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IoT based drips monitoring system in hospitals

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Abstract: Saline, one among the foremost popular intravenous (IV) therapies plays a serious role within the management of patients who are critically ill. Surveillance of saline bottle level is extremely important because when the bottle is emptied and therefore the needle isn't faraway from the vein then the blood flows outward into the bottle. In hospitals, the nurses or caretakers are liable for monitoring the saline bottle level. Mostly, thanks to negligence and any unusual condition, the precise timing of removing the needle from the patient's vein is ignored which causes a significant casualty and should lead to death as well. Furthermore, remote monitoring may be a got to provide telehealth services. To prevent the accident due to the ignorance of caretakers and to provide remote surveillance in telehealth services, we have proposed the cost-effective smart saline level.monitoring device which includes the mixture of sensor and Internet of Things (IOT) technologies. We have built this system by using load sensor and ultra-low power low cost Arduino micro controller. The load sensor converts the load of the bottle to a selected voltage. The ESP8266 micro controller generates and publishes a specific message based on the voltage received from the sensor. To publish and present the messages to the devices of subscribers like doctors, nurses or caretakers.This proposed monitoring system fulfills the reliable delivery of messages to the subscribers which is very important for healthcare. Automatically, saline bottle valve will be closed with human intervention

Keywords: saline, intravenous therapy, sensors, internet of things, load sensor, micro controller, transformer, rectifier, heartbeat sensor, Arduino UNO

I.INTRODUCTION

Internet of Things (IOT) is that the network of physical objects comprising of-- all the devices, vehicles, buildings and therefore the other items embedded with electronics, software and sensors which enables these objects to collect and exchange data among each other. The Internet of things has evolved thanks to convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Whenever a saline is fed to any patient, he/she must be constantly monitored by a nurse or any relatives. Most often due to negligence, inattentiveness, busy schedule and more number of patients, the nurse may forget to change the saline bottle as soon as it is totally consumed. Just after the saline finishes, blood rushes back to the saline bottle due to difference in blood pressure and pressure inside the empty saline bottle. This may cause reverse flow of blood to saline bottle from their vein. These results in the reduction of hemoglobin level of patients and may also lead to shortage of red blood cells (RBC's) in the patient's blood causing tiredness. Therefore, there is a need of developing a saline level monitoring system which will reduce the patient's dependency on the nurses or caretakers to some extent. In this system, Arduino based automatic alerting and indicating device. Load cell output voltage level changes when intravenous fluid level is below certain limit. The saline drops right down to a particular low level then an alarm generated to alert the nurse that the saline fed to the patient is over. The difference of weight is used to sense the amount of saline present in the bottle and alert through sms. If the nurse fails to attend the patient immediately then a motor arrangement is done which suppresses and flattens the saline tube. This prevents the upward flow of saline from the veins to the bottle.

II. EXISTING METHOD

This existing system presented a dynamic pole placement procedure, based on a static state feedback to improve the performance of target control infusion (TCI) in the control of the neuro muscular blockade (NMB) level by administration of the muscular relaxant rocuronium..
To apply this procedure, a novel identification method, based on the model structure, for the patient model parameters is proposed.
The resulting individualized control method of drug dosage for continuous infusion was validated by simulations supported real data collected during surgeries..

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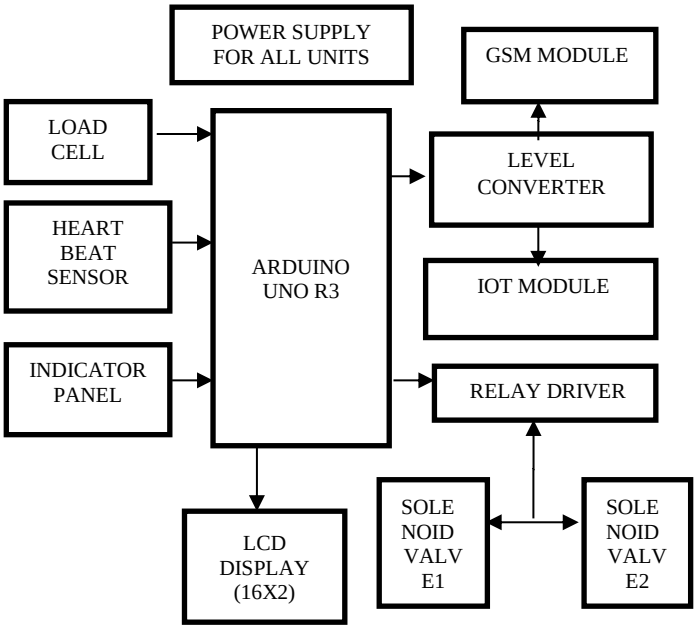
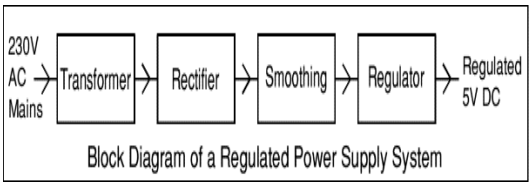
III. HARDWARE DISCRIPTION

BLOCK DIAGRAM



- **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.Power supplies for electronic devices can be broadly divided into linear and switching power supplies. The linear supply may be a relatively simple design that becomes increasingly bulky and heavy for top current devices; voltage regulation during a linear supply may result in low efficiency. A switched-mode supply of **an** equivalent rating as a linear supply are going to be smaller, is typically more efficient, but are going to be more complex.



Block Diagram of a Regulated Power Supply System

- **Transformer:**Transformers convert AC electricity from one voltage to a different with little loss of power. Transformers work only with AC and this is often one among the explanations 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.The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the 2 coils; instead they're linked by an alternating magnetic flux created within the soft-iron core of the transformer. The two lines within the middle of the circuit symbol represent the core. Transformers waste little or no power therefore the power out is (almost) adequate to the facility in. Note that as voltage is stepped down current is stepped up.The ratio of the amount of activates each coil, called the turn's ratio, determines the ratio of the voltages. A transformer features a sizable amount of activates its primary (input) coil which is connected to the high voltage mains supply, and a little number of turns on its secondary (output) coil to offer a coffee output voltage.

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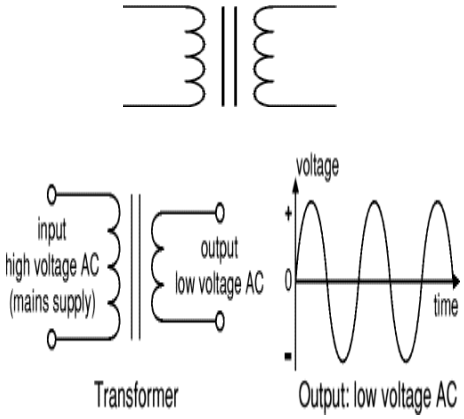
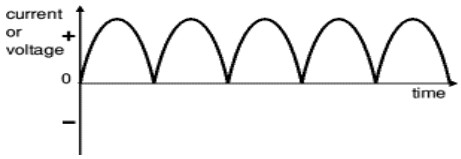


The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor.

- **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).Alternate pairs of diodes conduct, changing over the connections so the alternating directions of AC are converted to the one direction of DC.



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

- **Load Cell:** A load cell may be a transducer that's wont to convert a force into electrical signal. This conversion is indirect and happens in two stages. Through a mechanical arrangement, the force being sensed deforms a strain gauge . The strain gauge converts the deformation (strain) to electrical signals. A load cell usually consists of 4 strain gauges during a Wheatstone bridge configuration. Load cells of one strain gauge (Quarter Bridge) or two strain gauges (half bridge) are also available. The electrical signal output is usually within the order of a couple of milli volts and requires amplification by an instrumentation amplifier before it are often used. The output of the transducer is plugged into an algorithm to calculate the force applied to the transducer.Although strain gauge load cells are the most common, there are other types of load cells as well. In industrial applications, hydraulic (or hydro static) is perhaps the second commonest , and these are utilized to eliminate some problems with strain gauge load cell devices. As an example, a hydraulic load cell is resistant to transient voltages (lightning) so could be a simpler device in outdoor environments.Other types include piezoelectric load cells (useful for dynamic measurements of force), and vibrating wire load cells, which are useful in geo mechanical applications thanks to low amounts of drift.Every load cell is subject to "ringing" when subjected to abrupt load changes. This stems from the spring-like behavior of load cells. In order to live the hundreds , they need to deform. As such, a load cell of finite stiffness must have spring-like behavior, exhibiting vibrations at its natural frequency. An oscillating data pattern are often the results of ringing. Ringing are often suppressed during a limited fashion by passive means. Alternatively, an impact system can use an actuator to actively damp out the ringing of a load cell. This method offers better performance at a price of serious increase in complexity
- **Heartbeat Sensor:**Here we are using IR sensor for detecting the HEART BEAT. IR has less noise and ambient light than at normal optical wavelengths. The light is produced only current passes through within

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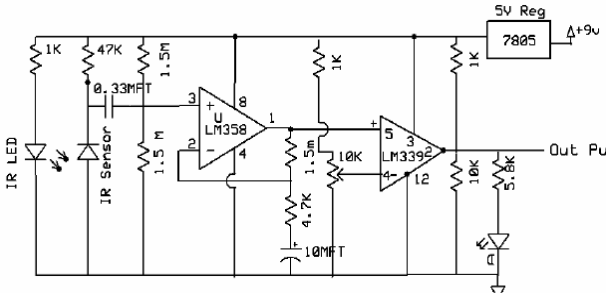
the forward direction and block current within the reverse direction. Plethysmograph is an infrared photoelectric sensor wont to record changes in pulsatile blood be due the finger. The Plethysmograph operates by recording changes in blood volume because the arterial pulse expands and contracts the micro vasculature



This is a non-invasive measurement for changes in finger blood flow during wakefulness and sleep. Pulse wave amplitude (PWA) is that the most often used parameter obtained by finger plethysmography. PWA is directly and positively correlated to finger blood flow. The hypothesis of this study was that finger plethysmograph detects pharmacologically induced changes in finger blood flow, especially changes induced by stimulation and blockade of vascular a-receptors. Due to the anatomic structure of the finger we expected that alterations of vascular tone following sympathetic activation or inhibition might be reflected by changes of PWA. A change in finger blood flow, reflected by PWA springs from the finger plethysmography. PWA derived from finger plethysmography allows continuous, noninvasive measurement of changes in finger blood flow during wakefulness and sleep. Finally, to demonstrate the ability of finger plethysmographto continuously monitor vascular tone, PWA responses to obstructive breathing and concomitant arousal events in patients with obstructive sleep apnea were recorded and analysed.

Arduino UNO: Arduino/Genuino Uno may be a microcontroller board supported the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 are often used as PWM outputs), 6 analog inputs, a 16 MHz quartz , a USB connection, an influence jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to urge started. You can tinker together with your UNO without fear an excessive amount of about doing something wrong, worst case scenario you'll replace the chip for a couple of dollars and begin over again."UNO" means one in Italian and was chosen to mark the discharge of Arduino Software (IDE) 1.0. The UNO board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The UNO board is that the first during a series of USB Arduino boards, and therefore the reference model for the Arduino platform; for an in depth list of current, past or outdated boards see the Arduino index of boards.Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),[1] permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits. The Arduino UNO is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 are often used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, an influence jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to urge started. The UNO differs from all preceding boards therein it doesn't use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the UNO board has a

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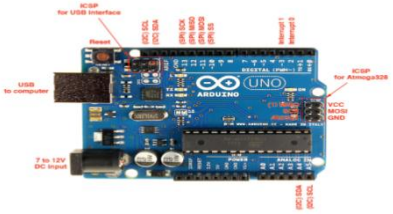
resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode Revision 3 of the board has the following new features: 1.0 pins out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields are going to be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The other may be a not connected pin, which is reserved for future purposes. Stronger RESET circuit. At mega 16U2 replace the 8U2. "Uno" means one in Italian and is known as to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 are going to be the reference versions of Arduino, moving forward. The Uno is that the latest during a series of USB Arduino boards, and therefore the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards. Arduino board designs use a spread of microprocessors and controllers



Specifications :Microcontroller ATmega328

Operating Voltage 5V Input Voltage (recommended) 7-12V

Input Voltage (limits) 6-20V

Digital I/O Pins 14 (of which 6 provide PWM output)

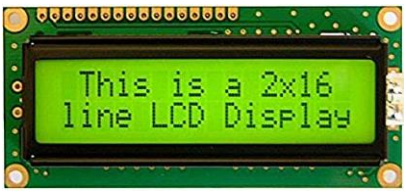
Analog Input Pins 6

DC Current per I/O Pin 40 mA

DC Current for 3.3V Pin 50 mA

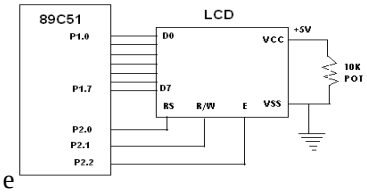
Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader SRAM 2 KB (ATmega328) EEPROM 1 KB (ATmega328) Clock Speed 16 MHz

- **LCD display**



LCD pin descriptions:The function of each pins of LCD is described below **VCC, VSS and VEE** while v and v provide +5v and ground, respectively, v is used for controlling LCD contrast.

LCD interface with micro controller :



e

- **GSM:**GSM, which stands for Global System for Mobile communications, reigns because world's generally used telephone technology. Cell phones use a telephone service carrier's GSM network by checking out telephone towers within the nearby area.The origins of GSM are often traced back to 1982 when the Groupie Special Mobile (GSM) was created by the European Conference of Postal and Telecommunications Administrations (CEPT) for the purpose of designing a pan-European mobile technology.It is approximated that

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80 percent of the world uses GSM technology when placing wireless calls, according to the GSM Association (GSMA), which represents the interests of the worldwide mobile communications industry. This amounts to just about 3 billion global people.For practical and everyday purposes, GSM offers users wider international roaming capabilities than other U.S. network technologies and may enable a telephone to be a "world phone". More advanced GSM incorporates the sooner TDMA standard.GSM carriers have roaming contracts with other GSM carriers and typically cover rural areas more completely than competing CDMA carriers (and often without roaming charges, too).GSM also has the advantage of using SIM (Subscriber Identity Module) cards within the U.S. The SIM card, which acts as your digital identity, is tied to your telephone service carrier's network instead of to the handset itself. This allows for easy exchange from one phone to another without new cell phone service activation.GSM uses digital technology and is a second-generation (2G) cell phone system. GSM, which predates CDMA, is especially strong in Europe. EDGE is quicker than GSM and was built upon GSM..

ESP 8266- 12E Node MCU (IoT module) Node MCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Express if Systems, and hardware which is predicated on the ESP-12 module. The term "Node MCU" by default refers to the firmware instead of the dev kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Express if Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs.The Internet of things (IOT) is the network of everyday objects — physical things embedded with electronics, software, sensors, and connectivity enabling data exchange. Basically, a touch networked computer is attached to a thing, allowing information exchange to and from that thing. Be it light bulbs, toasters, refrigerators, flower pots, watches, fans, planes, trains, automobiles, or anything else around, a little networked computer can be combined with it to accept input (especially object control) or to collect and generate informational output (typically object status or other sensory data). This means computers are going to be permeating everything around us — ubiquitous embedded computing devices, uniquely identifiable, interconnected across the web . Later that month, Tuan PM ported MQTT client library from Contain to the ESP8266 SoC platform, and committed to Node MCU project, then Node needed to modify the Arduino IDE in order that it might be relatively easy to vary the IDE to support alternate tool chains to permit Arduino C/C++ to be compiled right down to these new processors. They did this with the introduction of the Board Manager and therefore the SAM Core

- **Solenoid valve**:Control valves or proportional valves are power-operated devices wont to modify fluid flow or pressure rate during a process system. These valves are used throughout industry in many applications. Control valves types include globe, diaphragm, pinch, knife or gate, needle, butterfly, ball, and plug. Globe valves are linear motion valves with rounded bodies, from which their name springs. They are widely utilized in industry to manage fluid flow in both on/off and throttling service. Diaphragm valves are associated with pinch valves, but use an elastomer diaphragm, rather than an elastomer liner within the valve body, to separate the flow stream from the closure element. Instead of pinching the liner closed to supply shut-off, the diaphragm is pushed into contact with rock bottom of the valve body to supply shut-off. Pinch valves includes any valve with a versatile elastomer body which will be pinched closed, isolating flow, employing a mechanism or fluid pressure. Pinch valves are full bore, linear action valves in order that they are often utilized in both an off/on manner or during a variable position or throttling service. Gate or knife valves are linear motion valves during which a flat closure element slides into the flow stream to supply shut-off. Gate control valves are usually divided into two types: parallel and wedge-shaped. The parallel gate valve uses a flat disc gate between two parallel seats, upstream and downstream. Knife valves are of this sort , but with a pointy edge on rock bottom of the gate to shear entrained solids or separate slurry. Needle control valves have a slender, tapered point at the top of the valve stem that's lowered through the seat to limit or block flow. Fluid flowing through the valve turns 90 degrees and passes through an orifice that's the seat for a rod with a cone shaped tip.

IV RESULT AND DISCUSSION

The successful system is built using trial and error method. Various readings were taken for better accuracy.
Fig.3 showcases the complete kit comprising of various sensors. The entire kit functions properly based on the program in the Arduino UNO. Initially, the sensors were able to read the variations in weight of the saline bottle and heart beat. The following figure showcases the complete kit comprising of various sensors, Arduino, indicator panel, GSM module, and a level converter. All the sensors are interfaced and the voltage is stepped down to 5v using a step-down transformer. Since it requires a low voltage for operation. A smart phone is also used via WiFi

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through ESP8266 module to monitor all the values in a screen which can be recorded for further usages. All these are visible in the following figure.

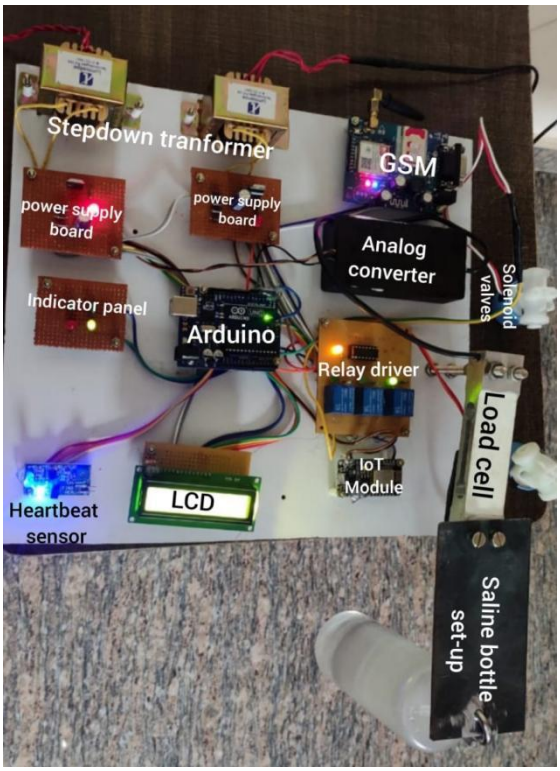

Fig 2: Implemented prototype

Fig.3 represents that the sensors were placed in specified positions in the saline..

Fig 3: Position of saline placed in the load cell

The readings of the various sensors were made visible in an LCD display with proper time interval for visualization. On reaching the abnormal values, the relays and solenoid valves were operated properly.

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V CONCLUSION

With IOT based saline level monitoring system, the manual effort on the part of the nurses is saved. As the entire proposed system is automated, it requires very less human intervention. It will be advantageous at night as there will be no such requirement for the nurses to visit patient's bed every time to check the level of saline in the bottle since an alert notification will be sent to the nurses, doctors, caretakers when saline reaches the critical level. It will save the life of the patients. This will reduce the stress in continual monitoring by the doctor or nurse at an affordable cost. This automatic saline level monitoring system provides more flexibility to doctors, thereby the patients caring is enhanced. Hence it saves lots of time for doctor or nurse who is on duty. It also proposes the system which can automatically monitor the saline flow by using micro controller. The system is reliable, cost effective and convenient for nurses. It can be reused for the next saline bottle. The system helps nurses to monitor the saline flow from a distance. It is mainly advantageous at night timing as there is no need for nurses to go to patient's bed to check the level of saline in the bottle.

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