Automatic Postpartum Hemorrhage Monitoring and Control System

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***Abstract*:- Primary postpartum hemorrhage (PPH) is an obstetric emergency causedby excessive blood loss that occurs most commonly after the placenta is delivered. PPH can lead to volume depletion, hypovolemic shock, anemia, and itis the leading cause of maternal mortality worldwide. With 470 deaths per 100,000 live births, the maternal mortality ratio is high in the world. It is estimated that 94% of births occur at home in developing countries and that 10%of maternal deaths are attributed to PPH. Currently, physicians use visual estimation to calculate blood loss and provide fluid during delivery Primary postpartum hemorrhage (PPH) is an obstetric emergency caused by excessive blood loss that occurs most commonly after the placenta is delivered. PPH can lead to volume depletion, hypovolemic shock, anemia, and itis the leading cause of maternal mortality worldwide. With 470 deaths per 100,000 live births, the maternal mortality ratio is high in the world. It is estimated that 94% of births occur at home in developing countries and that 10% of maternal deaths are attributed to PPH. Currently, physicians use visual estimation to calculate blood loss and provide fluid during delivery. The prototype was built and undergone different tests and iterations. The proposed device was tested for accuracy, cost- effectiveness, and easy to use. 91.28% accuracy has been achieved. The proposed design allows physicians, especially those in low-resource settings, to estimate blood loss and deliver fluid accurately.This helps to reduce the maternal mortality rate that may occur due to postpartum hemorrhage.**

Keywords: Postpartum hemorrhage, Blood loss, Blood pressure, Diagnosis, Fluid delivery, Maternal mortality

INTRODUCTION

Biomedical Instrumentation is an application of Bio Medical Engineering which focuses on the devices and mechanics used to measure, evaluate and treat, biological systems. It focuses are on the use of multiple sensor to monitor physiological characteristics of a human or animal. The Bio instumentation is a new and upcoming field, concentrating on treating diseases and bridging together the engineering and medical worlds. The majority of innovations within the field have occurred in the past 15-20 years. Bioinstrumentation as revolutionized the medical field, and has made treating patients much easier.

POSTPARTUM HEMORRHAGE

Postpartum hemorrhage (PPH) is severe vaginal bleeding after childbirth. It's a serious condition that can lead to death. Other signs of postpartum hemorrhage are dizziness, feeling faint and blurred vision. PPH can occur after delivery or upto 12 weeks postpartum. Early detection and prompt treatment can lead to a full recovery. Get help right away if you're experiencing symptoms of PPH. Postpartum hemorrhage is more bleeding than normal after the birth of a baby. About 1 in 100 to 5 in 100 women have postpartum hemorrhage. It's more likelywith a cesarean birth. It most often happens after the placenta is delivered, but itcan also happen later.

It's normal to lose some blood after giving birth. Women usually lose about halfa quart (500 milliliters) during vaginal birth or about 1 quart (1,000 milliliters) after a cesarean birth (also called c-section)

A c-section is surgery in which your baby is born through a cut that your doctor makes in your belly and uterus (womb). With PPH, you can lose much more blood, which is what makes it a dangerous condition. PPH can cause a severe drop in blood pressure. If not treated quickly, this can lead to shock and death. Shock is when your body organs don't get enough blood flow.

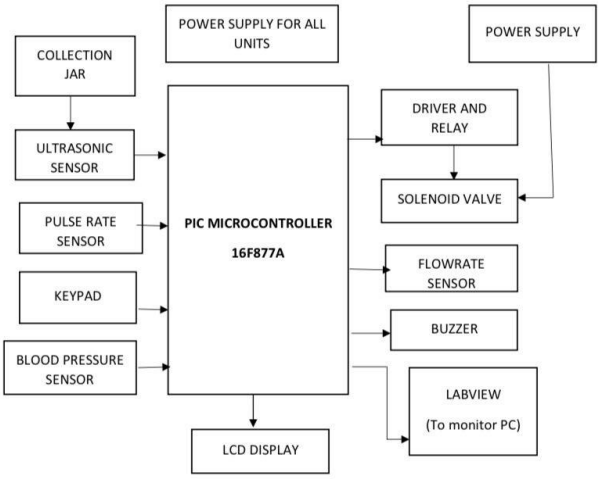
TYPES OF POSTPARTUM HEMORRHAGE

Uterine atony: Uterine atony (or uterine tone) refers to a soft and weak uterus after delivery. This is when your uterine muscles don't contract enough to clamp the placental blood vessels shut. This leads to a steady loss of blood after delivery.

Uterine trauma: Damage to your vagina, cervix, uterus or perineum (area between your genitals and anus) causes bleeding

Retained placental tissue: This is when the entire placenta doesn't separate from your uterine wall. It's usually caused by conditions of the placenta that affect your uterus's ability to contract after delivery

PROPOSED METHODOLOGY

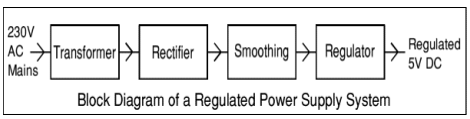


BLOCK DESCRIPTIONS

The Proposed system includes a blood loss collection and measurement system, vital sign monitor (pulse rate and blood pressure), processor unit, low rate monitor and regulator, display, and alarm system. Inputs from the blood loss measurement system. The alarm is used to notify the physicians in case of severe conditions, Under-buttock drape, which allows the blood loss to enter the collection jar without loss, an Ultrasonic sensor is used tomeasure the volume of blood collected in the jar. The solenoid valve controls the amount of fluid to be delivered to the patient. The solenoid valve and flow sensor will stay on until enough fluid is delivered. The flow rate will be used to calculatethe amount of fluid delivered. If the measured value is larger than the clinical setvalue the solenoid valve will be turned off automatically to prevent excess medication.

POWER SUPPLY

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.



Block Diagram of a Regulated Power Supply System

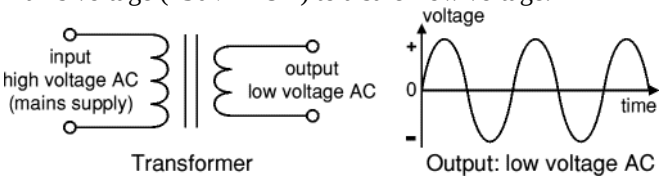
Linear Power supply:

An AC powered linear power supply usually uses a transformer to convert the voltage from the wall outlet (mains) to a different, usually a lower voltage. If it is used to produce DC, a rectifier is used. A capacitor is used to smooth the pulsating current from the rectifier. Some small periodic deviations from smooth direct current will remain, which is known as ripple. These pulsations occur at a frequency related to the AC power frequency (for example, a multiple of 50 or 60 Hz).

Transformers

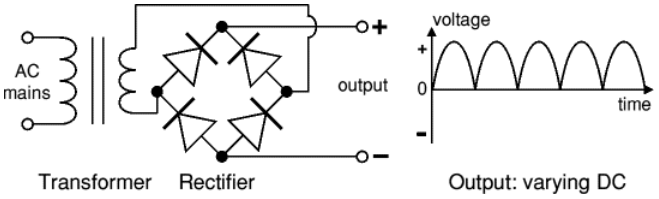
Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC

step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step- down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage.



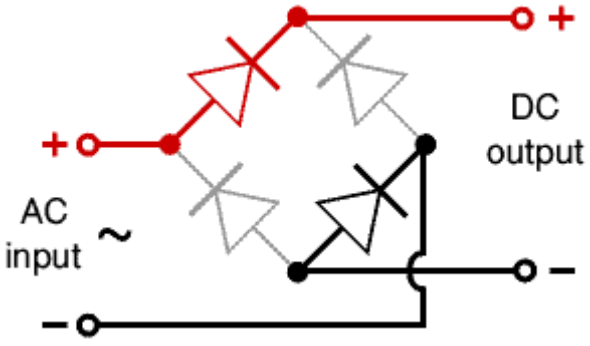
Rectifier:

be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half- wave varying DC

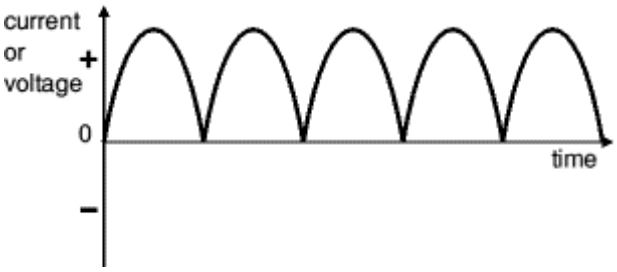


Bridge rectifier

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages). Please see the Diodes page for more details, including pictures of ridge rectifiers

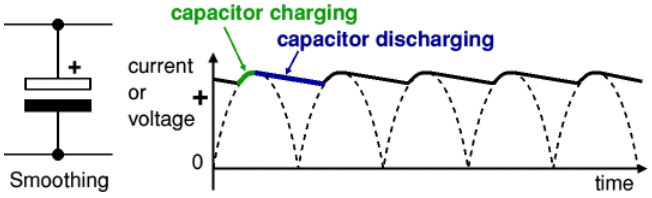


output: full-wave varying DC: (using the entire AC wave):



Smoothing:

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.



Note that smoothing significantly increases the average DC voltage to almost the peak value (1.4 × RMS value). For example 6V RMS AC is rectified to full wave DC of about 4.6V RMS (1.4V is lost in the bridge rectifier), with smoothing this increases to almost the peak value giving
1.4 × 4.6 = 6.4V smooth DC.

IMPLEMENTATION

SOFTWARE IMPLEMENTATION MPLAB IDE SOFTWARE

MPLAB is a proprietary freeware integrated development environment forthe development of embedded applications on PIC and dsPIC microcontrollers, and is developed by Microchip Technology.
MPLAB X is the latest edition of MPLAB, and is developed on the NetBeans platform. MPLAB and MPLAB X support project management, code editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit PIC microcontrollers.
MPLAB is designed to work with MPLAB-certified devices such as the MPLAB ICD 3 and MPLAB REAL ICE, for programming and debugging PIC microcontrollers using a personal computer. PICK it programmers are also supported by MPLAB.

DATAFLOW PROGRAMMING
The programming language used in LabVIEW, named G, is a dataflow programming language. Execution is determined by the structure of a graphical block diagram (the LabVIEW- source code) on which the programmer connects different function-nodes by drawing wires. These wires propagate variables and any node can execute as soon as all its input data become available. Since this might be the case for multiple nodes simultaneously, G can execute inherently in parallel. Multi-processing and multi-threading hardware is exploited automatically by the built-in scheduler, which multiplexes multiple OS threads over the nodes ready for execution.

GRAPHICAL PROGRAMMING
LabVIEW integrates the creation of user interfaces (termed front panels) into the development cycle. LabVIEW programs-subroutines are termed virtual instruments (VIs). Each VI has three components: a block diagram, a front panel, and a connector panel. The last is used to represent the VI in the block diagramsof other, calling VIs. The front panel is built using controls and indicators. Controls are inputs: they allow a user to supply information to the VI. Indicatorsare outputs: they indicate, or display, the results based on the inputs given to theVI. The back panel, which is a block diagram, contains the graphical source code.All of the objects placed on the front panel will appear on the back panel as terminals. The back panel also contains structures and functions which perform operations on controls and supply data to indicators. The structures and functionsare found on the Functions palette and can be placed on the back panel.

Collectively controls, indicators, structures, and functions will be referred to as nodes. Nodes are connected to one another using wires, e.g., two controls and anindicator can be wired to the addition function so that the indicator displays the sum of the two controls. Thus a virtual instrument can be run as either a program,with the front panel serving as a user interface, or, when dropped as a node ontothe block diagram, the front panel defines the inputs and outputs for the node through the connector pane. This implies each VI can be easily tested before being embedded as a subroutine into a larger program.
PARALLEL PROGRAMMING

LabVIEW is an inherently concurrent language, so it is very easy to program multiple tasks that are performed in parallel via multithreading. For example, this is done easily by drawing two or more parallel while loops. This isa great benefit for test system automation, where it is common practice to run processes like test sequencing, data recording, and hardware interfacing in parallel.

HOME BUNDLE EDITION

National Instruments provides a low cost LabVIEW Home Bundle Edition.
LabVIEW is a proprietary product of National Instruments. Unlike common programming languages such

as C or Fortran, LabVIEW is not managed or specified by a third party standards committee such as American National Standards Institute (ANSI), Institute of Electrical and Electronics Engineers (IEEE), International Organization for Standardization (ISO), etc.
DATAFLOW PROGRAMMING MODELRvd

Due to its thorough adoption of a data-flow programming model, as opposed to the sequential ordering of arbitrary commands like most other (usuallytext-based) languages, a barrier occurs for many people who attempt to apply already- learned principles from other programming approaches to LabVIEW. The inherent parallel nature of the execution of LabVIEW code is a perennial source of confusion among those accustomed to other approaches. Thus, most opinions tend to be highly polarised, with people being either very fond of it or very hostile to it.

RESULTS AND DISCUSSION

Different prototype iterations has been conducted to modify our design.It shows parts of the Final design. Under buttock drape for smooth flow of bloodto the jar, collection jar and an ultrasonic sensor to collect and measure blood loss, heart rate and pressure sensor to measure blood loss, heart rate and pressuresensor to measure the two parameters the two vital signs, a flow sensor and a solenoid valve to indicate flow rate and allow one directional flow of IV fluid, respectively and a display system. The following components has been used in the final design. HC- SR04 Ultrasonic sensor, Arduino Uno, Flow Sensor YF-S201, Liquid crystal display(LCD), Buzzer, 4*4 Keypad, Plastic solenoid valve, Pulse sensor, Blood pressure sensor, Plastic jar, Drape, Plastic tube, Resistors, Potentiometer, Jumper wires, and USB cable. It shows the final design of DPHMD.

The prevalence of PPH is disproportionately higher in low resource settings where there is limited access to skilled medical care and safe blood supplies. Despite the fact that it is largely preventable, by improving the quality of care, postpartum hemorrhage is the most common and most deadly form of obstetric bleeding. Initial treatment of PPH includes uterotonic medications suchas oxytocin and misoprostol plus bimanual massage. However, proper collectionand estimation of blood loss is required to manage PPH. This study presented a method for diagnosis and management of PPH digitally.

However, estimating blood loss alone may not giveenough information about the status of the patient. Blood pressure and heart ratemonitoring is key to hemodynamic assessment, with thresholds for systolic bloodpressure (SBP) and pulse used in clinical trigger or early warning systems to prompt intervention. Shock index, which is the ratio of heart rate and systolic pressure, are also used to predict blood loss in patients with PPH. However, usingvital signs in isolation may lead to inaccurate decision since vital sign change dueto PPH can be masked by the hemodynamic changes of pregnancy. Our methodprovides both measurement of blood loss a well as vital signs monitoring to detectand manage PPH.

CONCLUSION

In order to prevent complications, effective management of postpartum hemorrhage plays a huge role in treating and saving mothers suffering from PPH. Our Digitalized postpartum management device can be used as a decision supportsystem for physicians by determining the amount of blood loss and the patient's level of consciousness through vital signs continuous monitoring. The prototypewas built and undergo through different tests and iterations and it is 91.28% accurate. The proposed method will have a great impact in low resource settingswhere both the expertise and means is in scarce.

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