SMART INTRAVENOUS DRIP INFUSION MONITORING SYSTEM USING LOAD CELL & IoT

A MINI PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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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 far away 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, thanksto 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 care takers. This proposed monitoring system fulfills thereliable 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 cell sensor, transformer ,rectifier

LIST OF TABLES & LIST OF FIGURES

CHAPTER – 1

INTRODUCTION

Adequate hydration via a saline drip is essential during surgery, but recent reports suggest that getting the balance of salt and water just right could have an important impact on patient recovery. Researchers at Thomas Jefferson University found that a slightly saltier intravenous drip (hypertonic saline), and lower total volume of fluid received, reduced the overall rate of complications by 25 percent after the complex Whipple surgery for pancreatic cancer. This relatively minor change in intravenous fluids has had a tremendous effect on the overall complication rate for our patients. Saline delivered intravenously during and after surgery helps to maintain a patient's fluid balance and blood pressure within the appropriate range. The increased salt concentration in the hypertonic saline is designed to keep the body in equilibrium by helping to reduce fluid buildup in the lungs, interstitial spaces and swelling in the extremities. The hypertonic saline draws out the excess fluid that builds up in these tissues. Too much swelling can compromise the delivery of blood and oxygen to the organs. That reduction can slow the healing process. The current study is the largest of its kind and shows a benefit when hypertonic saline is used for the Whipple operation, which can take from to 5-9 hours to perform. Patients undergoing this operation for pancreatic cancer can have complications such as blood clots, pneumonia, wound infection, urinary tract infections, and others. The main objective of system is to provide authentic, accessible, easy and economic system for saline level monitoring. . It can wirelessly send the data to nurses or doctors' computer and display the results in the form of saline droplet rate,

number of droplets coming from saline bottle, saline solution given to the patient in ml and remaining time to empty the saline bottle with the help of serial port test software

1.1 SALINE INFUSION THERAPY FOR POST OPERATIVE PATIENTS

Intravenous salt solutions were first used in the 1830s for the treatment of fluid loss due to cholera and intravenous saline was administered to surgical patients in the late 19th century. As early as 1911 Evans warned of the dangers of excessive saline administration, a warning repeated in the mid 20th century by both Coller and Le Quesne. In 1959 Francis Moore coined the terms ‘sodium retention phase’ to describe the changes which accompany the flow phase of injury and ‘the sodium diuresis phase’ to describe the return of the normal ability to excrete sodium chloride and water, heralding recovery and convalescence. These observations emphasised how the pathophysiology of the response to injury increased the vulnerability of surgical patients to errors in fluid and electrolyte administration, and the importance of prescribing fluids with a clear understanding of this response. Despite all this previous work, a UK study in 1997 showed that postoperative patients were frequently in positive fluid balance of 7 litres or more, with a positive sodium load of 700 ml in the first few postoperative days. Whilst the problem of salt and water overload is not new, the magnitude of the problem is recent. Although avoidance of perioperative hypovolaemia remains an essential requirement and preoperative intravascular optimization improves outcome, excessive fluid

infusion leading to sodium, chloride and water overload is now becoming recognized as a major cause of postoperative morbidity and a contributory factor to length of hospital stay, organ failure and mortality.80 In a review of US practice, they reviewed 13 2 patients who died of postoperative pulmonary oedema; their mean postoperative fluid retention was 7 litres with a positive fluid balance greater than 67 ml/kg/day within the first 36 postoperative hours. In the USA if all of the other comorbidities which might be associated with pulmonary oedema were subtracted there would be 8315 patients who died each year from pulmonary oedema in the absence of causes other than excessive fluid administration. It is essential that the haemodynamic state of the patient is assessed when they arrive on the ward, HDU or ICU. Before deciding the postoperative fluid regimen, adjustment must be made for the volume and content of fluids given pre operatively and perioperatively together with perioperative fluid losses. A frequent mistake is to implement a standard postoperative fluid regimen instead of tailoring it to the individual patient's needs. This is partly because details of fluid balance are often poorly recorded on several different documents. It is important to recognize the point where adequate replacement or resuscitation has been achieved and the goal changes to fluid and sodium mobilisation. Overloading with fluids is frequently caused by continuing a replacement regime for longer than necessary. Postoperatively almost all patients will be in positive sodium and fluid balance often reflected by interstitial oedema, and the aim should be to restore the patient to their normal weight and extracellular volume status. Provided the patient is euvolemic, the

aim should be to allow cautious net excretion of the excess salt and water. The postoperative fluid regime should be considered in relation to the current balance due to prior fluid treatment pre- and intra-operatively. Adjustment should also be made for perioperative fluid losses and the haemodynamic state of the patient when they arrive on the ward, HDU or ICU. Fluid management is an important part of overall surgical therapy. Proper administration of fluids is critical, especially in patients who undergo major 3 surgeries such as emergency laparotomies, bowel resections and hepatectomy procedures. Body fluid composition may change in minutes or hours, resulting in impaired wound healing and homeostasis. Briefly, choice of strategy in intraoperative and postoperative fluid management may be significant. Homeostasis defines the tendency of the organism to maintain stability and balance. In this manner, body fluid balance is controlled by previously described compartment mechanisms. On the other hand, any physical intervention may cause imbalance of the body fluids. During relatively long lasting major surgeries, which are performed with general anesthesia, whole intake is controlled by the anesthesiologist and fluid loss happens in numerous different ways such as bleeding, drainage of ascites, urination, insensible water loss and “third space losses”. Intraoperative management of acute losses is not covered in this article. However, long term effects of these intraoperative events, such as possible over-hydrating by the anaesthesiologist, dehydration, and bleeding should be considered in the postoperative care unit.

1.2 CRYSTALLOIDS

Crystalloids consist of glucose or sodium chloride (saline) solutions. Osmolality of the solution determines if the solution is hypotonic, isotonic or hypertonic. Isotonic solutions have the closest osmolality to plasma and the other solution types are named comparing to plasma osmolality. Saline solution containing 0.9 g of NaCl in each liter of water is defined as isotonic saline, and it is the most popular intravenous fluid worldwide. Some widely used saline solutions also contain one or more of these components: potassium, calcium, bicarbonate, lactate, and glucose. Isotonic glucose solution contains 50 g glucose in each litre of water and it is defined as isotonic glucose. Glucose in these solutions is metabolized right after administration and solvent is mixed into total body water. On the other hand, 4 saline solution's high NaCl concentration serves to keep its solvent water in the extracellular compartment. However, any crystalloid solution can freely pass through double barrier of endothelium. This condition causes up to four fifth of the infused crystalloid to distribute directly into the interstitial compartment. Accordingly, crystalloid infusion in high amounts is related with serious complications, such as pulmonary edema, and hyperchloremic acidosis. Despite that, colloid solutions are generally imprisoned in intravascular compartment, unless double-barrier of endothelium is impaired. Major advantage of crystalloids to colloids is containing only ions or small sized molecules which can easily be metabolized in reasonable amounts.

PROBLEM IDENTIFICATION

Intravenous infiltration is a condition wherein an infused solution leaks inadvertently into soft tissue surrounding a hypodermic needle site. This occurrence affects approximately 6.5% of patients in hospitals worldwide, and can lead to severe tissue damage if not treated immediately. The methods currently used by medical staff to detect an infiltration are subjective and can potentially be prone to error. In our current medical care system, the monitoring of patients in a hospital throughout the day is a tiresome process. Sometimes Doctors or Nurses are too busy, so they can't monitor each patient. This causes many problems. The health related work should be properly done and that too with accurate manner. Infiltration is an even larger concern in pediatric patients, who have smaller veins than adults and have more difficulty in communicating pain or other discomfort associated with the infiltration with medical staff. In a hospital, the significant problem faced by the nurse or attendant is to ensure the level of saline bottle periodically. Reverse flow of blood would occur when the nurse forgets to change the saline bottle which leads to the patient life at risk. Intravenous infiltration is a condition wherein an infused solution leaks inadvertently into soft tissue surrounding a hypodermic needle site. This occurrence affects approximately 6.5% of patients in hospitals worldwide, and can lead to severe tissue damage if not treated immediately. The methods currently used by medical staff to detect an infiltration are subjective and can potentially be prone to error

OBJECTIVE

- Current health care organization requires manual caretakers and their heavy duties become a social problem in the modern world which is an extremely time-consuming job.
- We are proposing a system in which remote drip infusion monitoring and control system has been developed for hospitals.
- Life saving system
- This paper proposes a novel proof-of-concept system that uses non-invasive sensing in conjunction with a low-power embedded computing platform to deliver continuous infiltration monitoring around the IV catheter site.
- This kind of system could be able to detect an infiltration by non-invasively monitoring for known symptoms: swelling of soft tissue and increased skin firmness; these symptoms can be sensed by measuring skin stretch and local bio impedance.
- This need of invention will help the next era nursing and care takers to monitor the IV fluid feeding system fully automated method.
- Moreover, the low-power design and wireless capabilities can potentially enable continuous wear.

CHAPTER – 2
LITERATURE SURVEY

1.) S.Velmurugan et al "Fully Automated Single Window Saline Fluid Flow Control and Automatic Container Changing System" – IEEE, 2021

Due to the technology evolution many advanced techniques has been evolved for assuring quick recovery of the patients in hospitals. Intravenous therapy is treatment that infuses intravenous solutions, medicine, blood, blood products directly into a vein. In general the flow measurement of intravenous fluids or saline fluids needs to be measured and controlled. This existing paper a fully automated android and IoT based continuous monitoring, fluid flow control and automatic saline container changing using single window system is proposed. Multiple intravenous fluid can be injected in a single phase through a single window flow control based on Arduino and IoT Gateway.

2.) Ms. Sincy Joseph, Ms. Navya Francis et al "INTRAVENOUS DRIP MONITORING SYSTEM FOR SMART HOSPITAL USING IOT " – IEEE, 2019

The Bluetooth Module equipped with Arduino has the ability to conjoin with the smartphone application. The sensors collect data from the patient body and IV bag and send the information The Bluetooth Module equipped with Arduino has the ability to conjoin with the smartphone application. The sensors collect data from the patient body and IV bag and send the information For this, we will steadily monitor the heart rate, BP, temperature of the patient, and fluid level on the IV

bottle while injecting. If abrupt changes are coming, it will alert the medical personnel. For alerting, we use buzzer technique and messaging facility

3.) Ruhul Amin, Troyee Sharmistha Saha et al "IoT Based Medical Assistant for Efficient Monitoring of Patients in Response to COVID-19"- IEEE,2020

Monitoring of patients at regular intervals through an interconnected network among the doctors, nurses and patients with a view to minimizing the workload of the doctors and nurses, reducing the chances of medical professionals being infected by COVID-19 type of contagious disease and increasing the overall efficiency of patient monitoring in hospitals. Bio-medical sensors interfaced with microcontroller are used to collect the data of heart beat rate, body temperature and body movement to get an overview of the present health condition of the patient. The recorded data are stored in an excel file and updated automatically to the internet via OneDrive in every 30 seconds. In case of any large deviation from the normal condition, an automated alarm system will notify the assigned doctor about the condition of the patient.

4.) Jayeeta Saha, Arnab Kumar Saha et al "Advanced IOT Based Combined Remote Health Monitoring, Home Automation and Alarm System"- IEEE, 2018

Due to a busy schedule and irregular lifestyle, health hazard is not an age-dependent factor in the recent era. Under these circumstances, Internet of Things has provided a much easier solution for remote real-

time health monitoring of patients from the hospital as well as home. Sensors acquire the data of various parameters regarding patients' health, and the Internet of Things stored that data and displays through the website, which provides access for remote monitoring. Use of Sensor reduces the human error, and the size of the system reduces the occupied space of the room. The unique part of this proposed solution is the alarm generation to provide the prescribed medicine to the patient in time.

5.) Anagani Venkata Mohana Siva Sainadh et al "IoT Enabled Real-Time Remote Health Monitoring System" – IEEE, 2021

Use of Sensor lowers the mortal mistake, and the area of this strategy could lower the needed space of the room. The different organs of this preferred remedy is the sound generated from the buzzer to give better medical assistance to the victim in time. Also the next benefitting area of the structure is in the scheme of transmitting the warning notice through mail and cellular message if any of the health values exceeds the threshold value. Warning notice structure will keep the hospital personals in work to the condition of the patient. Another significant part of the preferred output is to construct the better environment which is affordable even by a common person who are in need of this medical assistance at a low expenditure and minimum knowledge in field of programming as per the requisites of the victim situation. Also in this project the usage of sensor is also very easy when compared with the real hospital machinery. In this project we will discuss the follow up of pulse rate, blood pressure, body temperature, and saline levels of the victim.

6.) Yi-Chun Du et al "A wearable conductivity sensor for sweat and blood leakage monitoring during hemodialysis" – IEEE, 2019

Some patients have the symptom called "cold sweating" that may occur during hemodialysis treatment. It affects the results of impendence measurement. So to distinguish the difference between blood leakage and sweat at the same time, it could provide better method for blood leakage monitoring during hemodialysis. This study presented a wearable device with a conductivity sensor for sweat and blood leakage monitoring based on wide frequency range analysis. The device had self-calibration function to reduce the interference in environment. The experimental results show that the proposed wearable device could distinguish blood concentration that mixed artificial sweat successfully. Overall, it has high potential application in clinical use.

7.) Haibin Zhang et al proposed "Connecting Intelligent Things in Smart Hospitals using NB-IoT" IEEE Internet of Things Journal - 2018

They have implemented use of Internet of Things (IoT), especially smart wearables, will play an important role in improving the quality of medical care, bringing convenience for patients and improving the management level of hospitals. However, due to the limitation of communication protocols, there exists non unified architecture that can connect all intelligent things in smart hospitals, which is made possible by the emergence of the Narrowband IoT (NB-IoT). In light of this, we

propose architecture to connect intelligent things in smart hospitals based on NB-IoT, and introduce edge computing to deal with the requirement of latency in medical process. As a case study, we develop an infusion monitoring system to monitor the real time drop rate and the volume of remaining drug during the intravenous infusion. Finally, we discuss the challenges and future directions for building a smart hospital by connecting intelligent things.

AUTHOR & YEAR	SUMMARY	KEYPOINTS / HIGHLIGHTS
C.GAVIMATH,KRISHNAMURUTHY BHAT,C.L.CHAYALAKSHI,R.S.HOOLI AND B.E.RAVISHANKERA 2012	A SIMPLE GSM BASED ALERT IN SYSTEM IN MOBILES	GSM BASED REMOTE MONITORING DEVICE
PRIYADHARSHINI,MITHUNA, VASANTH AUGUST 2012	PLACED THE ULTRASONIC SENSOR ON THE TOP OF THE IV BAG/BOTTLE	USING ULTRASONIC SENSORS
MANSI G. CHIDGOPKAR SEPTEMBER-2015	LITTLE OUTDATED METHOD USED (LIKE USING ROUTERS FOR DATA ANALYSIS)	WIRELESS BLUETOOTH MODULE AND Cc2500 TRANSRECEIVER
KALAIVANI,SINDHU, THAMARAISELVI MARCH-2017	USED THE IR SENSOR AND ULTRASONIC SENSOR AND TRANSFERED DATA TO THE WEB PLATFORM USING IoT	USING IR & ULTRASONIC SENSORS &IoT

Table 2.1 Other literature surveys

CHAPTER – 3

EXISTING SYSTEM

3.1 EXISTING SYSTEM

The existing system is an alert notification system. The system use the buzzer sound to alert the nurse. The LDR sensor detects the saline level by detecting light rays from the oppositely placed LEDs. When the saline level becomes very low, LDR detects and send the signal to the microcontroller via amplifier. Which initiates the buzzer alerting the concerned staff. This prevents the reverse blood flow of the patients from the vein. This system rectifies the problems caused due to the negligence of the staffs. Blood leakage can cause the patient a major blood loss and may lead to severe casualty.

3.2 PROBLEM IDENTIFICATION

- To overcome the inadequacies of the existing system, in this paper we have proposed an automated smart and secure saline infusion techniques for post operative patients who requires a lengthier saline infusion.

- In the proposed system, the infusion process can either be done fully automatically or can be controlled manually with an IOT platform.

- Number of the patient for quick recovery Hospital uses simple electrolytes bottles with no indication, it may create a problem

to patient because the reverse flow will start, blood start to flow from body towards bottle. In, Hospital ICU, CCU, NICU most of all department of hospital required such kind of automatic monitoring and indication system.

- Injection process, continuous monitoring is required, where it is difficult in many hospitals. The monitoring staff may forget about the patient.
- This forgetting may result in serious danger to the patient. when the saline bottle is about to empty the blood from the body of the patient flows back into the bottle.
- This flowing back of blood causes serious damage to the patient. The patient might be in a situation of unable to check his own saline bottle level

Fig.3.2.1 Saline image

CHAPTER-4

SYSTEM ANALYSIS

4.1 PROPOSED SYSTEM

- This study aims to develop an automatic system of tools infusion that can monitor the condition of the infusion volume and monitor the condition of droplets performed remotely using IoT technology.

- This paper relates with the saline level of a patient through remote technology in health care centers to monitor patient's data constantly. The design has been made simple with two main functions are remote monitoring for the condition of the contents/detection volume of infusion fluids and drips or absence of intravenous fluids.

- The status intravenous fluid volume used by patients divided into three categories namely: Safe: intravenous fluid condition > 10%; Standby: the condition of the infusion liquid 5%-10% and Empty: 0% condition intravenous fluids If the patient is sick firstly we should give a saline to patient.

- This paper relates with the saline level of a patient through remote technology in health care centers to monitor patient's data constantly. If the patient is sick firstly we should give a saline to patient. When the bottle is placed to patient we should check frequently the level of bottle. It is difficult to check all the time,

so we transmit data through cayenne cloud platform to nurse cabin.

- All most in all hospital, and nurse is responsible for monitoring the electrolyte's bottle level. But unfortunately most of the time, the observer may forget to change the bottle at correct time due to their busy schedule.
- To overcome this critical situation, a IoT based automatic alerting and indicating device is proposed where sensor is used as a weight sensor. It is based on the principle that the sensor output changes when fluid weight is below certain limit. The load sensor output is analog and its connected with ESP 8266-12E NODE (A0) pin, which has inbuilt ADC converter. When Fluid weight is low, will alerts the observer through the display/buzzer or/and mobile phone at the control room

4.1.2 AIM

This project aims to process the saline infusion in a smart and secure way.

4.1.3 OBJECTIVE

Objective is to develop a system in which saline fluid infusion is controlled and monitored by the system itself without manual assisting.

4.2 PROPOSED BLOCK DIAGRAM

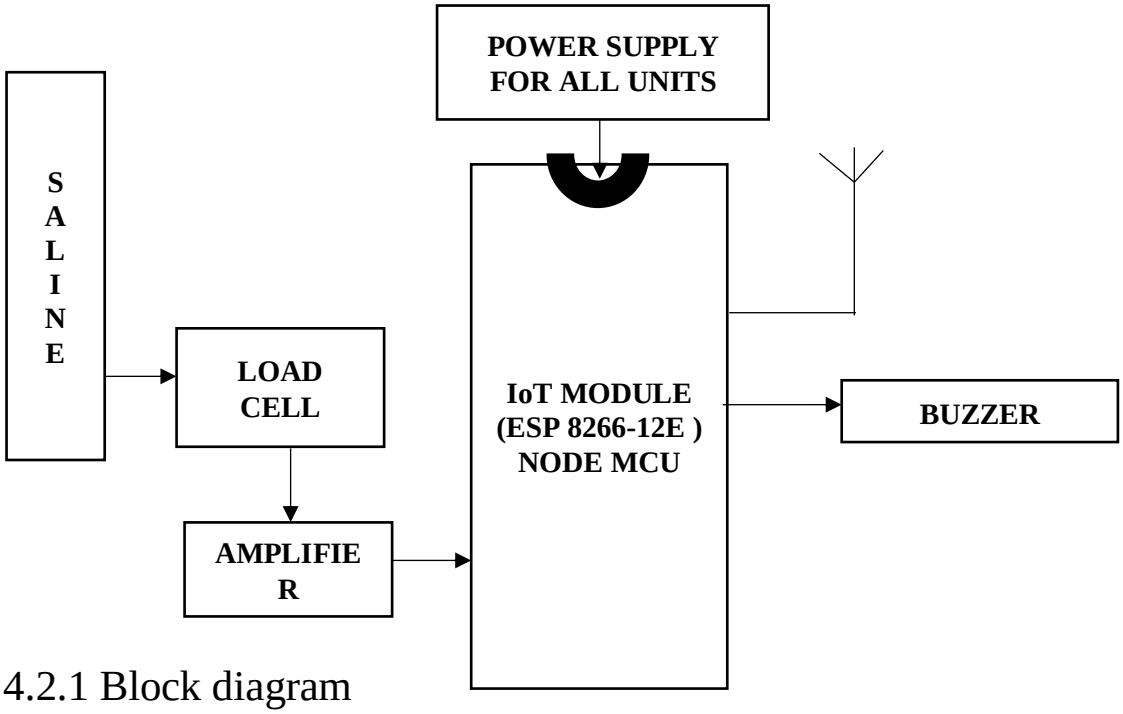


Fig. 4.2.1 Block diagram

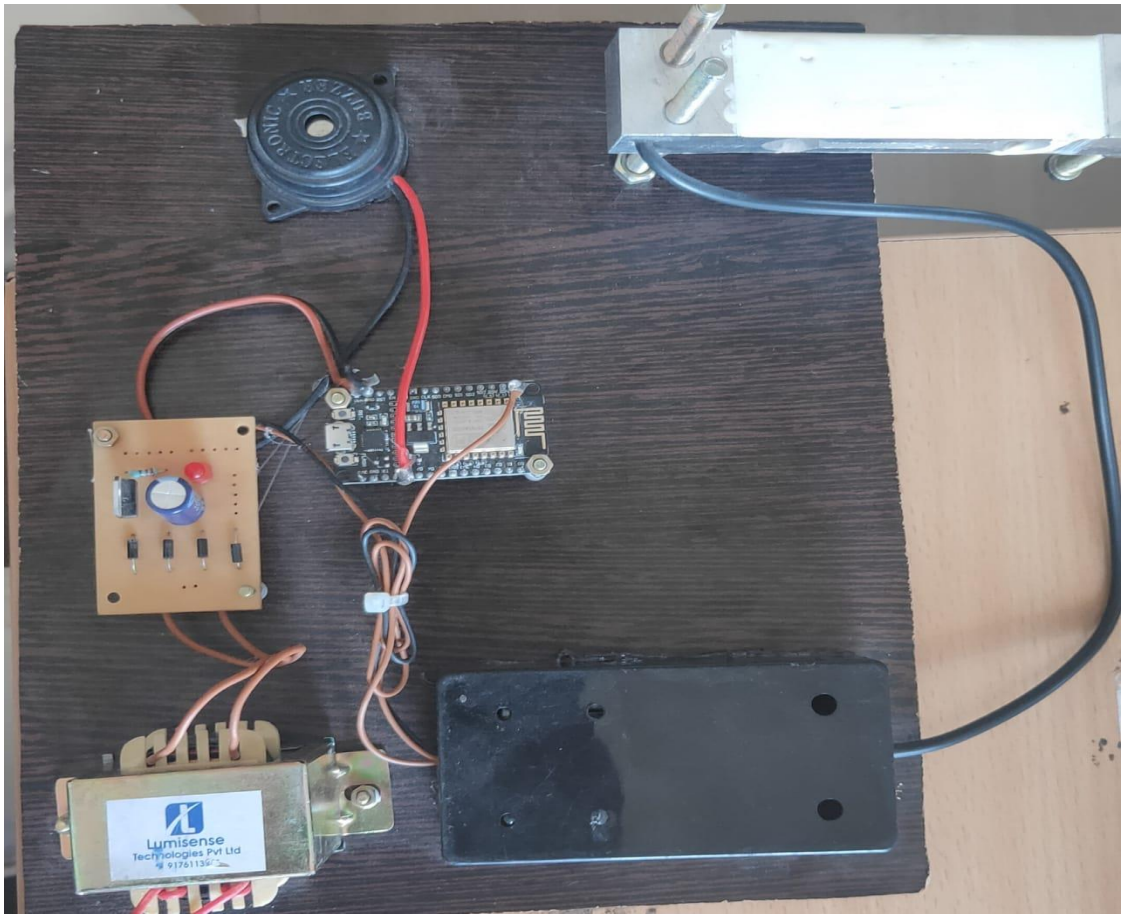


Fig. 4.2.2 Our model

CHAPTER-5
SYSTEM REQUIREMENTS

5.1 HARDWARE REQUIREMENT

- POWER SUPPLY
- LOAD CELL AND AMPLIFIER
- IOT MODULE (ESP 8266-12E)
- BUZZER

5.2 SOFTWARE REQUIREMENT

- SKETCH IDE – ESP NODE MCU MODULE PROGRAMMING IDE
- EMBEDDED C- ESP Programming Language
- Cayenne server and cayenne app - IoT server &ESP module Programming

5.2.1 IOT MODULE (Node MCU ESP8266 -12E)

- Node MCU is an open source IoT platform.
- Its operating voltage is 5v dc supply.
- It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.
- The term "Node MCU" by default refers to the firmware rather than the dev kits.
- The firmware uses the Lua scripting language.

- It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266.
- In our Project IOT is used to monitor saline level from far distance or from anywhere.
- We can monitor saline level by using IOT module from remote places likewise programmed for the NODE MCU which consists of inbuild wifi Shield, and transmitted to the Cayenne Server which works on the MQTT protocol.
- Wi-Fi controller board NodeMCU has a 32-bit Tensilica Xtensa LX106 core clocked at 8 MHz's It is a self-contained Wi-Fi networking solution that acts as a bridge between existing microcontrollers to Wi-Fi and is capable of running self-contained applications.
- NodeMCU can easily connect to components, such as sensors and actuators, through its integrated built-in 20 kb of RAM, 10 GPIOs, 4 megabytes of on-board storage, and TCP/IP.
- A built-in USB connector links to the computer using a USB cable to upload the codes, which is similar to other development boards available in the market, such as Arduino and Raspberry Pi.
- Compared with Arduino UNO, NodeMCU has many other good features, such as low cost, simplicity, smartness, a built-in power regulator, and a powerful processor.

5.2.2 MQTT PROTOCOL

- MQTT is a lightweight, publish-subscribe network protocol that transports messages between devices. The protocol usually runs over TCP/IP, however, any network protocol that provides ordered, lossless, bi-directional connections can support MQTT.
- According to measurements in 3G networks, throughput of MQTT is 93 times faster than HTTP's. Besides, in comparison to HTTP, MQTT Protocol ensures high delivery guarantees.
- HTTP is the most popular and widely used protocol. But over the last years MQTT rapidly gain tractions. Developers have to choose between them when we are talking about IoT development.

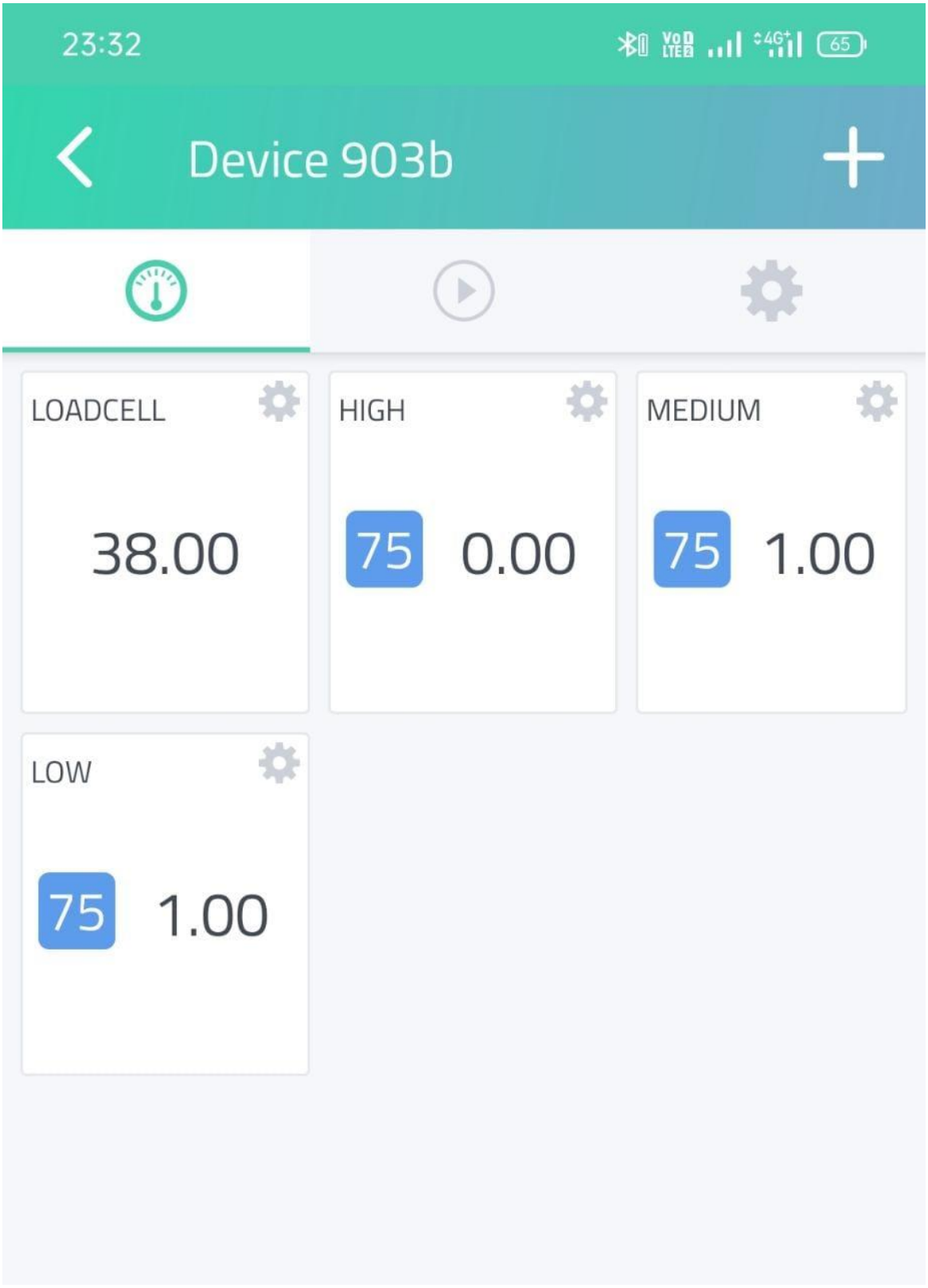


Fig. 5.2.2 (a) Cayenne interface

5.3 HARDWARE DESCRIPTION

5.3.1 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 is a relatively simple design that becomes increasingly bulky and heavy for high current devices; voltage regulation in a linear supply can result in low efficiency. A switched-mode supply of the same rating as a linear supply will be smaller, is usually more efficient, but will be more complex.

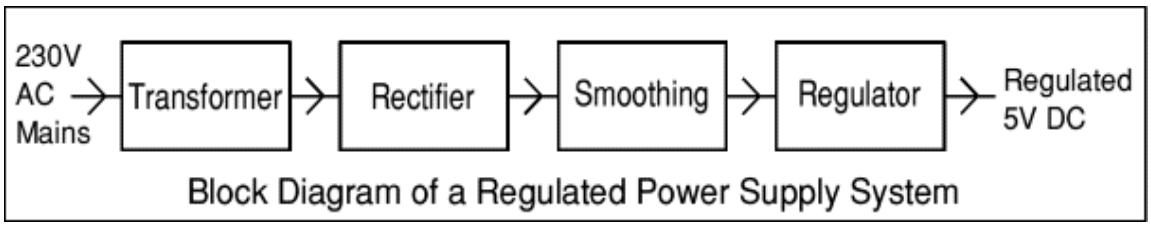
Linear Power supply:

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).

The voltage produced by an unregulated power supply will vary depending on the load and on variations in the AC supply voltage. For critical electronics applications a linear regulator will be used to stabilize and adjust the voltage. This regulator will also greatly reduce

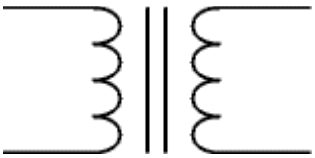
the ripple and noise in the output direct current. Linear regulators often provide current limiting, protecting the power supply and attached circuit from over current.

Adjustable linear power supplies are common laboratory and service shop test equipment, allowing the output voltage to be set over a wide range. For example, a bench power supply used by circuit designers may be adjustable up to 30 volts and up to 5 amperes output. Some can be driven by an external signal, for example, for applications requiring a pulsed output.



Block Diagram of a Regulated Power Supply System

5.3.2 Transformer:



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.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the

soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.

Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

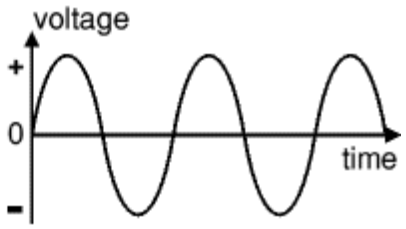
Turns ratio=Vp/Vs=Nn/Ns and Power out=Power in

Vs*Is=Vp * Ip

Vp = primary (input) voltage
Np = number of turns on primary coil
Ip = primary (input) current

Vs = secondary (output) voltage
Ns = number of turns on secondary coil
Is = secondary (output) current

Transformer

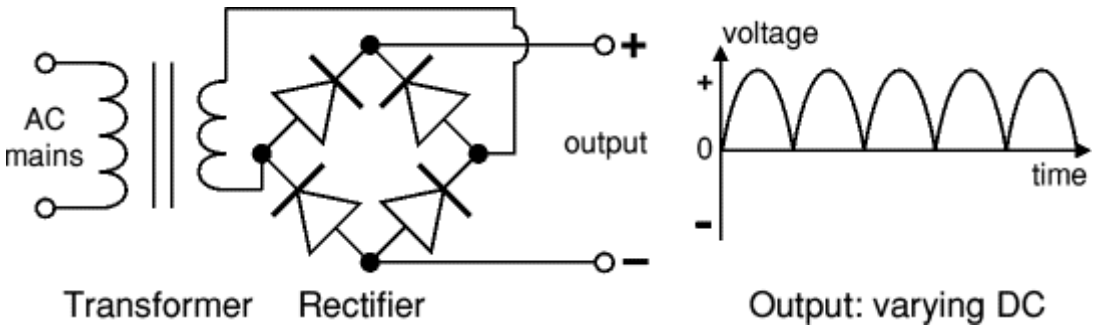


Output: low voltage AC

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.

5.3.3 Rectifier:

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also 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.

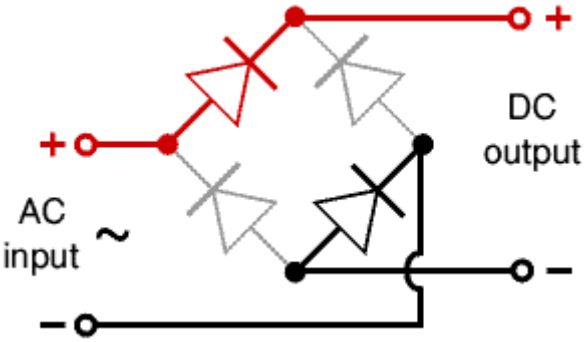


The varying DC output is suitable for lamps, heaters and standard motors. It is not suitable for electronic circuits unless they include a smoothing capacitor.

Bridge rectifier:

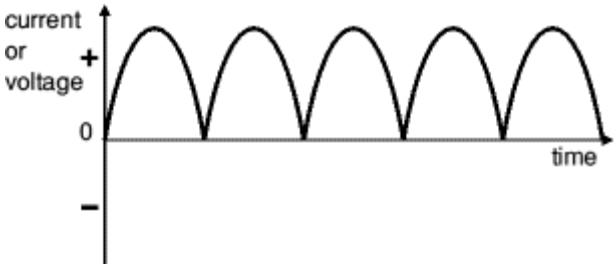
A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each 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). Please see the Diodes page for more details, including pictures of ridge rectifiers.



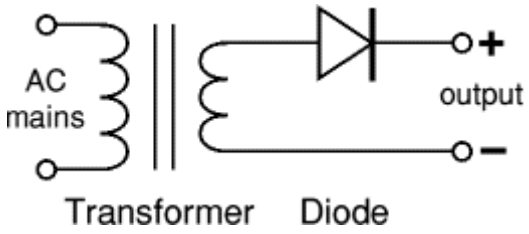
Alternate pairs of diodes conduct, changing over the connections so the alternating directions of AC are converted to the one direction of DC.

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

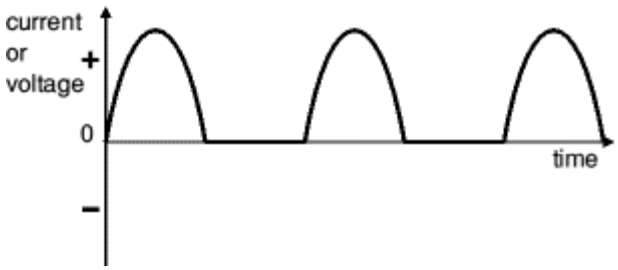


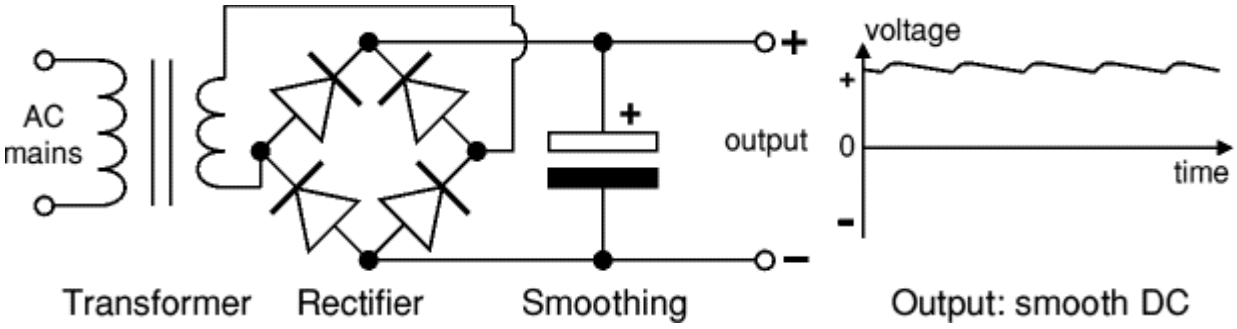
Single diode rectifier:

A single diode can be used as a rectifier but this produces half-wave varying DC which has gaps when the AC is negative. It is hard to smooth this sufficiently well to supply electronic circuits unless they require a very small current so the smoothing capacitor does not significantly discharge during the gaps. Please see the Diodes page for some examples of rectifier diodes.



Output: half-wave varying DC (using only half the AC wave):





The smooth DC output has a small ripple. It is suitable for most electronic circuits.

5.3.4 Regulator:

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment.

Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and current.

Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a heat sink if necessary.

The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

5.4 LOAD CELL

GENERAL DESCRIPTION

A load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. This electronic signal can be a voltage change, current change or frequency change depending on the type of load cell and circuitry used. The electrical signal output is typically in the order of a few milli-volts and requires amplification by an instrumentation amplifier before it can be used. The various types of load cells include hydraulic load cells, pneumatic load cells and strain gauge load cells. Here, we are using string gauge load cells.

PRODUCT DESCRIPTION

The strain gauge measures the deformation (strain) as a change in electrical resistance, which is a measure of the strain and the applied forces. Through a mechanical construction, the force being sensed deforms a strain gauge. A load cell usually consists of four strain

gauges in a Wheatstone bridge configuration. The output of the transducer can be scaled to calculate the force applied to the transducer. Sometimes a high resolution ADC, typically 24-bit, can be used directly, the load cells can be damaged by induced or conducted current. High voltages can break through the insulation between the substrate and the strain gauges. The gauges themselves are bonded onto a beam or structural member that deforms when weight is applied. The change in resistance of the strain gauge provides an electrical value change that is calibrated to the load placed on the load cell

Fig.5.4(a) Typical load cell image

5.4.1 LOAD CELL ADC OUT

FEATURES

- Input voltage: 5v DC
- Rated load: 10Kg
- Insulation resistance: 5000 Mega Ohm (50V DC)
- Operating Temperature: -20 °C to +65 °C

5.4.2 APPLICATIONS

- Weigh applications
- Retail
- Bench
- Counting scales

5.5 INTERNET OF THINGS (IoT)

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these objects to connect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure.

The figure of online capable devices increased 31% from 2016 to 8.4 billion in 2017. Experts estimate that the IoT will consist of about 30 billion objects by 2020. It is also estimated that the global market value of IoT will reach $7.1 trillion by 2020.

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities.

"Things", in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras streaming live feeds of wild animals in coastal waters, automobiles with built-in sensors, DNA analysis devices for

environmental/food/pathogen monitoring, or field operation devices that assist firefighters in search and rescue operations. Legal scholars suggest regarding "things" as an "inextricable mixture of hardware, software, data and service".

These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices

As of 2016, the vision of the Internet of things has evolved due to a convergence of multiple technologies, including ubiquitous wireless communication, real-time analytics, machine learning, commodity sensors, and embedded systems. This means that the traditional fields of coil resistance), and others all contribute to enabling the Internet of things.

The concept of a network of smart devices was discussed as early as 1982, with a modified Coke machine at Carnegie Mellon University becoming the first Internet-connected appliance, able to report its inventory and whether newly loaded drinks were cold. Mark Weiser's seminal 1991 paper on ubiquitous computing, "The Computer of the 21st Century", as well as academic venues such as Unicom and Parco produced the contemporary vision of IoT. In 1994 Reza Raji described the concept in IEEE Spectrum as "[moving] small packets of data to a large set of nodes, so as to integrate and automate everything from home appliances to entire factories". Between 1993 and 1996 several companies proposed solutions like Microsoft's at Work or Novell's NEST. However, only in 1999 did the field start

gathering momentum. Bill Joy envisioned Device to Device (D2D)communication as part of his "Six Webs" framework, presented at the World Economic Forum at Davos in 1999.

The concept of the Internet of things became popular in 1999, through the Auto-ID Center at MIT and related market-analysis publications. Radio-frequency identification (RFID) was seen by Kevin Ashton (one of the founders of the original Auto-ID Center) as a prerequisite for the Internet of things at that point. Ashton prefers the phrase "Internet for things." If all objects and people in daily life were equipped with identifiers, computers could manage and store them. Besides using RFID, the tagging of things may be achieved through such technologies as near field communication, barcodes, QR codes and digital watermarking.

In its original interpretation, one of the first consequences of implementing the Internet of things by equipping all objects in the world with minuscule identifying devices or machine-readable identifiers would be to transform daily life. For instance, instant and ceaseless inventory control would become ubiquitous. A person's ability to interact with objects could be altered remotely based on immediate or present needs, in accordance with existing end-user agreements. For example, such technology could grant motion-picture publishers much more control over end-user private devices by remotely enforcing copyright restrictions and digital rights management, so the ability of a customer who bought a Blu-ray disc to watch the movie could become dependent on the copyright holder's

decision, similar to Circuit City's failed DIVX.

A significant transformation is to extend "things" from the data generated from devices to objects in the physical space. The thought-model for future interconnection environment was proposed in 2004. The model includes the notion of the ternary universe consists of the physical world, virtual world and mental world and a multi-level reference architecture with the nature and devices at the bottom level followed by the level of the Internet, sensor network, and mobile network, and intelligent human-machine communities at the top level, which supports geographically dispersed users to cooperatively accomplish tasks and solve problems by using the network to actively promote the flow of material, energy, techniques, information, knowledge, and services in this environment. This thought model envisioned the development trend of the Internet of things.

5.5.1 APPLICATIONS

- Consumer application
- Smart Home
- Media
- Infrastructure Management
- Manufacturing
- Agriculture
- Energy management
- Environmental monitoring

- Building and home automation
- Metropolitan scale deployments
- Medical and healthcare
- Transportation

Consumer Applications

A growing portion of IoT devices are created for consumer use. Examples of consumer applications include connected car, entertainment, home automation (also known as smart home devices), wearable technology, quantified self, connected health, and appliances such as washer/dryers, robotic vacuums, air purifiers, ovens, or refrigerators/freezers that use Wi-Fi for remote monitoring. Consumer IoT provides new opportunities for user experience and interfaces.

Smart Home

IoT devices are a part of the larger concept of home automation, also known as demotics. Large smart home systems utilize a main hub or controller to provide users with a central control for all of their devices. These devices can include lighting, heating and air conditioning, media and security systems. Ease of usability is the most immediate benefit to connecting these functionalities. Long term benefits can include the ability to create a more environmentally friendly home by automating some functions such as ensuring lights and electronics are turned off. One of the major obstacles to obtaining

smart home technology is the high initial cost.

Home System Applications

One key application of smart home is to provide assistance for disabled and elderly individuals. These home systems utilize assistive technology to accommodate an owner's specific disabilities. Voice control can assist users with sight and mobility limitations while alert systems can be connected directly to Cochlear implants worn by hearing impaired users. They can also be equipped with additional safety features. These features can include sensors that monitor for medical emergencies such as falls or seizures. Smart home technology applied in this way can provide users with more freedom and a higher quality of life.

A second application of smart home is even more sophisticated. One can guide his or her connected device at home even from far away. If one for example leaves the office, it is possible to tell a connected air conditioner device via smart phone to cool down the house to a certain temperature.

Agriculture

The IoT contributes significantly towards innovating farming methods. Farming challenges caused by population growth and climate change have made it one of the first industries to utilize the IoT. The integration of wireless sensors with agricultural mobile apps and cloud platforms helps in collecting vital information pertaining to the environmental conditions – temperature, rainfall, humidity, wind

speed, pest infestation, soil humus content or nutrients, besides others – linked with a farmland, can be used to improve and automate farming techniques, take informed decisions to improve quality and quantity, and minimize risks and wastes. The app-based field or crop monitoring also lowers the hassles of managing crops at multiple locations. For example, farmers can now detect which areas have been fertilized (or mistakenly missed), if the land is too dry and predict future yields.

Medical and Healthcare

IoT devices can be used to enable remote health monitoring and emergency notification systems. These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized implants, such as pacemakers, Fitbit electronic wristbands, or advanced hearing aids. Some hospitals have begun implementing "smart beds" that can detect when they are occupied and when a patient is attempting to get up. It can also adjust itself to ensure appropriate pressure and support is applied to the patient without the manual interaction of nurses. According to the latest research, US Department of Health plans to save up to USD 300 billion from the national budget due to medical innovations.

Specialized sensors can also be equipped within living spaces to monitor the health and general well-being of senior citizens, while also ensuring that proper treatment is being administered and assisting people regain lost mobility via therapy as well. Other consumer devices to encourage healthy living, such as, connected scales or wearable heart

monitors, are also a possibility with the IoT. More and more end-to-end health monitoring IoT platforms are coming up for antenatal and chronic patients, helping one manage health vitals and recurring medication requirements

The IoT can assist in the integration of communications, control, and information processing across various transportation systems. Application of the IoT extends to all aspects of transportation systems the infrastructure, and the driver or user). Dynamic interaction between these components of a transport system enables inter and intra vehicular communication, smart traffic control, smart parking, electronic toll collection systems, logistic and fleet management, vehicle control, and safety and road assistance. In Logistics and Fleet Management for example, The IoT platform can continuously monitor the location and conditions of cargo and assets via wireless sensors and send specific alerts when management exceptions occur (delays, damages, thefts, etc.).

Building and Home Automation

IoT devices can be used to monitor and control the mechanical, electrical and electronic systems used in various types of buildings (e.g., public and private, industrial, institutions, or residential) in home automation and building automation systems. In this context, three main areas are being covered in literature:

- The integration of the internet with building energy management systems in order to create energy efficient and IoT driven “smart buildings”.
- The possible means of real-time monitoring for reducing energy consumption and monitoring occupant behaviors.
- The integration of smart devices in the built environment and how they might be used in future applications

Environmental Monitoring

Environmental monitoring applications of the IoT typically use sensors to assist in environmental protection by monitoring air or water quality, atmospheric or soil conditions and can even include areas like monitoring the movements of wildlife and their habitats. Development of resource-constrained devices connected to the Internet also means that other applications like earthquake or tsunami early-warning systems can also be used by emergency services to provide more effective aid. IoT devices in this application typically span a large geographic area and can also be mobile. It has been argued that the standardization IoT brings to wireless sensing will revolutionize this area.

5.6 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 Espressif Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the dev kits. The firmware uses the Lua scripting language. It is based on the eLua

project, and built on the Espressif 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 little networked computer is attached to a thing, allowing information exchange to and from that thing. Be it lightbulbs, 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 gather and generate informational output (typically object status or other sensory data). This means computers will be permeating everything around us — ubiquitous embedded computing devices, uniquely identifiable, interconnected across the Internet. Because of low-cost, networkable microcontroller modules, the Internet of things is really starting to take off.

NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Express if Systems begin production of the ESP8266. The ESP8266 is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications. Node MCU started on 13 Oct 2014, when Hong committed the first file of node mcu-firmware to GitHub. Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9. Later that month, Tuan PM ported MQTT client library from Contain to the ESP8266 SoC platform, and committed to Node

MCU project, then Node MCU was able to support the MQTT IoT protocol, using Lua to access the MQTT broker. Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glib to Node MCU project, enabling Node MCU to easily drive LCD, Screen, OLED, even VGA displays.

5.6.1 ESP8266 ARDUINO CORE

Arduino began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino Due, they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support alternate tool chains to allow Arduino C/C++ to be compiled down to these new processors. They did this with the introduction of the Board Manager and the SAM Core. A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file down to the target MCU's machine language. Some creative ESP8266 enthusiasts have developed an Arduino core for the ESP8266 WiFi SoC that is available at the GitHub ESP8266 Core webpage. This is what is popularly called the "ESP8266 Core for the Arduino IDE" and it has become one of the leading software development platforms for the various ESP8266 based modules and development boards, including Node MCUs.The Button is a Wi-Fi connected push button designed by Peter R Jennings. The Button is designed for single-purpose, internet-enabled functions. When the button is pressed, a connection is made to a web server which will perform the desired task. Applications include a doorbell or panic button.

5.6.2 Node USB

Node USB is an open IoT platform about the size of a standard USB stick. It was designed to leverage Node MCU (Lua) for easy programming and has the extra feature of USB capability. It is ideal for Plug-n-Play solutions, allowing easy prototyping for developers Node MCU provides access to the GPIO (General Purpose Input/Output) and for developing purposes below pin mapping table should be referenced.

IO index	ESP8266 pin	IO index	ESP8266 pin
0 [*]	GPIO16	7	GPIO13
1	GPIO5	8	GPIO15
2	GPIO4	9	GPIO3
3	GPIO0	10	GPIO1
4	GPIO2	11	GPIO9
5	GPIO14	12	GPIO10
6	GPIO12		

Node MCU is an open source IoT platform based on the ESP-12E module. The version 1.0 is the 5th design of NodeMCU devkit. This uses CP2102 as UART bridge and can flash firmware automatically by using nodemcu-flasher. Also, it has a voltage regulator to convert from 5V to 3.3V which is the required by the esp21e module.

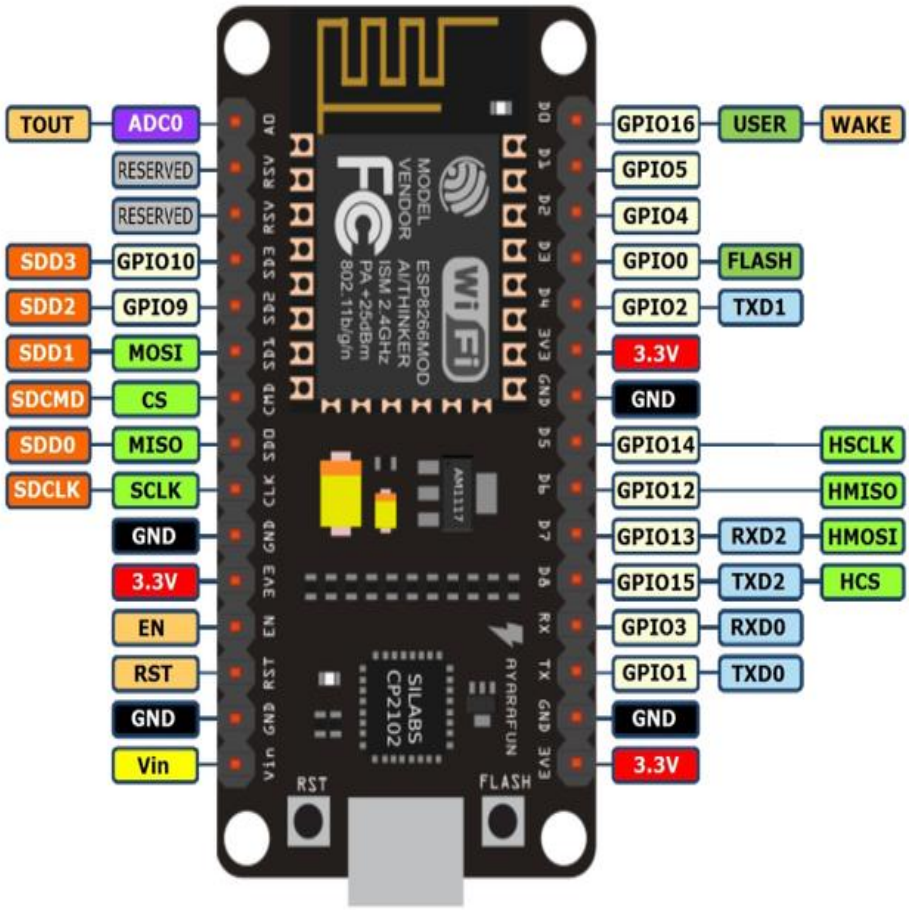


Fig. 5.6.2(a) ESP8266MOD

5.6.3 IoT Module

S.No.	Components	Node MCU v1.0	Arduino MKR1000
1	Microcontroller	ESP-12E module, with Espressif ESP8266 32bits	ARM Cortex M0+ 32bits
2	Clock Speed	80/160MHz	48MHz
3	Board Power Supply	5V	5V
4	Circuit Operating Voltage	3.3V	3.3V
5	Flash Memory	4MB	256KB
6	SRAM	64KB	32KB
7	EEPROM	No	No

S.No.	Components	Node MCU v1.0	Arduino MKR1000
8	Digital I/O Pins	10	8
9	PWM Pins	10	12
10	Analog Input Pins	1 (ADC 10 bit)	7 (ADC 8/10/12 bit)
11	Analog Output Pins		1 (DAC 10 bit)
12	Connectivity	IEEE 802.11 b/g/n Wi-Fi	IEEE 802.11 b/g/n Wi-Fi
13	Antenna Type	PCB	PCB
14	Supported Battery	No	Li-Po single cell, 3.7V, 700mAh minimum
15	UART	1 (+ TX only on pin GPIO2)	1

S.No.	Components	Node MCU v1.0	Arduino MKR1000
16	SPI	2	1
17	I2C	1	1
18	LED built in	D0 / GPIO 16	GPIO 6
19	Programming Languages	C++ / Python / Lua / Javascript	C++
20	Flashing	Locally / OTA	Locally / OTA

Table 5.6.3(a) Specifications

5.6.4 CHIP

The ESP8266 series, or family, of Wi-Fi chips is produced by Espressif Systems, a fabless semiconductor company operating out of Shanghai, China. The ESP8266 series presently includes the ESP8266EX and ESP8285 chips.

ESP8266EX (simply referred to as ESP8266) is a system-on-chip (SoC) which integrates a 32-bit Tensilica microcontroller, standard digital peripheral interfaces, antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules into a small package. It provides capabilities for 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose

input/output (16 GPIO), Inter-Integrated Circuit (I^2C), analog-to-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI), I^2S interfaces with DMA (sharing pins with GPIO), UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM). The processor core, called "L106" by Espressif, is based on Tensilica's Diamond Standard 106Micro 32-bit processor controller core and runs at 80 MHz (or overclocked to 160 MHz). It has a 64 KB boot ROM, 32 KB instruction RAM and 80 KB user data RAM. (Also, 32 KB instruction cache RAM and 16 KB ETS system data RAM.) External flash memory can be accessed through SPI. The silicon chip itself is housed within a 5 mm × 5 mm Quad Flat No-Leads package with 33 connection pads — 8 pads along each side and one large thermal/ground pad in the centre.

5.7 BUZZER

The buzzer is a sounding device that can convert audio signals into sound signals. If animal is detected by using PIR sensor, Arduino Uno board will trigger the buzzer to generates the beep sound. It is usually powered by DC voltage. It is widely used in alarms, computers, printers and other electronic products as sound devices. It is mainly divided into piezoelectric buzzer and electromagnetic buzzer, represented by the letter "H" or "HA" in the circuit.

5.7.1 Piezo buzzer

The piezoelectric buzzer uses the piezoelectric effect of the piezoelectric ceramics and uses the pulse current to drive the vibration of the metal plate to generate sound. Piezoelectric buzzer is mainly composed of multi-resonator, piezoelectric plate, impedance matcher, resonance box, housing, etc. Some of the piezoelectric buzzers are also equipped with light-emitting diodes. The multi-resonator consists of transistors or integrated circuits. When the power supply is switched on (1.5~15V DC operating voltage), the multi-resonator oscillates and outputs 1.5~2.5kHz audio signal. The impedance matcher pushes the piezoelectric plate to generate sound. The piezoelectric plate is made of lead zirconate titanate or lead magnesium niobate piezoelectric ceramic, and silver electrodes are plated on both sides of the ceramic sheet. After being polarized and aged, the silver electrodes are bonded together with brass or stainless steel sheets.

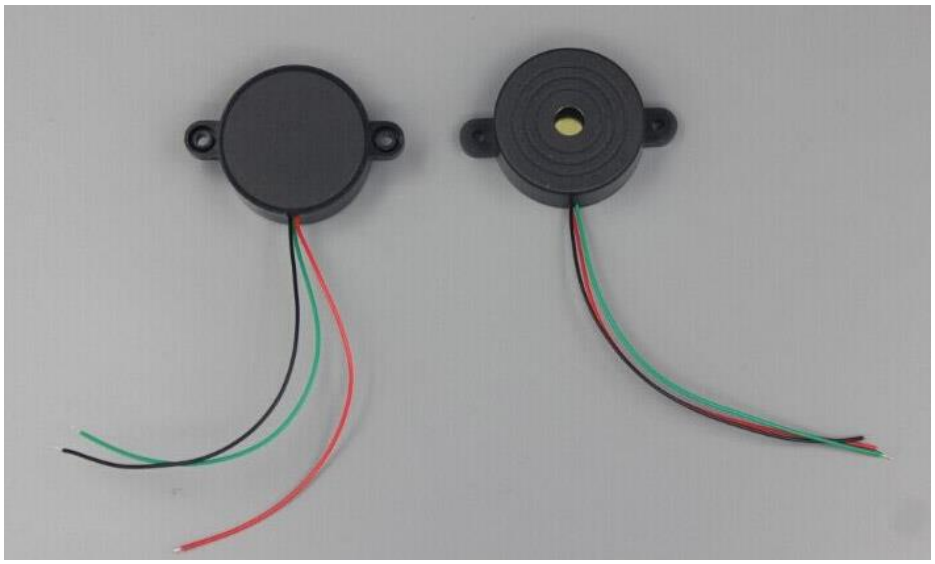


Fig.5.7.1 Piezo buzzer

5.7.2 Electromagnetic buzzer

Electromagnetic buzzer is composed of oscillator, solenoid coil, magnet, vibration diaphragm, housing, etc. When the power supply is switched on, the audio signal current generated by the oscillator passes through the solenoid coil, which generates a magnetic field. The vibration diaphragm periodically vibrates and sounds under the interaction of the solenoid coil and the magnet. The frequency of the general electromagnetic buzzer is 2-4 kHz.

Fig.5.7.2 Electromagnetic buzzer

Classification of buzzers

Classified according to buzzer construction

Piezoelectric buzzer: It uses piezoelectric material, which generates electric charge when the piezoelectric material is deformed by external force.Similarly, the piezoelectric material deforms when energized.

Electromagnetic buzzer: mainly uses the magnetic field generated by the energized conductor to drive the drum film fixed on the coil by the

magnetic force generated by a fixed magnet and the conducting conductor.

The two buzzers have different pronunciation principles. The piezoelectric buzzer is simple and durable in structure, but it has a single tone and color difference and is suitable for alarms and other equipment. The electromagnetic buzzer is mostly used for voice, music and other equipment because of its good sound color.

Classified according to the way the buzzer is driven

Active buzzer (with drive line): With oscillator inside, it can chime when energized. The ideal signal is direct current, usually marked as VDC, VDD, etc., which can convert constant direct current into pulse signal of a certain frequency.

Passive Buzzer (External Drive): There is no oscillator inside. It can not be chirped by DC signal. It must be driven by 2K~5K square wave because the magnetic circuit is constant.

How to distinguish active buzzer from passive buzzer

The height of active buzzer is slightly different from that of passive buzzer. The active buzzer is usually 9mm high and the passive buzzer is 8mm high. When placing the two buzzers with their pins facing up, the one with a green circuit board is a passive buzzer, and the one without a circuit board and sealed with vinyl is an active buzzer.

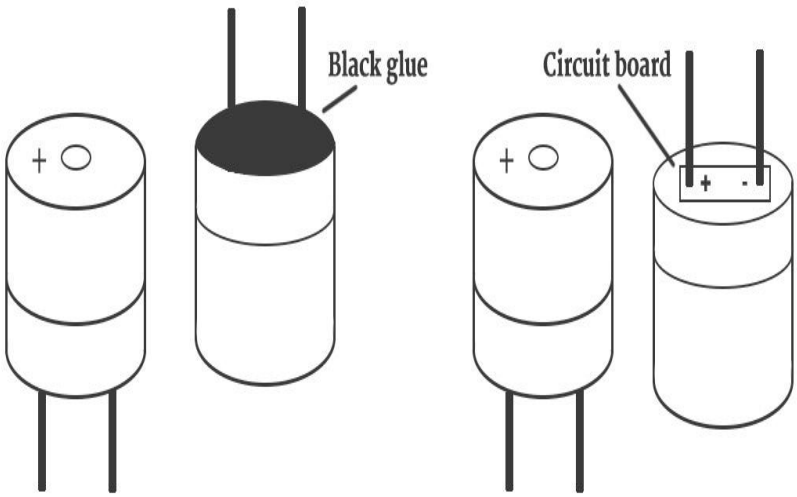


fig.5.7.3

How to distinguish active buzzer from passive buzzer

The height of active buzzer is slightly different from that of passive buzzer. The active buzzer is usually 9mm high and the passive buzzer is 8mm high. When placing the two buzzers with their pins facing up, the one with a green circuit board is a passive buzzer, and the one without a circuit board and sealed with vinyl is an active buzzer.

Multimeter resistance Rxl test: When the black meter pen contacts the'+'pin of the buzzer and the red meter pen touches back and forth on the other pin, if it clicks and the resistance is only 8Ω (or 16Ω), then it is a passive buzzer; connect the'+'pin of the buzzer with a black pen and touch the red pen back and forth on the other pin. If a continuous sound is emitted and the resistance is over several hundred ohms, then it is a active buzzer.

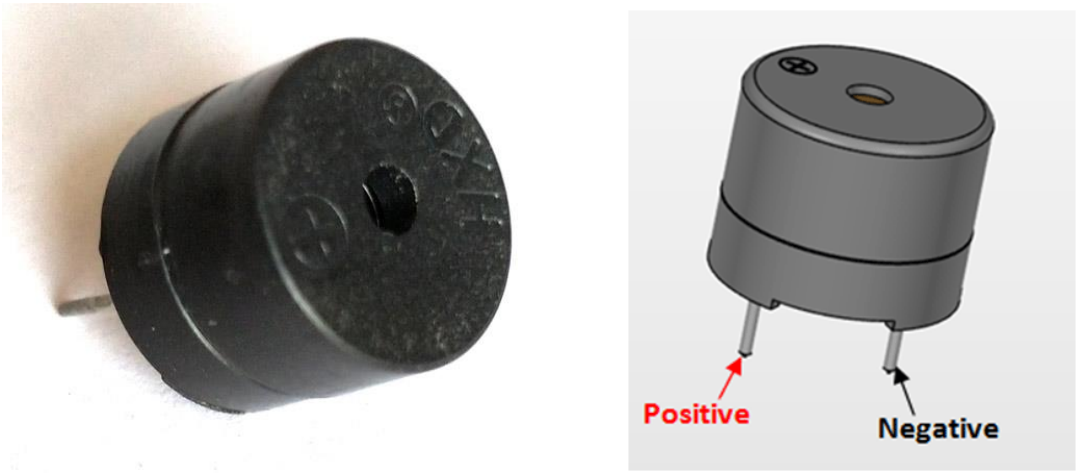


Fig.5.7.4 Typical Buzzer Image

Active Passive Buzzer Active Passive Buzzer Pinout

Buzzer Pin Configuration

Pin Number	**Pin Name**	**Description**
1	Positive	Identified by (+) symbol or longer terminal lead. Can be powered by 6V DC
2	Negative	Identified by short terminal lead. Typically connected to the ground of the circuit

Table.5.7.5 Buzzer Pin Configs

Buzzer Features and Specifications

- Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

5.8 SOFTWARE DESCRIPTION

SKETCH IDE – ARDUINO & NODE MCU MODULE PROGRAMMING SOFTWARE

5.8.1 ARDUINO SKETCH

A sketch is the name that Arduino uses for a program. It's the unit of code that is uploaded to and run on an Arduino board.

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.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy,[2] aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

5.8.2 ARDUINO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into

an output - activating a motor, turning on an LED, publishing something online. It can send a set of instructions to the microcontroller on the board. To do so the Arduino programming language (based on Wiring) is used and the Arduino Software (IDE), based on Processing is used for this.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source and it is growing through the contributions of users worldwide.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard and many others offer similar functionality. All of these tools take the messy details of

microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students and interested amateurs over other systems:

Inexpensive - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50

Cross-platform - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.

Simple, clear programming environment - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

Open source and extensible software - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, AVR-C code can be added directly into the Arduino programs if wanted.

Open source and extensible hardware - The plans of the Arduino boards

are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

5.8.3 VARIABLES

A *variable* is a place for storing a piece of data. It has a name, a type and a value. For example, the line from the Blink sketch above declares a variable with the name `LED Pin`, the type `int` and an initial value of 13. It is being used to indicate which Arduino pin the LED is connected to. Every time the name `LED Pin` appears in the code, its value will be retrieved. In this case, the person writing the program could have chosen not to bother creating the `LED Pin` variable and instead have simply written 13 everywhere they needed to specify a pin number. The advantage of using a variable is that it is easier to move the LED to a different pin: and only it is needed to edit the one line that assigns the initial value to the variable.

5.8.4 Functions

A *function* (otherwise known as a *procedure* or *sub-routine*) is a named piece of code that can be used from elsewhere in a sketch. For example, here's the definition of the `setup()` function from the Blink example:

```
Void                                    setup()
{
```

```
    pinMode(ledPin, OUTPUT);
}
```

The first line provides information about the function, like its name, "setup". The text before and after the name specify its return type and parameters: these will be explained later. The code between the `{` and `}` is called the *body* of the function: what the function does.

pinMode(), digitalWrite(), and delay()

The `pinMode()` function configures a pin as either an input or an output. To use it, the number of the pin to configure has to be passed and the constant INPUT or OUTPUT. When configured as an input, a pin can detect the state of a sensor like a pushbutton; As an output, it can drive an actuator like an LED.

The `digitalWrite()` functions outputs a value on a pin.

For example, the line:

```
digitalWrite(ledPin, HIGH);
```

The delay() causes the Arduino to wait for the specified number of milliseconds before continuing on to the next line. There are 1000 milliseconds in a second, so the line:

```
delay(1000);
```

setup() and loop()

There are two special functions that are a part of every Arduino sketch: `setup()` and `loop()`. The `setup()` is called once, when the sketch starts. It's a good place to do setup tasks like setting pin modes or initializing libraries. The `loop()` function is called over and over and is heart of most sketches. Both functions must be included in the sketch, if not needed even if you don't need them for anything.

Everything between the `/*` and `*/` is ignored by the Arduino when it runs the sketch (the `*` at the start of each line is only there to make the comment look pretty, and isn't required). It's there for people reading the code: to explain what the program does, how it works, or why it's written the way it is. It's a good practice to comment your sketches, and to keep the comments up-to-date when you modify the code. This helps other people to learn from or modify your code.

5.9 ADVANTAGES

• Avoids the risk of reverse blood flow.

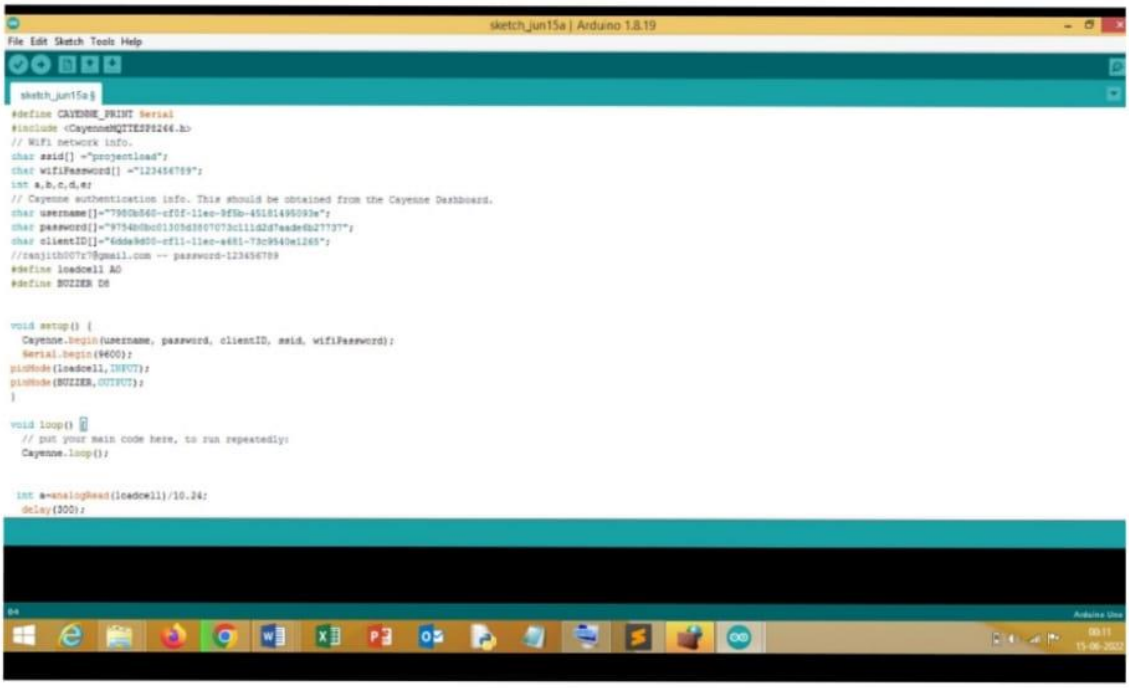
• Avoids the risk of over dosage

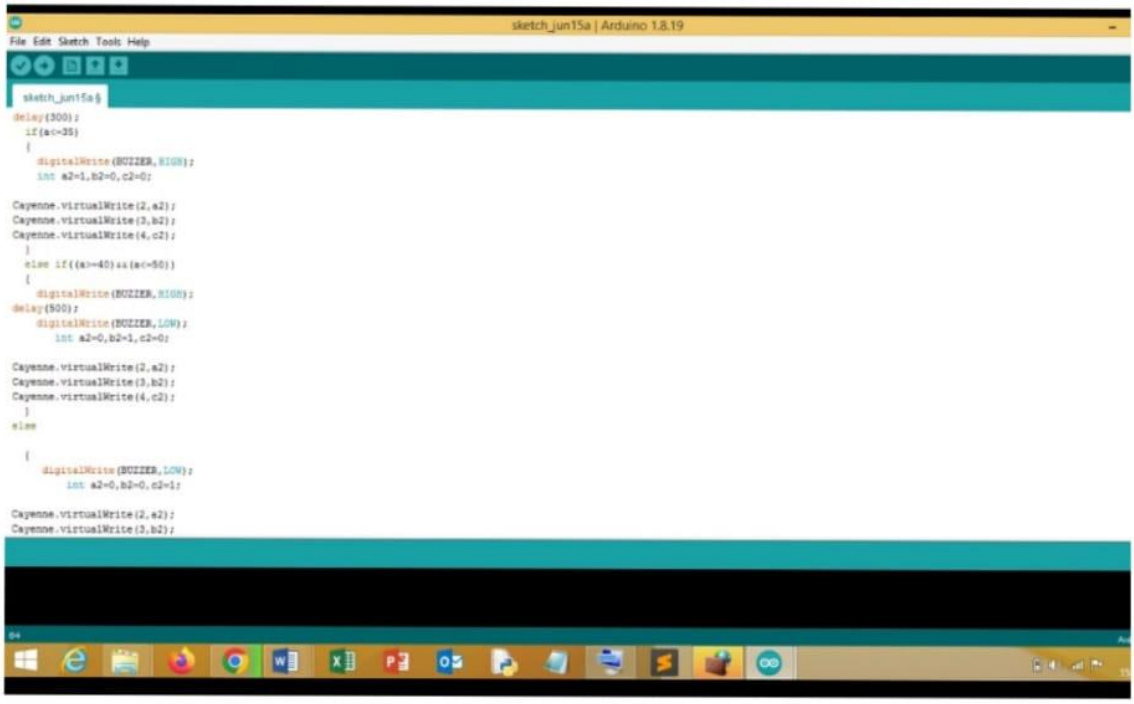
• Provides easiness in the monitoring of saline infusion of long duration.

5.10 DISADVANTAGES:

- Buzzer sound will disturbs the patients
- Implementation will take along time
- Network issues & Reliability should be taken into consideration

Fig.5.11-Code compiling in arduino IDE





CHAPTER-6

6.1 CONCLUSION

Based on the research that has been done, it can be taken some conclusions, as follows:

- SICoMS have to be designed with two main functions: remote monitoring for infusion fluid volume and detection of infusion fluid.
- The loadcell sensor can be used as the volume sensor of the infusion by converting the liquid mass

to the infusion volume. and loadcell mass measurement error of 4.48%

- Infrared sensors can be used as sensors to detect the presence or absence of drip drops.
- Arduino and GPRS A6 Thinker modules can be used as embedded systems that access cloud servers

to send data mass of bag infusion and data signal output sensor infrared to the database server.

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Based on the research that has been done, it can be taken some conclusions, as follows:

1. SICoMS have to be designed with two main functions: remote monitoring for infusion fluid volume and detection of infusion fluid.
2. The load cell sensor can be used as the volume sensor of the infusion

by converting the liquid mass to the infusion volume. and load cell mass measurement error of 4.48%

In this paper, we have proposed a cost-effective smart saline level surveillance system by which the level of the saline feeding to the patient can be monitored remotely by the nurse, caretaker, hospital staff, doctor etc. We have adopted MQTT-S protocol as it is efficient for low cost and low power devices. Furthermore, MQTT-S also provides guaranteed delivery of messages as it supports asynchronous communication using buffering of messages. We have believed that using this proposed monitoring system one can monitor the level of the saline bottle from a distant position which will aid in building smart healthcare system. This project mainly assures the safety of the patient by the correct manipulation of the valves through which the saline fluid is infused to the body. The correct and accurate automation of the saline infusion provides the patient and the medical staff the easiness of the medication. This project is the doorway to many future medical enhancement in saline drip infusion management of the admitted patient will be much easier by using this technique and will avoid the risks of reverse blood flow and over dosage caused due to negligence of the staffs.

FUTURE WORK

In the future a more compact system can be made by installing a

more efficient miniature load cell to the stand on which the saline bottle hangs. The Number of solenoid valves can be reduced by installing a multi functional solenoid valve which will make the system more compact. Accuracy in the dosage can be increased by providing more health vital data to the system which helps in giving other costly medications through saline infusion

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APPENDIX-1

CODING

```
#define CAYENNE_PRINT Serial
#include <CayenneMQTTESP8266.h>
// WiFi network info.
char ssid[] ="projectload";
char wifiPassword[] ="123456789";
int a,b,c,d,e;
// Cayenne authentication info. This should be obtained from the
Cayenne Dashboard.
char username[]="7980b560-cf0f-11ec-9f5b-45181495093e";
char password[]="9754b0bc01305d3807073c111d2d7aade6b27737";
char clientID[]="6dda9d00-cf11-11ec-a681-73c9540e1265";
//ranjith007r7@gmail.com -- password-123456789
#define loadcell A0
#define BUZZER D8


void setup() {
  Cayenne.begin(username, password, clientID, ssid, wifiPassword);
  Serial.begin(9600);
pinMode(loadcell,INPUT);
pinMode(BUZZER,OUTPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
  Cayenne.loop();


 int a=analogRead(loadcell)/10.24;
```

```
  delay(300);

  //1024/10.24=100% load cell
Cayenne.virtualWrite(1,a);
delay(300);
  if(a<=35)
  {
    digitalWrite(BUZZER,HIGH);
    int a2=1,b2=0,c2=0;

Cayenne.virtualWrite(2,a2);
Cayenne.virtualWrite(3,b2);
Cayenne.virtualWrite(4,c2);
  }
  else if((a>=40)&&(a<=50))
  {
    digitalWrite(BUZZER,HIGH);
delay(500);
    digitalWrite(BUZZER,LOW);
       int a2=0,b2=1,c2=0;

Cayenne.virtualWrite(2,a2);
Cayenne.virtualWrite(3,b2);
Cayenne.virtualWrite(4,c2);
  }
else

  {
     digitalWrite(BUZZER,LOW);
        int a2=0,b2=0,c2=1;

Cayenne.virtualWrite(2,a2);
Cayenne.virtualWrite(3,b2);
Cayenne.virtualWrite(4,c2);
  }
  }
```