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IOT BASED SMART RAIN WATER LEVEL INDICATOR USING ARM CORTEX M3 MICROPROCESSOR

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Abstract - *Over the last 20 year, more than two billion people have been affected by flooding disasters, according to an article from the United Kingdom's Channel 4 News. IoT rain gauges can be designed for rural agriculturalists to improve their irrigation systems to protect their assets and farmland.*

To achieve this, a simple low-cost sensor can be interfaced with any suitable microcontroller, which collects data. The sensor collects the data and stores it in the cloud. This can be further innovated to send a text message or an email to the user about the amount of rainfall. A modification can be made alerting with a buzzer and a light when the amount of rainfall exceeds the maximum safe level. This project can be powered by any USB cable or a 3.3V battery.

We present an innovative and cost-efficient intelligent rain gauge system, using Iot with the help of sensor and microprocessor module. It can read, collect and transfer data to cloud over network. This data can be dynamically used for life saving alert system and can be afforded by everyone.

Key Words: **IoT, Rainwater, GPS, ARM Cortex M3 Processor**

1. INTRODUCTION

The Internet of Things is simply "A network of Internet connected objects able to collect and exchange data." It is commonly abbreviated as IoT. This data can be accessible by other "things" too.

A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and is able to transfer data over a network.

Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.

An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analysed or analysed locally.

2. LITERATURE SURVEY

The concept of rain water level monitoring is very important. In this paper, we have discussed the optimal way to manage and collect the data from the sensor. We have outcome with a smart way to collect the data through a microcontroller. The initial step was to use an ESP8266 and a water sensor to collect the data and use it for further references. But use of ARM Cortex M3 microprocessor was found to be more efficient comparing to the ESP8266. The total project is cost efficient when compared to modern commercial similar devices. [1]

With the growth of the city, the ability to manage it efficiently also must be high. In many of the cities, this procedure is still under manual supervision. This can lead to lot of labour work, onsite maintenance and many more disadvantages. For remote places, manual presence to have a note is not easy. To provide a solution to this trouble, smart rain water level monitoring system is proposed to tackle. This system will provide an efficient way to record and track the required data and give a proposal for a competent rain water level monitoring. [2]

Now this is the modern era of technology where life is becoming simple and easier inside all the aspects of the advancement of technology. The world is now adopting automatic systems. In various remote places, having personal look at the device frequently will be a very difficult job. It leads to increase in the cost of labour, can lead to deficiency in personal health of people, and many more. Having waiting for long hours till the rain stops, doing manual calculations and predicting the outcome may consume a lot of time. There may occur sometimes errors in the instruments used for measurement, there may also occur errors while doing manual calculations. If the errors are present, predictions may go terribly wrong. By using this device, remote places can be accessed without human need of presence, data can be accurately collected, calculations

can be made accurately and the predictions may be precise. A GPS may be installed on the device to keep track of its installed locations. It can be programmed to send text message alerts to phone numbers where the authorities can take actions. [3]

This system mainly uses an ARM MICROCONTROLLER, a WATER SENSOR, which has metal markings on it to sense the amount of water. This system can be further modified to give alerts in multiple forms. It can be implemented by different LED alerts when the reading is different. Alerts in the form of text messages, WhatsApp messages, Email notification, on screen prompt can be obtained. A simple tool called TWILIO can be used for all this needs. With correct implementation of code and components, this project can be made efficiently, precisely. When it comes to cost, it can definitely be manufactured with less cost comparatively to similar commercial products available in market. [4]

3. OBJECTIVE OF THE STUDY

However, the technology is developed to its core, implementation of smart city is very challenging task, which consists of several departments such as power distribution, garbage collection, traffic control, smart home etc. Our project is mainly focusing on smart and efficient way of collecting the data and using it for required calculations.

4. MOTIVATION OF THE STUDY

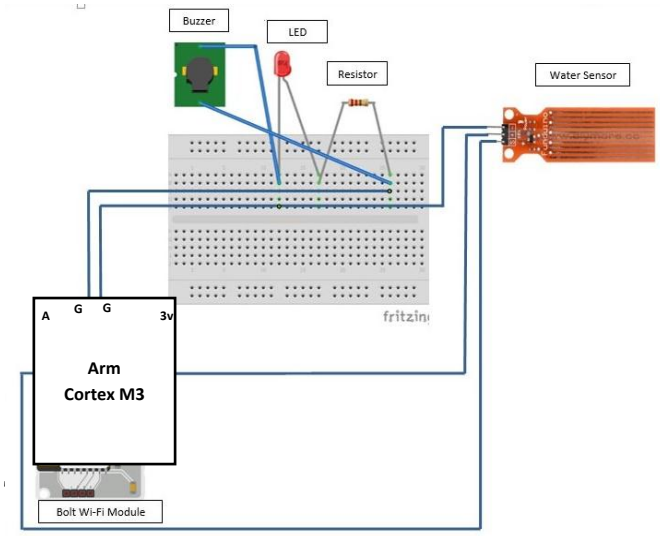
Using a system wisely and efficiently plays a vital role in the field of technology. The accessibility of remote places to human reach can sometimes may be beyond reachable. Even the idea is just collecting the data from instrument and perform calculations may seem tiny, it makes a great deal with human presence, perfection, accuracy and precision. The commercial devices for the same purpose are available in the market whose price is comparatively high. Organizations whose main motive is to monitor rainfall can buy these instruments. But to consumer reach, it can be non-affordable. Our main motive is to project this device with utmost accuracy and affordable to consumer reach.

5. WHY ARM CORTEX M3 PROCESSOR OVER ESP8266

ESP8266 Wi-Fi modules initially stormed the maker market for IoT applications due to their low price, and later it became the dominant Wi-Fi IoT platform for hobbyists because of its large community of developers. But technology progresses over time, and it's always fun to look out for new solutions, and Realtek RTL8710 could prove to be an interesting audio support, faster Wi-Fi performance, while alternative with its ARM Cortex-M3 processor @ 166 MHz, a little more user memory (48KB), still keeping a low price.

The processor is said to run FreeRTOS operating systems, which happens to be the one also used in Espressif ESP8266. Debugging and programming can be done through the micro USB port using CMSIS DAP or JLINK.

6. COMPONENT DIAGRAM



The working of this project is very simple. It basically consists of a sensor, an Arm Cortex M3 processor, few miscellaneous electrical components like buzzer, led etc.

The sensor has metal traces whose resistance varies depending upon the amount of the trace being exposed to the water. This sensor has a weak pull-up resistance of 1 MΩ. When the amount of exposed trace varies, the pull-up resistance varies accordingly. This varied resistance acts as data to our processor.

This data is an analog data. This obtained analog data is transferred to the processor. On chip Analog to Digital converter is used to convert the data from analog to digital form. The ADC present in the processor converts this analog data in form of readable digital data.

This processor can be interfaced with any controller for further uses like uploading the data to the cloud, increasing the alerting system etc.

Collecting the data is only the primary task in this project. Main motive is to process the data to use it as suitable alerting system. The sensor data collected is not the required number. To know the exact reading of the rainfall, few tests must be done to check the reading of sensor for known value of data. After perfect collection of sensor value tests, suitable formula can be formulated to obtain the exact reading.

This system works mainly based on the code written for it. We can use various platforms and various languages to code

for it. To this day advancement, python code is widely used for its user friendliness.

We can set conditional options for alerting system. Rainfall is considered moderate if the amount if it is in the range of 2.5 to 10 mm. If the rainfall is in the range of 10 to 50 mm, then it is considered as heavy rainfall. If the reading exceeds 50 mm, it's a storm. By considering this range, we can program the device to our needs. We can further modify it by using LED alerting system. If the rainfall is moderate, green led glows and when there is heavy rainfall, red led glows.

For further alerting system, we can use a platform called TWILIO which sends text message alerts.

8. COMPONENTS AND APPLICATIONS

8.1 WATER SENSOR

A water sensor is a device used in the detection of the water level for various applications. Water sensors can come in several variations that include ultrasonic sensors, pressure transducers, bubblers, and float sensors.

The Water Sensor module is part of the Grove system. It indicates whether the sensor is dry, damp or completely immersed in water by measuring conductivity. The sensor traces have a weak pull-up resistor of 1 MΩ. The resistor will pull the sensor trace value high until a drop of water shorts the sensor trace to the grounded trace.

This circuit will work with the digital I/O pins of Arduino or can use it with the analog pins to detect the amount of water induced contact between the grounded and sensor traces.

This sensor has three pins. They are:

S: Signal input

+: power supply

-: ground

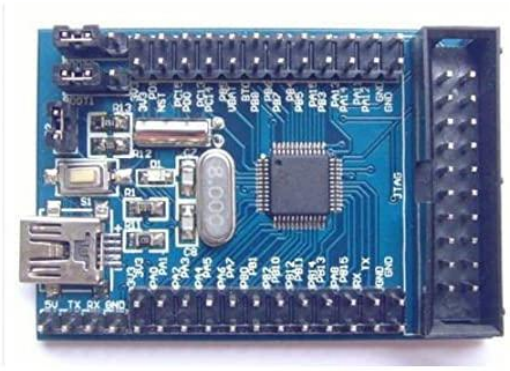
8.2 TWILIO

Twilio is a cloud communications platform as a service (CPaaS) company based in San Francisco, California. Twilio allows software developers to programmatically make and receive phone calls, send and receive text messages, and perform other communication functions using its web service APIs.

Twilio uses Amazon Web Services to host telephony infrastructure and provide connectivity between HTTP and the public switched telephone network (PSTN) through its APIs.

Twilio follows a set of architectural design principles to protect against unexpected outages, and received praise for staying online during the widespread Amazon Web Services outage in April 2011.

8.3 ARM CORTEX M3 PROCESSOR



The ARM Cortex-M is a group of 32-bit RISC ARM processor cores licensed by Arm Holdings. These cores are optimized for low-cost and energy-efficient microcontrollers, which have been embedded in tens of billions of consumer devices. The cores consist of the Cortex-M0, Cortex-M0+, Cortex-M1, Cortex-M3, Cortex-M4, Cortex-M7, Cortex-M23, Cortex-M33, Cortex-M35P, Cortex-M55. The Cortex-M4 / M7 / M33 / M35P / M55 cores have an FPU silicon option, and when included in the silicon these cores are sometimes known as "Cortex-Mx with FPU" or "Cortex-MxF", where 'x' is the core number.

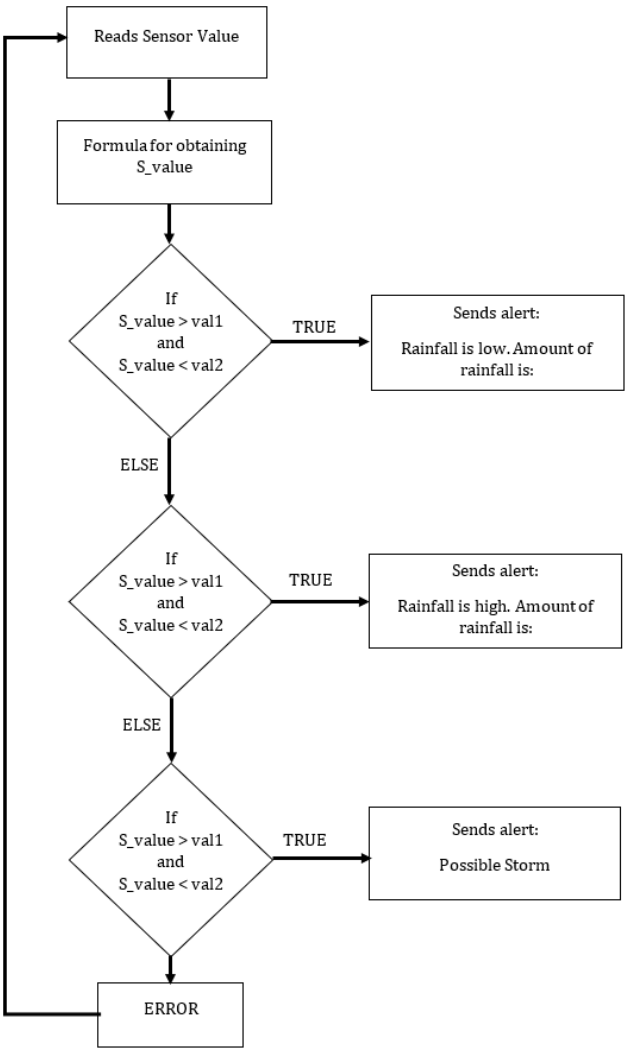
It offers the significant benefits to the developers. The ARM architecture is a 'Harward architecture' which offers

separate data and instruction buses for communicating with the ROM and RAM memories.

9. SIMPLIFIED PYTHON CODE

```
val1 = 2.5
val2 = 10
val3 = 50
while True:
    print("Reading Sensor Value")
    response = analogRead('A0')
    data = json.loads(response)
    print("Sensor value:" +str(data['value']))
    try:
        s_value = int(data['value'])
        if s_value > val1 and s_value < val2
            print("Amount of Rainfall :" +str(s_value))
            response = sms.send_sms(Moderate rainfall. Amount of rainfall:" +str(s_value))
        if s_value > val2 and s_value < val3
            print("Amount of Rainfall :" +str(s_value))
            response = sms.send_sms(Heavy rainfall. Amount of rainfall:" +str(s_value))
        if s_value > val3
            print("Amount of Rainfall :" +str(s_value))
            response = sms.send_sms(Possibility of storm
    except Exception as e:
        print("Error")
    time.sleep(10)
```

10. SIMPLIFIED WORKING FLOWCHART



We can use TWILIO to send text messages or MAILGUN to send Email alerts. It requires a simple and basic coding ability to configure the application to send alerts.

The main program can be set to take readings at a regular interval of time. It can be helpful in finding data at every interval of time thereby helping the prediction more accurately.

For example, if the amount of rainfall is 4mm for a period of 10 minutes and 5 mm for another period of 10 minutes, variation in the rainfall for different time can be calculated easily.

11. WHY ARM CORTEX M# PROCESSOR OVER ESP8266

	Realtek RTL8710	**Espressif ESP8266**
Package	QFN-48 (6×6 mm)	QFN-32 (5×5 mm)
CPU	ARM Cortex M3 @ 166 MHz	Tensilica LX106 @ 80 / 160 MHz
RAM	48KB available to user	36KB available to user
Flash	1MB Built-in	1, 2, 4, 8 or 16MB
Wi-Fi	802.11n up to 150 Mbps, 802.11g up to 54 Mbps	802.11n up to 65 Mbps, 802.11g up to 54 Mbps
GPIO	Up to 21	Up to 17
I2C	Up to 3	Up to 1
PCM	Up to 2	None
PWM	Up to 4	
UART	2x high-speed UART, 1x low-speed UART	Up to 2x UART
Power	Voltage: 3.0 to 3.6V; Current: 80 mA	
Temperature range	-40 to 125 °C	
Standard certifications	FCC/CE/TELEC/SRRC /Wi-Fi Alliance	FCC/CE/TELEC/SRRC

12. MERITS OF THE PROPOSED WORK

- Prevention of manual presence in remote areas which is a beneficial factor.
- Precise and accurate in calculations.
- Affordable by all classes of people compared to present commercial devices available.
- Reduced human effort and struggle in collecting and processing data.
- Data are stored in cloud periodically, so these data are analyzed for future prediction.
- Alerts to users through various modes of communication like text message, on screen prompt, Email etc.
- Devices can be tracked by installing GPS having a good chance of device tracking
- Helps in precise and accurate future climate predictions

13. CONCLUSIONS

In this paper, we have proposed a way to monitor the rainfall through an efficient and accurate way. Though it sounds a tiny concept, it plays a vital role in the field of Meteorology. Meteorological departments are in constant research for better and innovative concepts for their accurate outcome and predictions. This concept can be proposed for its accuracy, remoteness, flexibility in working areas, precision and cost effectiveness.

Modern day similar equipment costs around 10,000 rupees whereas this device can be done in a very small cost of around 2000 to 3000 rupees.

This device is not only for official purposes but can be used by general public for any innovative projects or experiments.

This system is an innovation to the existing technology that reduces the need for human supervision in remote places, smart and accurate. Human calculations are not required to maximum extent. This product is generally a time saving and human friendly device.

14. REFERENCES

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