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RTC AND IOT DRIVEN SMART URBAN UITILITIES MANAGEMNET SYSTEM USING GSM

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Abstract:

In this project, we present an IoT-based municipal water induction motor pump control and manhole monitoring system using the ESP32 microcontroller. The system leverages IoT technology to automate pump control, monitor manhole water levels, and manage streetlight operation based on a scheduled time using an RTC module. An ultrasonic sensor continuously monitors the water level in manholes, providing real-time data to prevent overflow and potential hazards. The ESP32 microcontroller processes sensor data and transmits alerts via a GSM module for remote monitoring. The RTC module ensures accurate scheduling of water pump operations and automatically turns streetlights on and off at predefined times, optimizing energy consumption and maintenance. Implemented using IoT, ESP32, GSM, RTC, LCD, buzzer, and embedded C programming, this smart solution enhances public safety, reduces manual intervention, and improves municipal resource management. Future enhancements will focus on integrating AI for predictive maintenance and expanding IoT capabilities for more efficient urban infrastructure monitoring.

Keywords: RFID Technology, Ultrasonic Sensor, IoT (Internet ofThings), App Connectivity, ESP32 Micro controller.

1. INTRODUCTION

Around 5% of total energy is consumed by the street lights, lighting of parking lots, pedestrian area along with park lighting which contains both the working part and the wasted part. The wastage of the power occurs mainly due to the timing of manual operation of lights. This paper is a projection of a process which demolishes the wastage in case of Bangladesh. A practical implementation of this model will also be presented which took place in Mirpur Cantonment, Dhaka, Bangladesh. This model is structured using the GSM-GPRS shield. The whole model has the superiority to be controlled in full-automated, semi-automated and manual method. The GPRS part has the access to internet which can use the sunset and sunrise timing to allow the system to operate in full-automated method. On the other hand, utilizing the GSM part and RTC module, semi-automated control can be administrated. Even if there is issue with these automated systems, there is also a feature of manual control method. Moreover, the proposed system has the option of detecting the fault associated with potential transformer and current transformer. The entire process is controlled by ATmega-328p microcontroller. IOT (Internet of Thing) nowadays this becoming a major part of human life. In the future IOT plays the important role in human's life from waking up in the morning to going to sleep these IOT devices used by humans in every aspect of their life. For example, when leaving the home without switching off the fans and lights, by using mobile it can switch off fans and lights and other things automatically. To make those things work through mobile by using IOT and another example is, switch on and off the light automatically when walking in the specific area in that particular area the light is on, after leaving that area the lights are turned off automatically. These both examples reduce electricity consumption. So IOT is not only used for the people to work easily, but it also saves the energies like electricity, water etc. That's why the devices present in this project work based on IOT. Using this hardware device which uses IOT, the water, and electric resources can be saved. So IOT corrects the man's mistakes by turning the motor off. The IC connected in the circuit and the oscillator attached to the tank makes the relay that connects the motor and the circuit will turn on and off accordingly. When the water level touches the top of the tank the oscillator senses the water and sends the signal. As this relay is connected to the motor it breaks the circuit so that no electricity passes through it. This Oscillator is attached at the top of the tank. In the circuit, there is a Relay that acts as a switch and connects the circuit to the power supply when the tank is empty and disconnects the power supply when it is full. The power comes to the circuit through the power supply that is connected to the circuit. This diode sends the current in a single direction and the regulator, regulates the current and supply to the circuit. The Crystal Oscillator which having the sensor attached at the top of the tank since the water vibrations when the tank is full and these signals are sent to the IC555 which works on a timely basis reacts to the signals that received from the oscillator and transfer the pump off signal to the relay which is connected to the IC. This relay reacts to the signal send by the IC and turn off the pump that is connected to the relay. This process stops the water from overflow. Same when the water is down that is when the water is empty in the tank the Oscillator identify the vibrations and send the signal to the IC and the IC send the signal that the tank is empty the pump to be switch on the relay allows the pump to be switch on the current. This Diode is connected to the Regulator which regulates the flow of current. When voltage is suddenly increased or decreased, this sometimes results in circuit break down. The regulator regulates the currents and supplies an equal amount of current to the device all the times. All these are connected to the IC555 on the PC board. Connect the LEDs and Switches to it and [6, 7] make sure all are connected properly. Connect a push Button and IC sockets to the pc board and finally connect the crystal Oscillator. This Crystal Oscillator contains a sensor in it that can converts vibrations into electric signals. This Oscillator is attached [9] at the top of the tank. In the circuit, there is a Relay that acts as a switchand connects the circuit to the power supply when the tank is empty and disconnects the power supply when it is full. The power comes tothe circuit through the power supply that is connected to the circuit. This diode sends the current in a single direction [13] and the regulator, regulates the current and supply to the circuit. The Crystal Oscillator which having the sensor attached at the top of the tank since the water vibrations when the tank is full and these signals are sent to the IC555 which works on a timely basis reacts to the signals that received from the oscillator and transfer the pump off signal to the relay which is connected to the IC. This relay reacts to the signal send by the IC and turn off the pump that is connected to the relay. This process stops the water from overflow. Same when the water is [4] down that is when the water is empty in the tank the Oscillator identify the vibrations and send the signal to the IC and the IC send the signal that the tank is empty the pump to be switch on the relay allows the pump to be switch on the current. Water pumps are designed [9] to move water from oneplace to another. In many places, water supply can be given at early

mornings so the one should wake up and turn on the motor of 45.5KΩ's doesn't exist as a standard worth resistor, so we would have to choose the closest favored worth resistor of 47kω's which is accessible in every one of the standard scopes of resilience from the E12 (10%) to the E96 (1%), giving us another recalculated time postponement of 517ms. In the event that this time distinction of 17ms (500 – 517ms) is inadmissible rather than one single planning resistor, two diverse worth resistor could be associated together in arrangement to change the beat width to the specific wanted worth, or an alternate planning capacitor esteem picked. We presently realize that the time deferral or yield beat width of a monostable 555 clock is controlled when consistent of the associated RC organization. On the off chance that long time delays are needed in the 10's of seconds, it isn't generally fitting to utilize high worth planning capacitors as they can be actually huge, costly and have enormous worth resilience's, e.g., ±20%. One elective arrangement is to utilize a little worth planning capacitor and a lot bigger worth resistor up to about 20MΩ's to deliver the require time delay. Likewise, by utilizing one more modest worth planning capacitor and distinctive resistor esteems associated with it through a multiposition revolving switch, we can deliver a Monostable 555 clock oscillator circuit that can create diverse heartbeat widths at each switchturn, for example, the switchable Monostable 555 clock circuit appeared underneath.

2. LITERATURE SURVEY

Suseendran et al. [1] represented the brightness controlling of the street light using sensors, based on IoT (Internet of Things), video vehicle detection and LDR (Light Decreasing Resistance) sensor. Each lamp unit encompassed two sensors- video vehicle detection sensor and LDR sensor. All the data were collected and processed on a regular basis which had required a huge data processing system.

Lavric et al. [2] revealed a practical implementation of street light monitoring and controlling system employing WSN (Wireless Sensor Network System). The authors had focused on the software-based method and then performed a real-time implementation using limited number of lights. This archetype included Doppler sensor to allow vehicle detection. According to the appearance of vehicle, lights for that region increased intensity.

Archibong et al. [3] worked with IoT based PV solar self-powered lighting system for street with anti-vandalism monitoring and tracking competency. LDR sensor switched the lights on-off along with an IR (InfraRed) sensor having the ability to save power. The anti-vandalism system was installed with a User Interface (UI), where the street lights communicated with the people and devices through wi-fi module at the control station.

Prasad et al. [4] projected a case-study of Nagpur Street lighting system, where LED lights were utilized along with motion detection system. The arbitration showed that energy consumption was lessen by55% per month.

Abdullah et al. [5] using Lora WAN in accompany with motion detector and illuminance sensor to mitigate the power consumption. In this model, every street light had been furnished with Lora WAN communication module, which controlled the LED lights by exchanging data with main server. Mary et al.In the year 2016.

Manish Kumar [6] published a paper on streetlight regulation using a Zigbee wireless module. A transmission module, an LDR, and a microcontroller were among the components. Wireless connectivity with the lamp module is possible thanks to Zigbee. The computer analyses day-night variations and lamp safety using two LDR sensors. After the LDR data has been read, it is transferred to the microcontroller and then to the transmission module. The data is sent to the control centre via wireless Zigbee, which monitors and manages each streetlight. The device connects to a Zigbee wireless network witha limited range.

3. PROPOSED METHODOLOGY

The RTC module is programmed with a predefined schedule for municipal water distribution. At the scheduled time, the ESP32 microcontroller activates the water pump, allowing water to flow through the distribution network. If the system detects pump failure, an alert is sent via SMS to the registered authorities, and a buzzer alarm is triggered. The entire water distribution status is displayed on the LCD screen and updated to the IOT cloud for remote monitoring. The RTC ensures streetlights turn on and off according to a pre-set schedule, eliminating the need for manual operation. A Light Dependent Resistor (LDR) continuously monitors the brightness of the streetlights. If a streetlight fails to illuminate even after being switched on, the system triggers a buzzer alarm and sends an SMS alert to the authorities for maintenance action. real-time status of streetlights is displayed on the LCD screen and updated to the IOT dashboard for centralized monitoring. An ultrasonic sensor is placed inside the manhole to continuously monitor the water level. If the water level exceeds a predefined threshold, indicating a potential clogging or overflow, the system immediately: Activates a buzzer alarm for local alerting.

3.1 Block Diagram:

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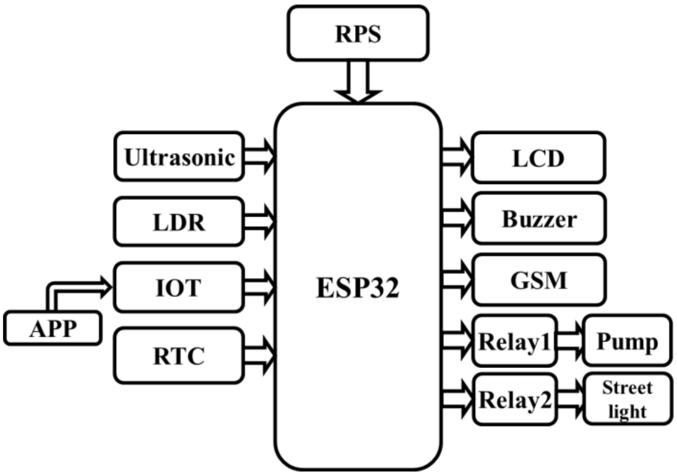

Fig – 3.1 Block Diagram of Circuit

Sends an SMS notification to the municipal authorities for quick intervention. Logs the incident data to the IoT cloud, allowing authorities to track and analyse clogging trends for preventive maintenance.

All operational data, including water supply status, streetlight conditions, and manhole water levels, is displayed on an LCD screen. The system continuously updates the IoT cloud, enabling municipal authorities to remotely monitor and manage city infrastructure in real time from a dashboard. In case of any fault detection, the system provides instant SMS alerts and buzzer notifications to ensure prompt maintenance action.

This fully automated IoT-based system significantly enhances municipal service efficiency by eliminating manual intervention, ensuring reliable water supply, optimizing streetlight operation, and preventing manhole overflows. By integrating IoT, real-time monitoring, and automated alerts, the system improves urbaninfrastructure sustainability, safety, and responsiveness.

3.2 Project Working:

Manhole monitoring is another major concern in urban infrastructure. At present, manholes are not routinely monitored in real-time. The condition of a manhole is typically noticed only when it becomes clogged or overflows, causing traffic disruptions, health hazards, and potential accidents. Without an early warning system, municipal authorities can only take action after a problem has already occurred, leading to reactive rather than proactive maintenance.

To address these issues, this project introduces an IoT-based automated system that eliminates manual intervention in water supply management, streetlight operation, and manhole monitoring. By integrating IoT technology with an ESP32 microcontroller, the system automates water pump control, ensuring efficient and scheduled water distribution while reducing human dependency. An RTC module is used to automatically turn streetlights on and off at predefined times, optimizing energy consumption and enhancing public safety. Additionally, an ultrasonic sensor continuously monitors water levels in manholes, providing real-time alerts to prevent overflow and allowing authorities to take preventive action before a major issue arises.

3.3 SCHEMATIC DIAGRAM

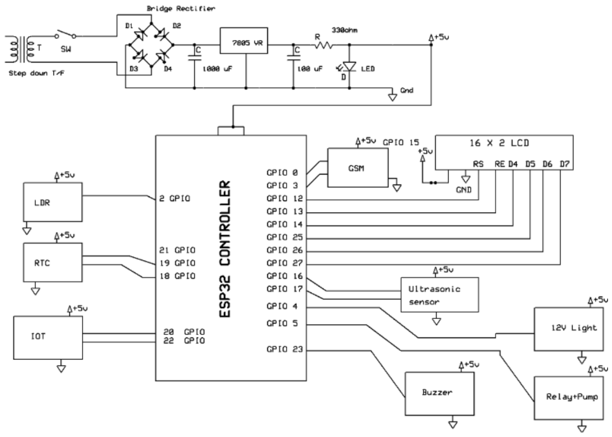

Fig-3.3 Schematic Diagram of ESP32 Controller

In this project, we are using ESP32 Microcontroller. It has a total of 40 pins. Here the 20 and 22 are connected to the IOT, for transmitting and receiving the data. 12, 13, 14, 25, 26, 27 pins are connected to 16*2 LCD, 0, and 3 pins are connected to a GSM modem which can send alert messages to the registered user, the 23 pin is connected to the buzzer, the 5 pin is connected to the pump. 2 pin is connected to the LDR sensor, 4 pin is connected to 12v LED. A4-A5 pins are connectedto RTC.

4. EXPERIMENTAL ANALYSIS

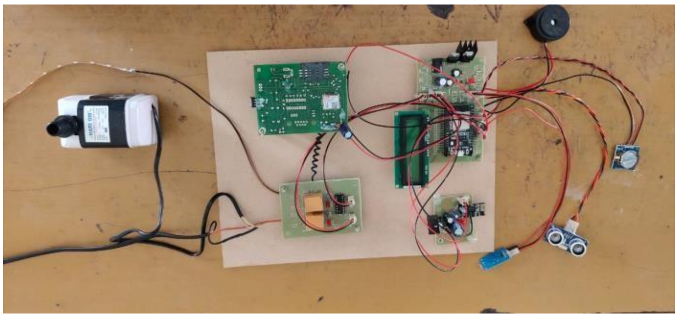

Fig 9.1: Arrangement of components

Fig 9.1: The image shows an IoT-based urban utilities management system with a microcontroller, sensors, an LCD display, and a Wi-Fi module, likely designed for smart monitoring and automation.

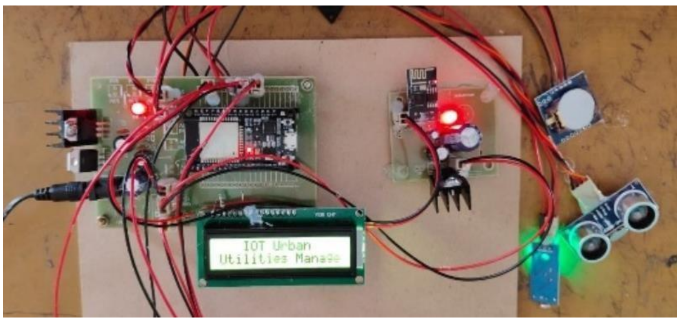

Fig 9.2: LCD displays the title

Fig 9.2: The image shows an IoT-based electronic project with an LCD display, microcontroller, and multiple interconnected circuit boards, likely used for real-time monitoring and automation.

Fig 9.3: showing date and time for RTC.

Fig 9.3: The image shows an IoT-based electronic project with an LCD display, microcontroller and multiple interconnected circuit boards, likely used for real-time monitoring and automation.

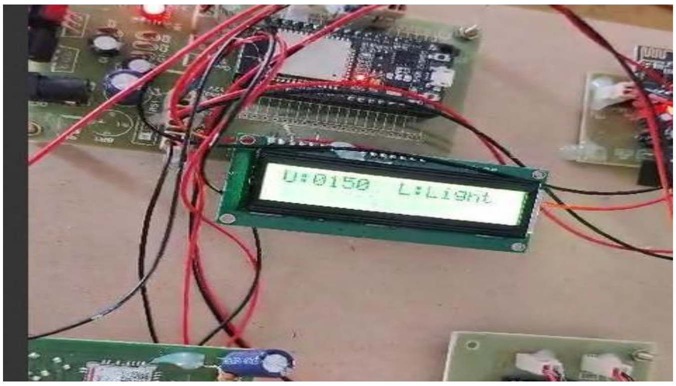

Fig 9.4: The light configuration

Fig 9.4: The image shows an electronics project. It has a microcontroller and an LCD display. There are multiple wired connections. The LCD shows numbers or text. The circuit boards havecapacitors and resistors. It may be a prototype for automation or IoT.

5. CONCLUSION

This project successfully demonstrates an IoT-based municipal automation system that enhances water pump control, manhole monitoring, and streetlight management using the ESP32 microcontroller. By integrating IoT connectivity, ultrasonic sensors, an RTC module, and a GSM alert system, the solution ensures real-time monitoring, automated operations, and timely alerts, significantly reducing manual intervention. The system optimizes water distribution, prevents manhole overflows, and improves streetlight efficiency, contributing to better public safety, resource management, and urban sustainability. In conclusion, the development and implementation of an RTC and IoT-driven smart urban utilities management system using GSM represent a transformative approach to addressing the growing complexities of urban resource management in modern cities. By integrating real-time clock functionality for precise scheduling and synchronization, IoT sensors for comprehensive data collection, and GSM technology for reliable, wide-reaching communication, this system offers an efficient, scalable, and resilient solution to monitor and control critical utilities such as water, electricity, gas, and waste. The ability to collect and analyze real-time data empowers city administrators to optimize resource allocation, reduce wastage, and respond promptly to anomalies like leaks, outages, or overflows, thereby enhancing operational efficiency and sustainability. Furthermore, the use of GSM ensures that the system remains functional even in areas with limited internet connectivity, making it adaptable to diverse urban and peri- urban environments. Beyond operational benefits, the system fosters greater transparency and engagement by providing stakeholders— utility managers and residents alike—with accessible, actionable insights through user-friendly interfaces. Ultimately, this innovative fusion of RTC, IoT, and GSM technologies not only mitigates the challenges of rapid urbanization but also paves the way for smarter, more resilient cities capable of meeting the demands of the future while improving the quality of life for their inhabitants.

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