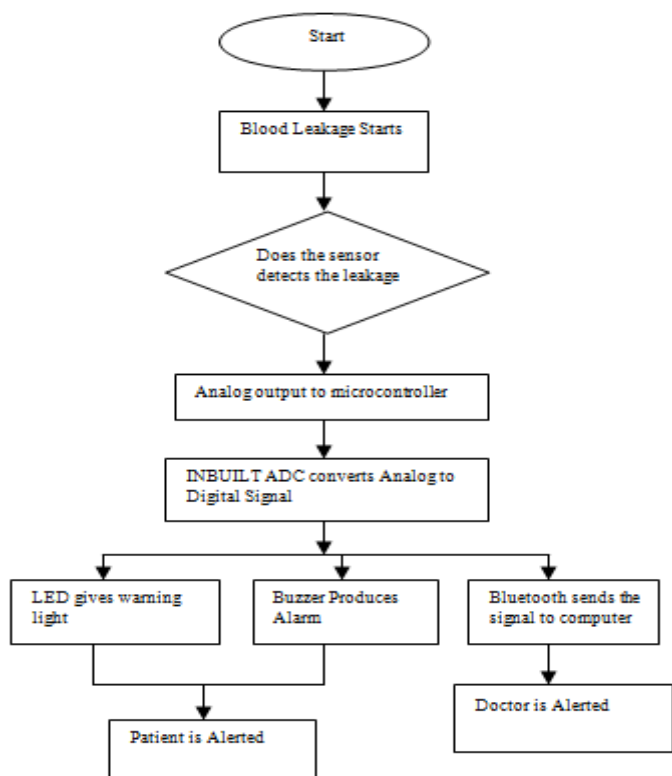
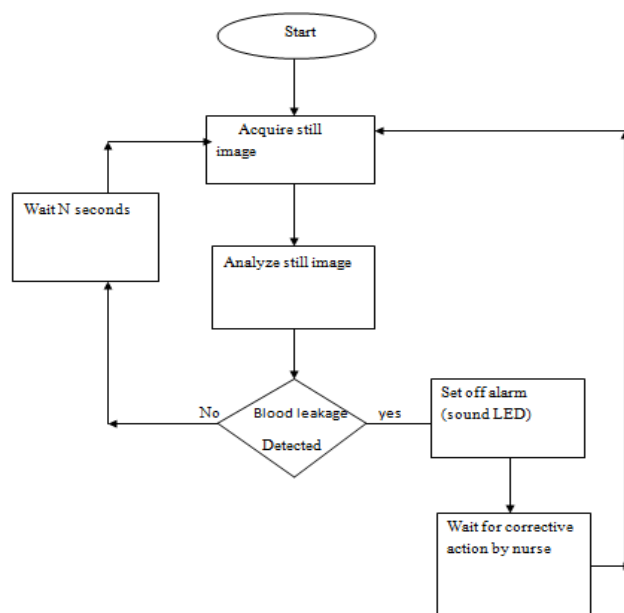**Figure 7:Flow chart of the blood leak Monitoring Operation**

Figure 7 flow chart

Figure 8:Flow chart of blood leak monitor

IV. Results:

In this paper, the developed blood leakage monitoring system is implemented to monitor the blood leakage condition during hemodialysis treatment. In Figure 9, the user interface software installed on the monitoring computer gives alert through a window screen of that the blood leakage occurrence during hemodialysis treatment. In this project, we have to detect the blood leakage during haemodialysis by using Image processing we have build OpenCV python algorithm to detect the blood leakage. Here we are using heartbeat sensor, Temperature sensor, MC, Power supply, RS232, LCD as the hardware parts. Here we are also had detected the patient heart rate and temperature. We have to acquire the images of blood then have to analyze the images of blood. If blood leakage is detected, we have set off the alarm that will give a warning that blood leakage is detected then the doctor has to take care of that. If Blood leakage is not detected then we have acquired the images again and then the process is repeated.Finally, the blood leakage is detected including patient heart rate and also temperature.
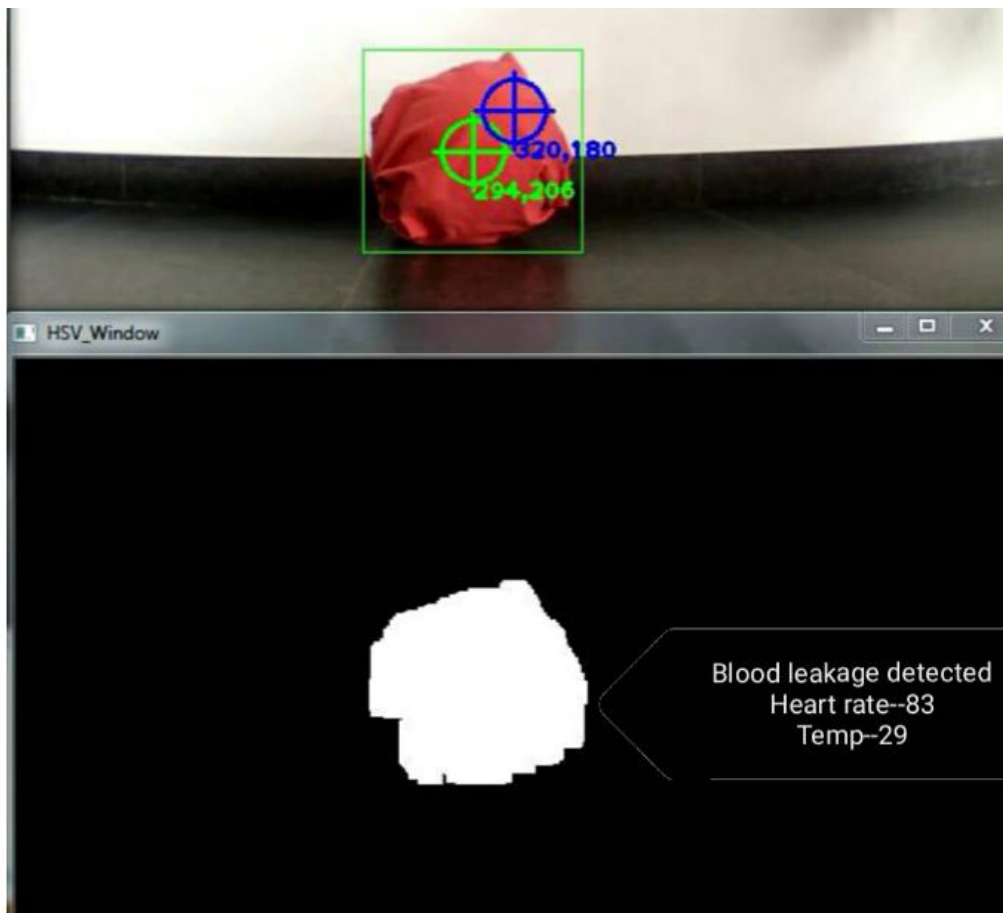
Figure 9:Blood Leakage Detected.

V.CONCLUSION:

In this study, the developed blood leakage monitoring system is an independent system, and thus, it could be simply used along with the current haemodialysis equipment. In addition, the blood leakage occurrence is detected by non-invasively and it can be accessed by the easy installation of the detector on the human arm. The main feature of the developed blood leakage monitoring system is that once the blood leakage is detected, the alert sound. Thus, healthcare workers can take appropriate action immediately and prevent any risks happen to the patient.

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