

## **IOT-BASED SMART SALINE LEVEL AND HEALTH MONITORING SYSTEM**

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### **Abstract**

The many uses of saline solution include as providing temporary fluids when there is under or no hydration among the trauma cases. In addition, they participate in the control of salt and the levels of electrolytes in the body. To maintain the level of a saline bottle, hospital nurses or aides prime responsibility is to check it on a regular basis. The failure to replace them in time may result in a reversal of blood flow, compromising the patient's life. An Internet of Things (IoT)-based Smart Saline Level was developed to solve this issue and to provide an automated and efficient solution for remote monitoring. The Proposed system employs Internet of Things (IoT) technology, integrating NodeMCU, a load cell amplifier (HX711), Arduino UNO, Pulse oximeter (MAX 30100) sensor, DHT11 Sensor and a voltage regulator(L7805). The load cell, in combination with the HX711 amplifier, accurately measures the weight of the saline bottle. MAX30100 sensor measures Heart Rate & Oxygen saturation (SPo2) levels in blood. DHT11 Sensor detects the Humidity and Temperature levels. All the data is transmitted to the Arduino UNO, which serves as a master, the NodeMCU facilitates wireless communication, relaying the collected data from the Arduino UNO to the designated IoT cloud platform for remote monitoring.

**Keywords-** Internet of Things (IoT) ; NodeMCU; Load cell Amplifier ; Arduino UNO; Pulse Oximeter; DHT11 Sensor; Voltage Regulator.

### **1 Introduction**

Internet of Things is defined as combination of physical devices, which are included with the embedded software, sensors, and other technologies. IoT is primarily used for devices to communicate

with the cloud. IoT includes a vast network of devices, enabling them to send and receive the data without human intervention. In healthcare, saline therapy demands vigilant monitoring of saline levels, patient's pulse, and oxygen saturation. However, manual monitoring in hospitals can result in mistakes, delays, or negligence, particularly in busy or understaffed hospitals which leads danger to the patient's life. To reduce risks, a programmed and smart saline level and health monitoring system is necessary. It promptly alerts medical personnel when saline levels are low or when a patient's vital signs deviate from the normal.

Therefore, this paper proposes an IoT based system that is capable of automatically checking the salinity using a loadcell sensor with HX711 amplifier and alerts the nurse/staff through an alert message from the Blynk IoT App that the saline bottle must be replaced. The system also watches the patient's Heart-rate, oxygen level in blood using a pulse oximeter (Max30100) sensor and Temperature, Humidity using a DHT11 sensor, and presents all the data on the 16x2 I2C LCD.

The main purpose of the suggested system is:

1. For alerting a person and/or a nurse in case of saline level when it crosses the predetermined threshold.
2. Display of Temperature, Humidity, Oxygen saturation, Heartbeat rate, and Saline level of the patient.

The goal of this suggested system is to improve the medical facilities by reducing risks and errors associated with saline treatment and to ensures real-time monitoring of saline levels and patient's well-being, enabling healthcare professionals to pro-actively manage patient's health.

## 2 Literature Study

Shyama Yadav, Preet Jain[1] suggested a system that observes the flow of saline automatically, controls the infusion rate. With the aid of Wi-Fi, it sends data to server, displays the specifics in terms of percentage of saline droplet, failure condition, and infusion volume on the central monitor.

Karthik M[2] suggested a system where by the load sensor detects the saline level and displays it on LCD. As the level of saline attains a designated value, this system transmits an SMS to the hospital staff through a GSM.

A.Allwyn Gnanadas [3] et al developed a system in which the nurse will watch over and regulate the bag used for saline infusion. Sensor is used to monitor the load and a solenoid valve the catheter tube can be managed. The valve pulls the IV Tube when saline level touches the valve at its end..

Nikhil Manikandan.K[4] et al introduced a novel system with automatic stopping and alert. It analyses the level of saline and stops the flow when necessary and alerts the caretaker via buzzer beeps.

Dr.N.Neelima[5] et al proposed a system in which the saline level is recognised via a load cell and constantly displays the patient's heartbeat rate, oxygen saturation on LCD. It also alerts staff about the level of saline through a buzzer sound.

Zheng, Z. Li, and B. Li[6] proposed a theoretical load cell system to detects saline levels. The photoelectric sensor records the liquid level and the data is transmitted to the nursing staff with visual and verbal messages.

Hence, based on the literature review, the GSM Module is not compatible with recent technologies related to Internet of Things (IoT). Here in our proposed system, the accurate and reliable data were obtained by using NodeMCU Wi-Fi Module.

## 3 Components

### 3.1 Temperature and Humidity Sensor (DHT11)

DHT11 is a Humidity and temperature Sensor. DHT11 has range of 0-50 degrees Celsius temperature and a range of 20-90% RH humidity. DHT11 Operates with accuracy of  $\pm 2$  degrees Celsius for temperature and  $\pm 5\%$  RH for humidity. The sensor outputs a digital signal with a sampling rate of one reading every two seconds. Its integrated design includes a built-in resistor. DHT11 Operates at 3.5V to 5.5V DC.

### 3.2 Pulse Oximeter (MAX30100)

The MAX30100 is a pulse oximeter and, heartbeat rate sensor module. This sensor is designed to measure heart rate and oxygen saturation levels without causing physical pain. It has heart rate measurement range of 30-250 BPM with a reliability of  $\pm 1$  BPM, SpO<sub>2</sub> measurement range spans

from 0% to 100% with an accuracy of  $\pm 2\%$  of SpO<sub>2</sub> within the range of 70% to 100%. The operating voltage is low and ranges from 1.8V to 3.3V.

**3.3 Load Sensor**

Load sensor is an electronic device, which allows for converting of mechanical forces (tension or compression) into electronic signals. The sensor contains the mass weighing information and converts the saline level weight into an electrical signal. Then, the amplifier can accept the signal and transmit it to the central system. An analog weighing sensor with a load cell having the form of the said scale. The weighing applications are common, and a “straight bar load cell” which is also called as strain gauge can be converted into an electrical signal under the weight of about 5 Kg (force). By amplifying analog voltage of the output signal, which the converter has already transformed into digital PWM voltage, the HX711 chip receives this signal.

**3.4 HX711 Amplifier**

The HX711 load cell amplifier is the integral part of the precision system that is used to measure weights. The HX711 is an advanced 24-bit ADC that can provide pinpoint precision analog-to-digital conversions. It interacts with a micro controller by a simple 2-wire serial interface: this is Clock and Data. It prevents electrical noise and leads to the right data collection. The operating voltage range of the sensor is 2.6 V to 5.5 V.

**3.5 Voltage Regulator(L7805)**

The L7805 is a linear voltage regulator circuit (IC) that provides a stable output voltage of 5V. It protects the IC from overheating and limits the current in case of a short circuit. The L7805 has a typical input voltage range of 7- 35 V and a maximum output current of 1.5A. The recommended outcome current is 1A for optimal performance. Its operating temperature range is 0 to 125 degrees Celsius.

**3.6 Arduino UNO**

The Arduino UNO is a popular board for building electronic projects. It uses the Atmega328P microcontroller and it comes with 14 digital I/O pins, consisting of 6 PWM and 6 analog input pins. The microcontroller runs at 16 MHz and has a 32KB of flash memory. One can connect it to a computer through USB for both programming and power. The board has a voltage regulator allowing 7-12V input, giving a stable 5V output. To program the Arduino UNO Board, the Arduino IDE is used which supports the C++ programming language.

**3.7 I2C Liquid Crystal Display**

An I2C LCD (16X2) module is a Liquid Crystal Display that incorporates an I2C (Integrated Circuit) interface for communication with microcontrollers. It uses a two-wire serial communication protocol (SDA and SCL) for easy integration with microcontrollers. The module features two lines(16X2), indicating the amounts of columns and rows in the display. It enables users to adjust the display contrast and brightness and has LED backlighting. It operates at a 5V power supply.

**3.8 NodeMCU (ESP8266)**

The NodeMCU is an ESP8266 Wi-Fi module. It incorporates a microcontroller unit (MCU) and integrates Wi-Fi capabilities. The main feature of NodeMCU is it is integrated with a Wi Fi module, permitting it to link to wireless network and communicate through the internet. It has a clock speed of 80 or 160 MHz, flash memory of 4 MB or 8MB. The NodeMCU consists of General-Purpose Input/Output (GPIO) Pins for connecting with actuators, sensors, and other devices. It generally operates at an operating voltage of 3.3V.

The Table 1: Component Specifications provides an overview regarding the hardware and its methodology.

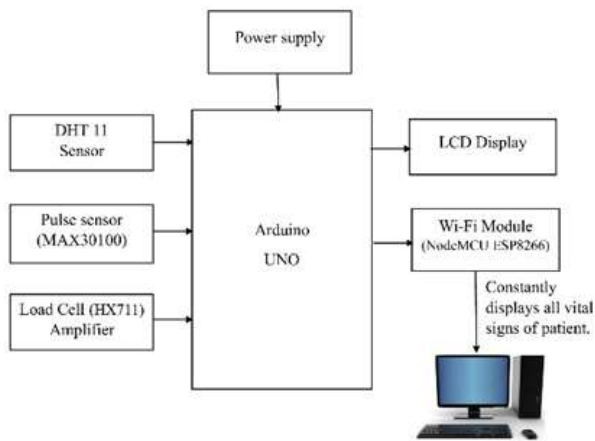
Table 1: Component Specifications

S. No.	Components Used	Specifications
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	Arduino UNO (ATmega328P)	Input Voltage: 7V-12V Output Voltage: 5V Digital I/O: 14 pins Analog I/O: 6 pins Clock: 16 MHz Flash:32KB
	NodeMCU (ESP8266)	Voltage:3.3V Clock: 80/160 MHz Flash:4MB/8MB
	Load Cell (HX711) Amplifier	Voltage: 2.6V- 5.5V Resolution: 24-bit Interface: Two- Wire serial (Clock & Data)
	Temperature and Humidity (DHT11) Sensor	Voltage: 3.5V- 5.5V Temp Range: 0-50 degrees Humidity Range: 20% -90% Accuracy: ±2°C(Temp), ±5% (Humidity)
	Voltage Regulator (L7805)	Input Voltage: 7V - 35V Output Voltage: 5V Max Current: 1.5A Temp: 0-125°C
	Pulse Sensor (MAX30100)	Voltage: 1.8V - 3.3V HR Range: 30- 250 BPM Accuracy: ±1 BPM SpO2 Range: 0%- 100% Accuracy: ±2%
	I2C LCD (16X2) Module	Voltage: 5V Interface: I2C Display: 16X2
	Batteries	Voltage:3.7V

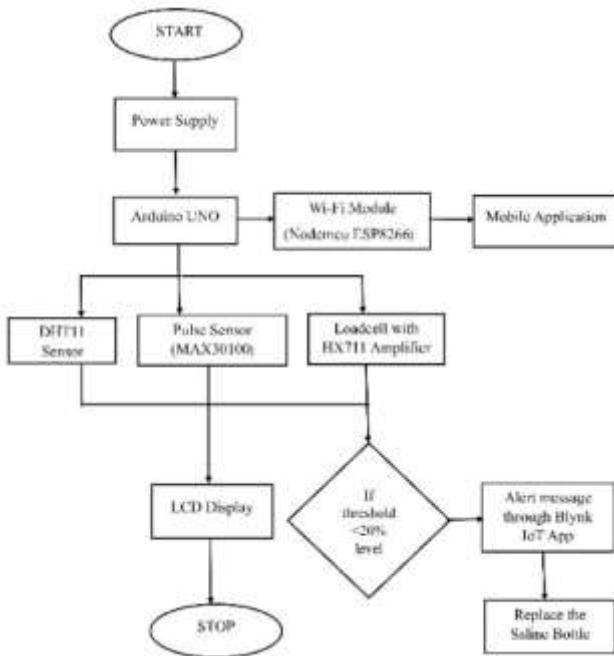
**4 System Architecture**

The Block Diagram of the suggested system is shown as follows in fig.1. The controller that is being used is Arduino UNO (ATmega328P Microcontroller) which co-ordinates the sensor output.



**Fig.1.** Block Diagram of suggested work

The below flowchart illustrates the flow of the suggested system as shown in fig.2.



**Fig.2.** Flow Chart of suggested work

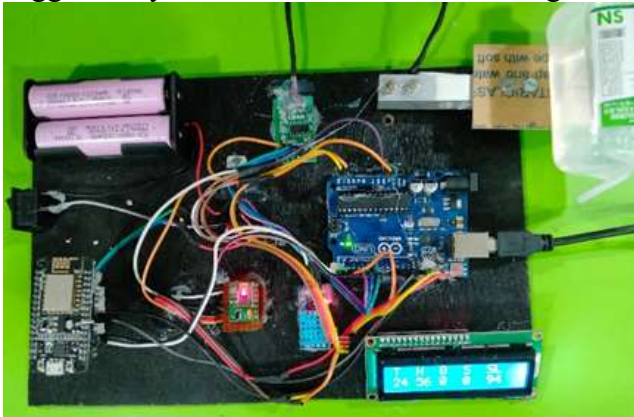
**5 Implementation**

**5.1 Hardware Implementation**

The suggested system is energized by two batteries-7.4V(approx. 8V) i.e., 3.7V each. Since the electronic components are operated under 5V, a voltage regulator(L7805) is used to convert the 8V to 5V.The voltage regulator provides a regulated 5V supply to power the NodeMCU, load cell amplifier (HX711),Pulse oximeter(MAX 30100) sensor and DHT11 Sensor. The Micro-controller of the system is ATmega328P. The Temperature and Humidity(DHT11) is connected to Arduino UNO which yields the humidity and temperature values. The MAX30100 is linked to Arduino UNO that produces patient’s oxygen saturation and heartbeat rate as an output. The System collects real-time data on levels of saline using the load cell(HX711)Amplifier. The strain that is produced and is converted into an electrical resistance of the same magnitude is used to calculate the weight of the saline bottle.

All the collected data is processed and analysed using Arduino UNO, and the NodeMCU wirelessly transmits it to the Blynk IoT platform. The system constantly displays the parameters i.e., Saline level, temperature, humidity, pulse rate, and oxygen saturation levels of the patient on the 16x2 I2C LCD Display, Blynk IoT app simultaneously and it also sends an alert message through blynk IoT app, as

the level of the saline is reaches level of threshold (i.e., <20%) for remote monitoring. The Model of suggested system is shown as follows in fig.3.



**Fig.3.**Model of suggested system

**5.2 Software Implementation**

The suggested system makes use of Arduino IDE and Blynk IoT software. The Arduino IDE is the go-to tool for creating and uploading code to Arduino boards. With a user-friendly interface and support for C++, it simplifies the development process. The IDE includes handy features like the Serial Monitor for real-time debugging, making it easier to work with various components in Arduino projects.

Blynk IoT is like a remote control for smart devices. It lets us create custom buttons on our phone to connect with our gadgets. Simply dragging, dropping, and tapping to monitor or control things from anywhere, ensuring seamless communication.

Here, the NodeMCU and Arduino UNO utilizes the Arduino IDE for programming to establish a connection in between the Blynk IoT and Arduino UNO, with the NodeMCU acting as a Wi-Fi in suggested system. The Arduino Microcontroller processes the sensor output, and NodeMCU helps it to be wirelessly sent to the Blynk IoT platform. Arduino functions as a master, and NodeMCU receives the code upload.

The Arduino IDE interface is presented as follows in the fig.4.



**Fig.4.**Arduino

IDE 1.8.19

The Blynk IoT platform is shown as follows in fig.5.1. and fig 5.2.



**Fig.5.1**



Fig.5.2

### 6 Analysis and Results

This suggested work measures, displays the patient’s temperature, saline level, humidity, oxygen saturation, heart rate levels, that results in elimination of manual efforts of the nurse/staff. The output of the Arduino UNO appears on LCD. The temperature, humidity, pulse rate, and oxygen saturation, saline levels i.e., all parameters of the patient’s body are displayed constantly on the LCD Display and Blynk IoT platform simultaneously as shown in the below figures.

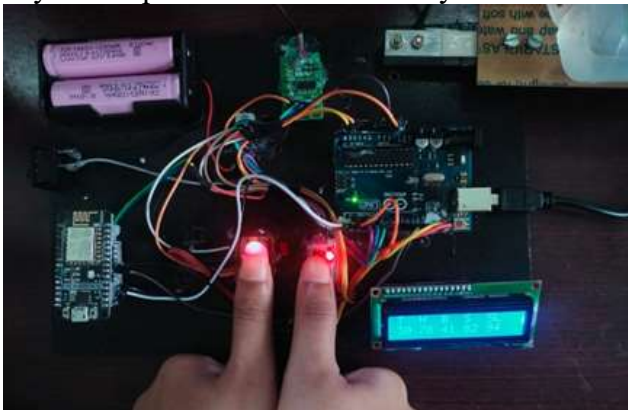


Fig.6.1.

Display of output on LCD at initial stage

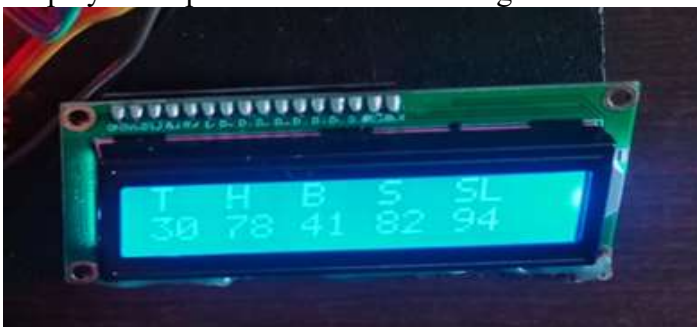


Fig6.2. Display of all parameters on the LCD Display



Fig.7. Display of all parameters on the Serial monitor of Arduino IDE



Fig.8.

Display of all parameters in the Blynk IoT App

The saline bottle level gradually drops. The proposed work transmits an alert message to the hospital staff once the saline level reaches a certain threshold (<20%) level and it also displays on the LCD and Blynk IoT platform as shown in the below figures.

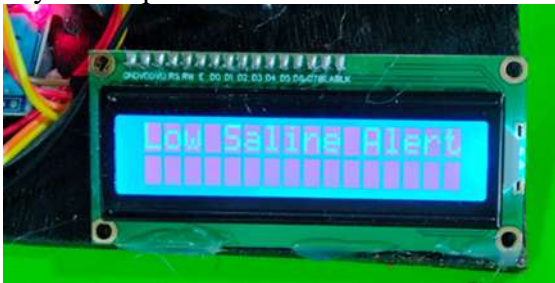


Fig.9. Display

of alert message on the LCD

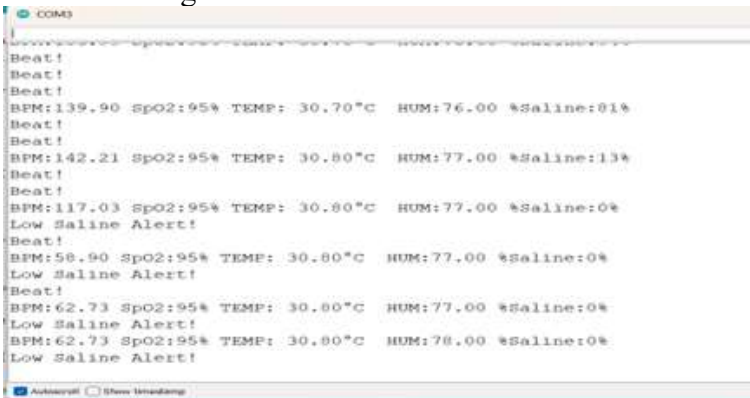
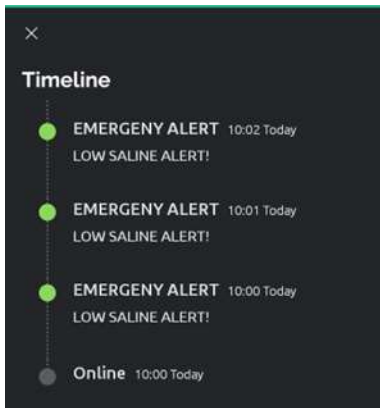


Fig.10. Display

of alert on Serial monitor of Arduino IDE



**Fig.11**

Display of alert message in the Blynk IoT App

From the above figures 6 to 11, all parameters are constantly displayed and the alert message clearly states that the bottle has to be changed by the hospital staff as it had reached a certain threshold (20%) level.

## 7 Conclusion

In this suggested work, the saline level is determined using a load cell (HX711) Amplifier, the patient's heartbeat rate, oxygen saturation levels and temperature, humidity levels are constantly displayed on the I2C LCD Display and Blynk IoT platform, making it easier for remote monitoring. As the saline level decreases and when it reaches a certain threshold level, the NodeMCU wirelessly transmits this information in-terms of an alert message and alerts the nurse/staff. This proposed work would be of a great use during the night time as there can be reduced patient visitation times. This proposed system provides enhanced accuracy in monitoring (up to 97%) and offers 24/7 continuous surveillance, these are the unique features of this work when compared to all other works.

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