IOT BASED UNIVERSAL WATER LEVEL CONTROL SYSTEM FOR SUMP AND/OR TANKUSING STM32

Dr. S. Jagan Mohan Rao **B. Durga Manjula** **D. Sri Harsha** **I. Padma Rekha** **B. Gowrinadh**

Professor **Undergraduate** **Undergraduate** **Undergraduate** **Undergraduate**

Abstract

Water is the most fundamental natural resource for all living things. Water scarcity is becoming the most serious problem confronting the majority of the world's cities, and transmission waste is becoming a worldwide danger. More than half of the earth's surface is covered by water, yet 96.5 percent of it is saltwater and just 2.65 percent is freshwater. As a result, controlling and conserving water is critical for our future. Overhead tanks or containers are erected in many regions for water storage due to the increasing population and everyday demands. Traditional water tanks do not regulate or conserve the water level in the tanks. There is a need to automate the water management system by deploying sensors and monitoring the data on the server using technologies such as the Internet of Things (IoT) and cloud computing. A prototype system for autonomous control and monitoring utilizing IoT has been built in this study. smart water management, so that the water level is automatically monitored, preferably pumping water at a low level and stopping at a full level. The prototype model incorporates two operational control systems: In mode 1, it functions as a system controlling the automatic operation of tank and sump level monitoring. In mode 2, it performs an automatic operation on borewell motor operation and tank water level monitoring, employing float sensors for water level monitoring and flow sensors for water flow in the pipe. The STM32 is used as the system's brain to control the entire process. A buzzer is used to warn the system when the water level is high or low. The IoT system is intended to use MQTT (Message Queuing Telemetry Transport), and the collected data will be transferred to the cloud. The ESP8266 is used to wirelessly link sensors to the router.

key words

ESP8266, IoT (Internet of Things), Float sensor, Flow sensor, UBIDOTS.

1. INTRODUCTION

Water is a main part of the everyday lifecycle. Android application for smart multiple water tanks based on IOT. In which case, tank can control and monitored directly over the smart phone from everywhere. The android application is developing. In can see the level of water can manually stop the motor if necessary. Automatically, the motor can be switched off. when the water level reaches its the maximum level and minimum level, The objective of this application is to avoid the overflow of water in urban areas by calculating the statistics of water send supply and sending this supply to the rural areas. The Same goes for colleges too. Now, their management has become difficult. The purpose of technology is to make our lives easier. So, with the advantage of technologies like the Internet of Things, we can change the way we do things in a better way. The management of water saving becomes smart and easy using Internet of Things. In this project, the main focusis to manage water level and indications via an android application. The proposed IoT- based system is fully automated, which save human energy and time. So, there is no need to check the water level manually. In real time monitoring, a smart water tank consists of a sensor attached to it to sense the water level. A microcontroller reads the sensor data and sends the data to the UBIDOTS cloud using its on-chip Wi-Fi to operate the system anywhere in remote areas. Themotor will act automatically in accordance with the water level in the tank. ESP8266 is used for communication to alert the user if there is any failure in the motor actuator takes place so that the motor needs physical switching.

2. LITERATURE REVIEW

In (3), a non-contact water measurement PIC microcontroller and an ultrasonic sensor HC-SR04 are used. The system measures the level of the water over 30cm andprovides an early intimation to the observer if there is a shortage or excess of water in the overhead tank. In (4), we have developed an automated water tank using Android application. The entire system includes an ultrasonic sensor, sensing unit, control unit, motor system, ESP8266 Wi-Fi module, Fire base Cloud for real time accessing of sensor data, and an Android mobile application MIT App Inventorto set threshold values in the tank.

In (5), we have implemented a water level monitor in a tank using IoT. The system consists of Node MCU, ULN2003 and an embedded circuit to automate the water pump control. The system easily detects water level and switch es on/off the pump as a consequence of the status of the tank. To view the data in real time, an android application called Blynk is used and an email alert is sent to the user.

In (6), we have presented multiple water tank control systems using Field Programmable Gate Array (FGPA) technology. This system includes an Atmega328 microchip, a buzzer, an actuator and VHSIC-HDL (Very High-Speed Integrated Circuit Hardware Descriptive Language) to control and monitor the water flow in an overhead tank.

In (7), GSM-based water level monitoring using ultrasonic sensors based on IoT technology is presented. The system involves an Arduino microcontroller and a Graphical User Interface (GUI) can be used at any location, which easily detects the water level in a tank using visual indicator and graphical icons. Also, the GSM module will provide the observer with an early message when deficiency of water is seen in the tank.

In (8), they have developed a water level indicator based on IoT for smart villages. The proposed system consists of an IoT-based architecture including a presentation layer, service layer, and physical layers. Liquid level sensors, Arduino, ethernet shield for the Internet, carriots.com and freeboard.io are included to acquiredetails of water level from any location.

In (9), they have developed an Automatic water level system using sequential logic based on flip-flops. The system checks and controls the flow of water through the pump in nine steps. A Motor pump using a relay and a seven-segment display are part of the design.

In (10), they presented automated water level control using insulated conducting wires will acts as sensing probes to check the water in four stages. A BC548C transistor is used as an amplifier and an LM7805 is used as a five-volt regulator to power the whole system.

In (11), they have developed an AU water level control system including the pressure sensor MPX2010DP to detectpressure in the tank, an INA126 amplifier to amplify the signals,and an android application Modbus to setup the threshold point.

In (12), we implemented a water level controller system for, greenhouse sump tanks using 2 electrodes made of copper protrude to act as sensors which sense waterlevel at high and low levels in the tank. The embedded control circuitry includes LED’s, buzzers, MAX4094 act as a comparator and CMOS4011BIC.

The developed system helps with better irrigation in green houses. It is clear that various researchers designed water level indicators using different sensors like ultrasonic sensors, PIR sensors, and technologies like MIT App, FGPA, Blynk, GUI, VHSIC-HDL, CMOS, and pressure sensor MPX2010DP.

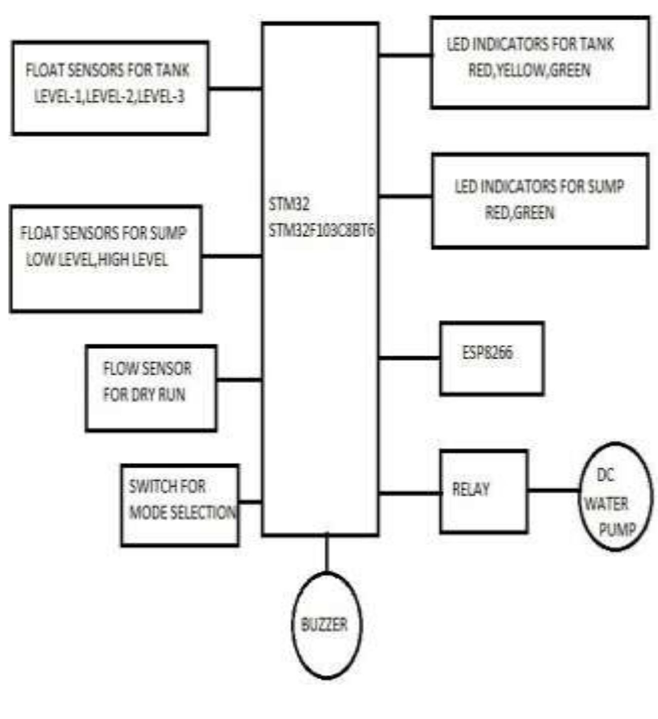
Furthermore, an IoT based water level monitoring system using Texas instruments and its Geo-Tagging is very rarely seen. So, developing an IoT based real-time water level controller using a low-cost ultrasonic sensor, HC-SR04, will be a cost- effective solution for domestic applications.

3 PROPOSED SYSTEM

To monitor the water level in real time using IoT and cloud computing technologies to avoid the wastage of water in water storage tanks and sumps. Methods/Analysis: The level of water in a tank is detected by using a float sensor, which works on the principle of converting mechanical energy to electrical signal and on-chip Wi-Fi microcontroller. When the water reaches the reserve position, the motor will normally be switched off. Once the water attains a maximum level before overflow occurs,its pump gets turned off. In that case, the flow sensor continuously detects the water flow in the pipe. If the flowsensor detects dry in the flow sensor, the motor gets turned off. Inthe event of a failure of the motor actuator (relay), it needs a physical switch of the motor. Novelty: In this study, we have designedan IoT based water level indicator in the UBIDOTS cloud with minimum power consumption, which can be used for Domestic applications.

In this project we implemented two applications by using switch we can operate two applications like 1. Sump and tank ,2. Only tank with borewell water .in these two applications we are using float sensors for checking water level in the tank and led indicators for display the water level in the tank and sump, first we check the switch condition for which mode we want to run, suppose it is in sump and tank mode then check the level sensors according to the motor will be on/off at the same time the data is sent server(UBIDOTS) .suppose if water is not there then we check dry run protection for this motor also in second modes. It uses the borewell switching and motor gets turn on/off depends upon the water tank level monitoring. The main use of cloud server is monitoring the status of tank and sump water level and mode of working.

4` BLOCK DIAGRAM



The block diagram above shows the prototype circuit. In addition, non-contact water measurement STM32, flow sensors, and float sensors are used. The system measures the level of the water and provides an early warning to the observer if there is a shortage or excess of water in the overhead tank. Wehave developed an automated water tank and sump system to work in two different modes using the UBIDOTS cloud server. The entire system includes float sensor, flow sensor, sensing unit, control unit, motor system, ESP8266Wi-Fi module, UBIDOTS Cloud for real time monitoring ofsensor data, and gives continuous indication through LED's which indicate the live water level. The relay connected to the motor turns on/off according to the coordinates given by STM32. The buzzer alerts the user to indicate the excess or shortage of water and the dry condition through the flow sensor.

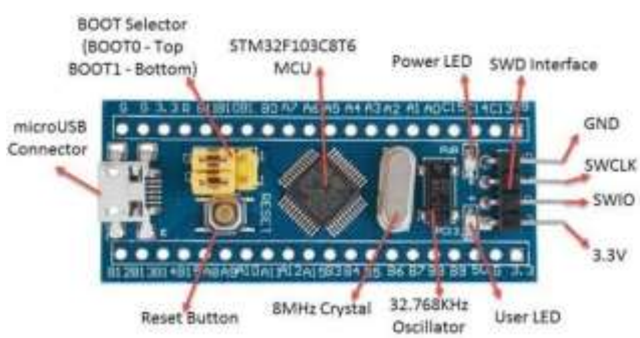
HARDWARE REQUIREMENTS:

- STM32 (BLUEPILLBOARD)
- INDICATORS WITH LEDS (RED, GREEN, BLUE)
- ESP8266
- FLOAT SENSORS
- WATER PUMP DC
- FLOW SENSOR
- POWER SUPPLY
- BUZZER
- SWITCH (SUMP+TANK, TANKMODESELECTIO)

SOFTWARE REQUIREMENTS:

- Knowledge of embedded C for programming.
- Arduino's IDE
- UBIDOTS SERVER

A.STM32



The STM32F103C8T6 is one of the mid-range microcontroller units of the STM32F103x8 family based on the RISC architecture. An integrated Blue Pill Development Board was introduced as a low-cost board as an alternative to STMicroelectronics STM discovery boards.

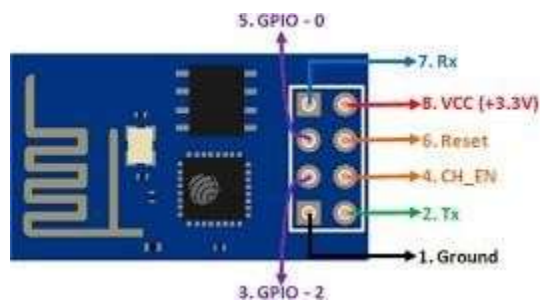
STM32F103C8T6 microcontroller comes with GPIO pins, processor, memory, USB port, Analog to Digital Converters, and other peripherals. An ARM Cortex Core with an amazing speed of 72 MHz and remarkable power efficiency.

STM32F103C8T6 Blue Pill Development Board contains a 32-bit Cortex-M3 RISC ARM core with an internal oscillator of 4 - 16MHz. It is a CMOS flash technology chip. This chip has 37 GPIO pins and 10 Analog pins. It has some modern communication interfaces like a CAN and a USB port. The peripherals give outstanding control of the board as it operates at very low voltage, so it is suitable for low-power applications. It also comes with an integrated watchdog and a window watchdog timer for the proper execution of instructions.

STM32F103C8T6 Blue Pill is programmed to execute the overall work and the sensors are connected to GPIO pins all modules like relays, buzzer, flow sensors, float sensor, LED's and communication interfaces are done by Rx-Tx pins of ESP8266 Wi-Fi Module

B. ESP8266(Wi-Fi Module)

ESPRESSIF's ESP8266EX delivers a highly integrated Wi-Fi SoC solution to meet users' continuous demands for efficient power usage, compact design, and reliable performance in the Internet of Things industry. The ESP8266EX can function as a standalone application or as a slave to a host MCU due to its complete and self-contained Wi-Fi networking capabilities. When ESP8266EX hosts the application, it promptly boots up from the flash. The integrated high-speed cache helps to increase the system performance and optimize the system memory. Also, ESP8266EX can be applied to any microcontroller design as a Wi-Fi adaptor through SPI/SDIO or UART interfaces.



The Wi-Fi module shown above is attached to the STM32 board through the UART communication interface, and it is used to transmit and receive data via Wi-Fi, where it is connected to the hotspot using the user's SSID and password, which are contained in the application. Instead ofbulky circuits, the GPIO pins of the ESP8266 are utilized for control and monitoring. In this work, we use this Wi-Fi module to monitor the state of the water monitoring system.

ISSN- 2394-5125 VOL 09, ISSUE 02, 2022

C. Float sensor

Water Level Switches operate on a direct, simple principle. In most models, a float encircling a stationary stem is equipped with powerful, permanent magnets. As the float rises or lowers with the liquid level, the magnetic field generated from within the float actuates a hermetically sealed, magnetic reed switch mounted within the stem. The stem is made of non-magnetic metals or rugged, engineered plastics. When mounted vertically, this basic design provides a consistent accuracy of 1/8 inch. Multi-station versions use a separate reed switch for each level point being monitored.

Side-mounted units use different actuation methods because of their horizontal attitude. The basic principle, however, is the same: as a direct result of rising or falling liquid, a magnetic field is moved into the proximity of a reed switch, causing its actuation.

D. Flow sensor

An ultrasonic flow meter is a type of flow meter that measures the velocity of a fluid with ultrasound tocalculate volume flow. Using ultrasonic transducers, the flow meter can measure the average velocity along the path of an emitted beam of ultrasound by averaging the difference in measured transit time between the pulses of ultrasound propagating into and against the direction of the flow or by measuring the frequency shift from the Doppler effect. Ultrasonic flow meters are affected by the acoustic properties of the fluid and can be impacted by temperature, density, Viscosity, and suspended particulates depending onthe exact flow meter. It is used to sense the dry status in the event of a motor or pipe failure.

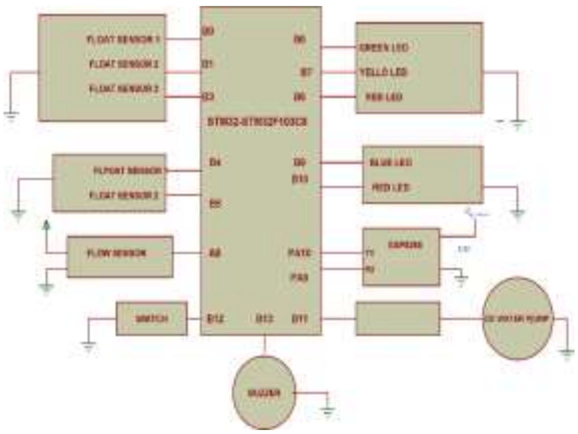
E. UBIDOTS

UBIDOTS is an Internet of Things (IoT) data analytics and visualization company. We turn sensor data into information that matters for business-decisions, machine-to-machine interactions, educational research, and increasing the economization of global resources. UBIDOTS exists as an easy and affordable way to integrate the power of the IoT into your business or research.

The UBIDOTS technology and engineering stack were developed to deliver a secure, white-glove experience for our users. Device-friendly APIs (accessed over HTTP/MQTT/TCP/UDP protocols) provide a simple and secure connection for sending and retrieving data to and from our cloud service in real-time. UBIDOTS' time-series backend services are performance optimized for IoT data storage, computation, and retrieval. Our application enablement platform supports interactive, real-time data visualization (widgets), and an IoT App Builder that allowsdevelopers to extend the platform with their own HTML/JS codefor private customization when desired. UBIDOTS exists to empower your data from device to visualization.

ISSN- 2394-5125 VOL 09, ISSUE 02, 2022

5. Schematic Diagram



The circuit diagram shown above is the circuit for the water level monitoring system. In the circuit, the power supply is connected through a regulated power supply. The 5V supply is required for the operation of STM32. The float sensors 1, 2, 3are connected to the pins B0, B1, and B3 and are used to detect the tank's level in low, medium, and full states. Case of low-level sensing, the motor gets turned on and in case of high-level sensed, the motor gets turned off. The sumptank, which is in the downward stair, is connected with the float sensor, which is used todetect the sensor position and continuously detect and activate the motor in the on or off position depending upon the sump water level.

The flow sensor is connected to an A0 pin which is connected to the water pipe line to protect the water pump in the dry free run of the motor, in the dry run case the motor automatically turn's off when the data signal is given by flow sensor to the STM32 control unit, The indication, and alert of the excess or low water level case is given by buzzer and LED'S, where the buzzer was connected to B13, The tank indication LED's which is used to indicate tank level is connected to B6,B7,B8, and the sump indication LED's are connected to pins B9,B10 and to monitor the status of the system in the cloud the ESP8266 Wi-Fi module Tx-Rx pins are connected to PA9,PA10 pins which upload the status of the system to the UBIDOTS cloud using the internet which is non-other than the Internet of Things, the whole system is used to give alert and control the watering system, which can be achieved by controlling the water pump, it can be turned on/off by using RELAY which was connected to the pin B11 of STM32 MCU.

We previously detailed how our prototype operates in two modes.

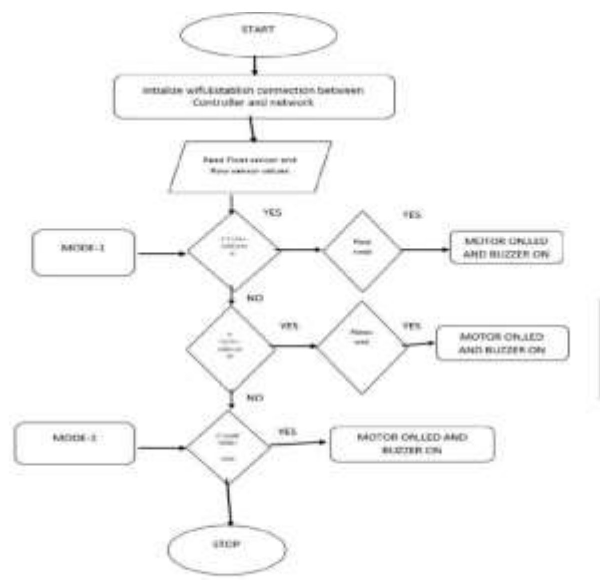
In mode 1, the system is powered by the water in the overhead tank and ground-level sump. The water tank indicates its level by indicating LEDs by monitoring the level of float sensors in the tank; if the float sensor indicates a low level and the sump float sensor indicates a full level, the motor turns on and a buzzer sounds an alert; otherwise, if the tank float sensor indicates a high level or the sump float sensor indicates a low level, the motor turns off.

In mode 2, the motor functions as a borewell motor; when the overhead tank sensor detects a low level of water, the motor turns on; when the tank detects a high level of water, the relay receives the signal and the motor turns off; an alert is given by a buzzer, and data is sent to the UBIDOTS server.

6. ALGORITHM

The figure shows a flow chart that explains the procedure. In mode 1, the wi-fi is activated and establishes a connection between the controller and the network, reading the values of thefloat sensor and flow sensor. If the tank float sensor F1 shows alow level and the sump float sensor F4 shows a high level, the motor is activated, and the flow sensor's wet condition is indicated by the led and buzzer.

If the tank float sensor F3 indicates a high level and the sump float sensor F6 indicates a low level, the motor activates, indicating flow sensor wetness and LED and buzzer indication. In mode 2, the borewell is connected, and the low/high level turn-on/off motor is activated depending on whether the flow sensor is wet or dry.



7. CONCLUSION

The development of a low-cost real-time water level monitoring system using Geo-tagging. The developed system can continuously monitor the water level in the tank using a float sensor and a flow sensor, and the sensor data is sent to the UBIDOTS cloud for real-time observation. Additionally, a relay-based embedded system controls the DC motor pump ON/OFF based on the water level in the tank [Overflow/Reserve]. Sensor data may be downloaded at any time and from any location around the globe. In addition, an alarm is delivered to the observer requiring quick action. The system has been designed with fewer hardware components and minimal power consumption, making it scalable, accessible, and cost-effective.

8. REFERENCES

[1] Rmsm D, Wickramaarachchi H. IoT Based Water Level Monitoring System Using Nodemcu. In: Applied Science, Business& Industrial Research Symposium(ASBIRES) , Sri Lanka, 2019, p. 35–38. Available from: https://www.researchgate.net/publication/338002821.

[2] Nishmitha, Kotari DM, Shetty P, Sudharshan G, Shetty S. WaterTank Monitoring System. International Journal of Engineering Research and Technology. 2019;7(8):21–25. Available from: https://www.ijert.org/rtesit-2019-volume-7-issue-08

[3] Mohammed SL, Al-Naji A, Farjo MM, Chahl J. Highly Accurate Water Level Measurement System Using a Microcontroller and an Ultrasonic Sensor. In: IOP Conference Series: Materials Science andEngineering;vol. 518. IOP Publishing. 2019. Available from: https: //iopscience.iop.org/article/10.1088/1757-899X/518/4/042025.

[4] Theja B. IOT based Smart Water Tank with Android Application. International Journal for Research in Applied Science and Engineering Technology. 2018;6(1):2622–2627. doi:10.22214/ijraset.2018.1359.

[5] Jeughale MS, Jadhao AP, Bachate PA, Chankhare DA, , Narkhede VPP, et al. IoT Based Tank water level monitoring and controlling: A Review. International Journal of Advent Research in Computer and Electronics. 2016;p. 1–4.

[6] Lukman A, Ajao A, Agajo J. Automated Multiple Water Tanks Control System Using ATMEGA and FGPA Technology. In: Proceedings of 1st IEEE International Conference on Mechatronics, Automation and Cyber-Physical Computer System, (MAC). 2019.

[7] Smith EJ, Kpochi KP, Ibrahim AA. An Ultrasonic & Gsm Module Based Water Level Monitoring System via Iot. American Journal of Engineering Research. 2018;7

[8] :21–25. Available from: http://www.ajer.org/papers/Vol-7-issue-8/D07082125.pdf. 8) Malche T, Maheshwary P. Internet of Things [IoT] based water level monitoring system for smart village. In: and others, editor. Proceedings of International Conference on Communication and Networks advances in Intelligent systems and Computing. 2017;p. 1–7.

[9] Getu BN, Attia HA. Implementation of sequential design based water level monitoring and controlling system. In: and others, editor. Proceedings of 5th International Conference on Electronic Devices Systems and Applications;vol. 9. 2016.

[10] Getu BN, and AHA. Automatic Water Level Sensor and Controller System. In: and others, editor. Proceedings of 5th International Conference on Electronic Devices Systems and Applications (ICEDSA). 2016. doi:10.1109/ICEDSA.2016.7818550.

[11] Roy O, Roy A, Roy DD. Automatic Water Level Indicator.International Journal of Emerging Trends in Engineering and development. 2016;6(2):145–148. Available from: http://www.rspublication.com/ijeted/2016/march16/3.pdf.

[12] Aphiratsakum N, Suvittayakul W, Saingam K. AU Water Level Process Control system. Proceedings of 12th International Conferenceon Electrical engineering/Electronics, Computer, Telecommunicationsand Information Technology. 2015. doi:10.1109/ECTICon.2015.7207039.

[13] An N, A YA. A, Water-Level Controller for Greenhouse Sump Tank. Proceedings of 2nd IEEE International Conference on Mechanic Automation and Control Engineering. 2012. doi:1004-1006. 10.1109/MAEC.2011.5987102.

[14] CC3200 SimpleLinkTM Wi-Fi® and IoT Solution with MCU Launchpad Hardware. . Available from: http://www.ti.com/lit/ug/swru372b/ swru372b.pdf.

[15] Koval L, Vaňuš J, Bilík P. Distance Measuring by UltrasonicSensor. IFAC-PapersOnLine. 2016;49(25):153–158. doi:10.1016/j.ifacol.2016.12.026.

[16] Guide HSU. HC-SR04 user guide. 2020. Available from: https://elecfreaks.com/estore/download/EF03085-HC- SR04_Ultrasonic_Module_User_Guide.pdf.

[17] GSM GPRS SIM900A MODEM Datasheet . 2020. Available from: https://researchdesignlab.com/projects/GPRSGSM%20SIM900A%20MODEM.pdf.

[18] ThingSpeak. 2020. Available from: https://thingspeak.co