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SMART SALINE BOTTLE USING IOT

Venu Kaushik Varrey[1], Gandra Mahesh[2], TBSS Rohit[3], Madasu Likhitha Veni[4]

[1][2][3][4]*Dept. of Electrical and Electronic Engineering,*
Sir C R Reddy College of Engineering, Eluru

Abstract - *Saline is a crucial ingredient as part of the intravenous solution that plays a significant role in managing critically ill patients. Continuous monitoring of the saline bottle is critical because when the saline level is empty and the pin is not removed, there will be a reverse blood flow inside the bottle. In many clinics or hospitals, nurses or caretakers are responsible for the surveillance of saline levels. Mainly, due to any unusual conditions or negligence of caretakers, the exact timing of removal of the needle from the vein is ignored, which causes severe casualty and may also lead to death. There is no such automatic method that helps to detect the acute level of saline. To prevent accidents due to the ignorance of the caretakers, we designed a simple, intelligent saline bottle that works with the combination of the Internet of Things (IoT), Microcontroller, and sensors. We created this system using a weight sensor, which converts the weight into specific voltage signals. These signals are identified by the ESP-8266 Microcontroller, an ultra-low power circuit. It generates and sends the message based on these voltage signals. We have used the MQTT broker to transmit or receive the notifications, which run over the Transmission Control Protocol. So the nurses or caretakers receive the letters, and we also attach a servo motor such that the caretaker can control the valve of the saline bottle using Google Assistant. The proposed system is reliable and essential for health care.*

Key Words: **NodeMcu, MQTT, Weight sensor, Servo motor, IFTTT, Saline Bottle**

1) INTRODUCTION

Saline solution is supplied to the patients whenever they need some energy. The saline solution needs to be injected slowly, which will take more time to complete. In this injection process, continuous monitoring is required, which is difficult in many hospitals. The caretaker may forget about the patient or be busy with some other work. So, whenever the saline is going to be empty due to reverse osmosis, the blood will flow inside the bottle, resulting in danger and leading to the patient's death. According to the latest report by Global Health Advisory, the ratio of physicians is less than 1 per 1000 persons. So, by building intelligent health care, we can ensure that care is reachable for every patient. Many authors addressed this problem. They suggested using a buzzer that alerts the caretaker. A buzzer will cause noise and disturb the hospital environment, which is unsuitable. On the other hand, we can send alert messages to the nurse's mobiles. We designed a cost-efficient, low-power saline monitoring system that used IoT technology. The components we used were load cell, weight sensor, NodeMcu (Esp8266), servo motor, and Message Query Telemetry Transport (MQTT) protocol, which is used wider in many IoT applications.

2) LITERATURE REVIEW

Traditional methods for monitoring patients in hospitals are getting difficult due to the rise in population. Caretakers manually need to check every patient's condition, which will be quite difficult and time-consuming. Many innovative ideas are being developed for the auto-monitoring of patients. Many sophisticated systems are being developed using the latest sensors, controllers, and technologies. This paper mainly focused on advanced saline level monitoring systems [1].

This paper focused on Radio Frequency based control and indicating system. In this system, an Infrared sensor (IR) is used to indicate the level. IR sensor output voltage changes when the fluid is less than a certain limit. The comparator compares the voltage with the threshold value and sends the signal that the Arduino will receive. It identifies that the fluid level is low and sends an alert buzz to the caretakers, and there is an LCD screen in the control room that indicates the patient's room number so that the custodian will take quick action [2].

Generally, the application layer is responsible for sending messages. Hyper Text Transfer Protocol is the most commonly used protocol for message formatting and publication. But the author commented that the HTTP protocol is unsuitable for resource-constrained environments because it arouses a large parsing overhead. They also discussed two alternative protocols, Message Queue Telemetry Transport (MQTT) and Constrained Application Protocol (CoAp), which are widely used in IoT applications [3].

The suggested System consists of sensors and controllers interconnected using remote correspondence modules. The data gathered by sensors are sent to custodians as a message or notification via the internet, which was feasible using the ESP8266 microcontroller, an open-source IoT platform. The data gathered can also be viewed on the Adafruit app or any webpage and observed by the nurses or caretakers [5].

3) PROPOSED SYSTEM

The proposed system mainly consists of the following components: Weight sensor, ESP8266, IFTTT, Breadboard, Servo Motor, MQTT Broker, and Client.

We integrated all these components and made them into a single unit. The load sensor is kept on the saline hanger, and the saline bottle is hung. The load sensor will send the voltage signals based on the weight of the bottle to ESP8266. Out of the endless amount of input voltage received at a specific voltage, ESP8266 will send the output message such as "EMPTY ALERT." Then the generated output messages are published over the Wi-Fi network. Here we are using the MQTT protocol as it was very lightweight and consumed less power. The ESP8266 Microcontroller posted the output message over the MQTT broker, and the clients, such as nurses' or caretakers' smartphones or tablets, will subscribe to this topic on MQTT. The MQTT broker will receive and forward the message to the subscribed clients. The proposed System also consists of a servo motor, and if the nurse could not come to the patient in time, they could turn off the value of saline by giving a command in Google Assistant.

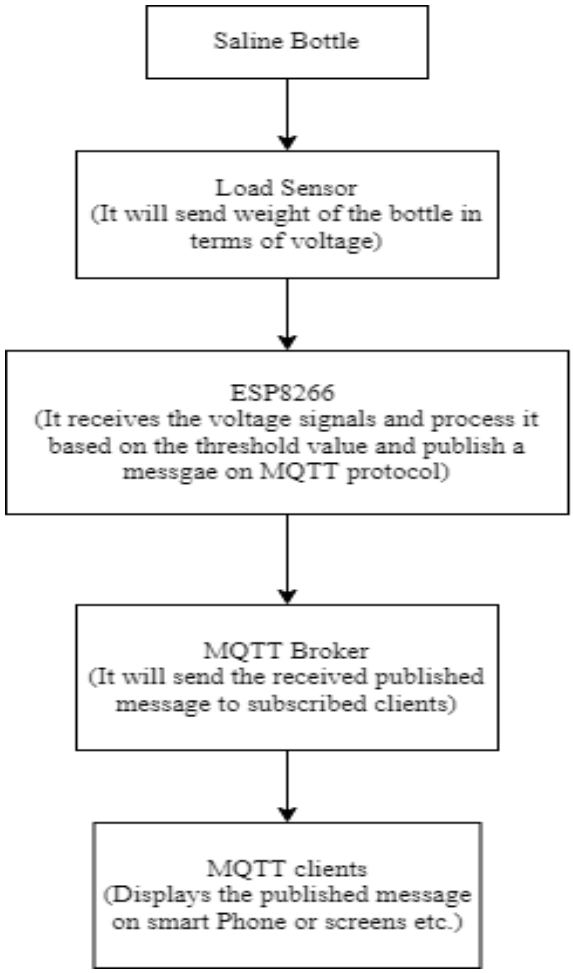


Fig. 1. Block diagram of the proposed system

We are using IFTTT (If This Then That) application; here, we are creating an appellate such that IF we send a command through Google Assistant, THEN the message was published on MQTT, so the subscribed client here is the ESP8266, receives the signal, and it will activate the servo motor, servo motor will turn off the valve of saline bottle after receiving the command. Using this mechanism, we can prevent the reverse flow of blood into the saline bottle by switching off the value even if the caretaker cannot reach the patient in time. This will reduce the severity even the caretakers unable to reach the patients immediately.

4) SYSTEM ARCHITECTURE

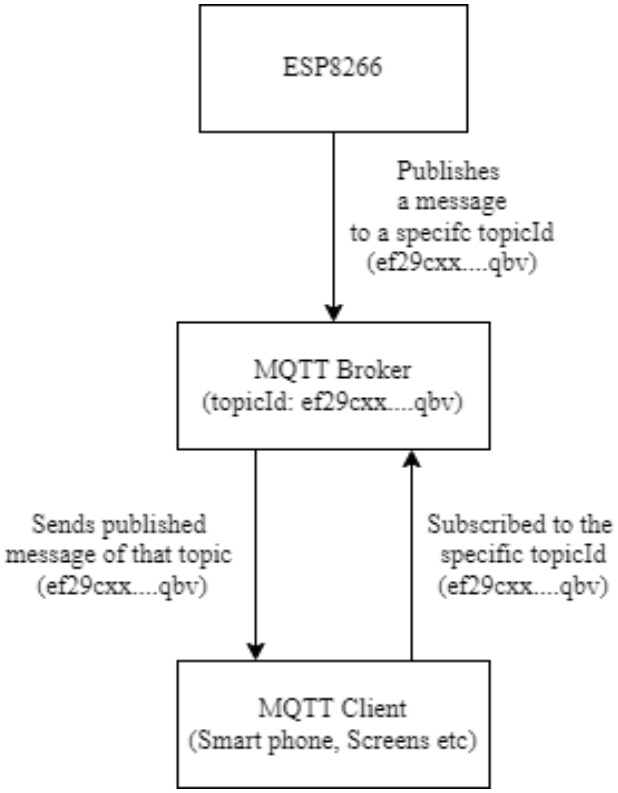
In the proposed system, calculating the weight of the saline bottle when the liquid is going to be empty, ESP8266 will send alerts to the end users through the MQTT protocol, and the user also controls the valve of the saline bottle from wherever they are. Below we are explaining each module.

1) **Weight Sensor:** It consists of a load cell that acts as a transducer that converts mechanical load into an electrical voltage output. It also consists of an HX711 chip which converts this analog voltage into pulse width digital voltage that is delivered to the input of the ESP8266 chip

2) **ESP8266 Chip:** This low-powered Microcontroller with an inbuilt Wi-Fi chip. The ESP8266 chip continuously receives the digital voltage from the load sensor. Generally, the saline bottle weighs 500g for each weight; the voltage will differ. The voltage received by the ESP8266 when the saline level is going to be empty is called threshold voltage. We set this value when the saline bottle weight becomes 50g. We programmed this chip in such a way that it will publish a message over the MQTT broker, which is a communication protocol. MQTT will send this message to all subscribed clients like smartphones, tablets, etc.

3) **MQTT Protocol:** It is a lightweight protocol specially designed for low-power circuits. It is a topic based publish or subscribe paradigm. Each client either acts as a publisher or subscriber. The client can post messages on specific topics on the MQTT broker; clients subscribed to that topic will receive those messages. Each case has a unique identification number called topic. In this project, we used Adafruit.io, a cloud-based service; we connected the MQTT client to Adafruit. Adafruit MQTT API exposes feed value using special topics. Clients can publish/subscribe to a feed topic.

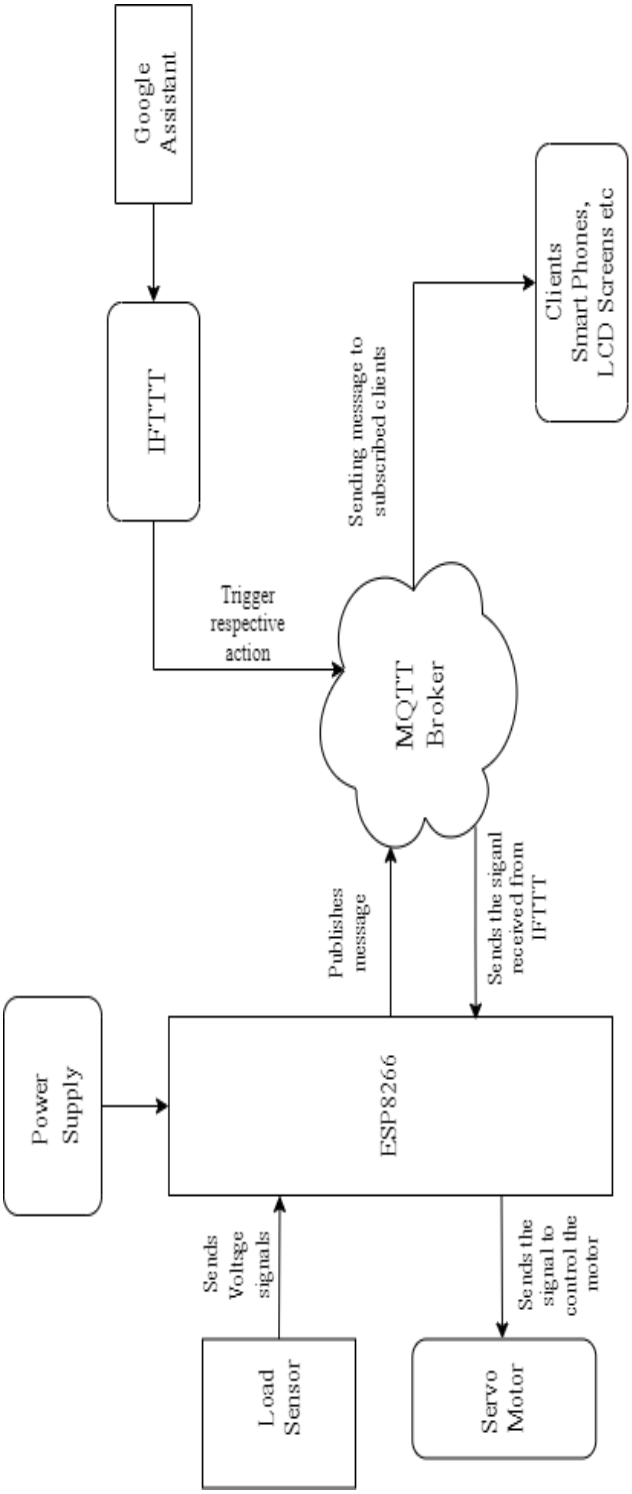
For registration, the subscriber gives its identification number, for example, MAC address of the network interface, and topicId, to the broker. Whenever the broker receives the message, it can send that message related to the subscribed topicId to the registered subscriber, through online.



4) **IFTTT:** IFTTT is derived from the programming conditional statement "If this, then that. It is a software platform that connects different devices and apps to trigger one or more automation actions involving those apps and services. In IFTTT, we use automation applets that combine two or more services to activate the necessary steps. In this project, we used Google Assistant to initiate the movement. If we give a command over Google assistant, it starts the MQTT connected to Adafruit. So the clients subscribed to this topic receive the signal, and necessary action occurs.

The entire source code for the application was present in the following Github repository.

https://github.com/vvenukaushik/SmartSalineBottle



5) CONCLUSION:

Through this project, we proposed an intelligent saline level monitoring system by which nurses or caretakers can remotely monitor the patients. The nurses can also control the valve of the saline bottle from the position where they are present. Using this saline monitoring system, one can monitor and control the saline level of the patient remotely.

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