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Development of a Real-Time Urban Flood Detection and Alerting System Using Smart Sensors

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Abstract: *The project proposes an IoT based flood monitoring system utilizing Arduino Uno, soil moisture sensor, LCD, buzzer, Wi-Fi module (like ESP8266) and ThingSpeak cloud platform. It measures the moisture level of the soil and gives notifications when crossing a certain threshold, indicating imminent floods. The soil moisture sensor is used to detect the moisture content and it is shown on LCD screen for real time monitoring. A buzzer sounds to inform of high moisture levels. A Wi-Fi module enables wireless connectivity and sends data to the ThingSpeak cloud platform for centralized storage and analysis. Users may access real-time and historical data through an interface using Thing Speak. The Wi-Fi module is configured to connect to a specific network and send data to the server using a unique API key. With Thing Speak you can see, analyse and create alerts depending on the soil moisture, it is a complete solution to monitor floods. This low-cost solution, based on open-source hardware and cloud platforms, increases accessibility and ease of deployment and is appropriate for many environmental monitoring applications There is no question now about the need of understanding about environmental circumstances. Having environmental conditions can assist us to know more about our surroundings. In recent years, due to global warming, it's become more difficult to tell the sort of weather happening around us. So, the weather is hard to anticipate and must be checked often. So, we need good knowledge on the weather. So that the decision maker may take the proper weather decision. So, the decision maker has to create a system which can monitor and anticipate the weather in real time situations. The Internet of Things (IoT) is highly useful in forecasting and monitoring such sort of situation. thus, it can operate with real time data as well as the previously recorded data. The IoT provides data to the computational devices through Wireless Sensor Network (WSN) for result generation. Therefore, many have transitioned from predicting physical parameters of floods to computational real-time monitoring. The suggested system employs several atmospheric sensors including humidity, temperature, pressure and rain fall. The data captured is kept and sent to the device and therefore the result is received.*

Keywords: IoT, WSN, Buzzer, Wi-Fi, ThingSpeak

I. INTRODUCTION

Floods as natural calamities may have disastrous effects with extensive damage to infrastructure, crops and populations. To forecast and mitigate consequences of floods, timely and precise monitoring of environmental indicators such soil moisture levels is necessary. In this sense, the use of Internet of Things (IoT) technology is a novel way to improve flood monitoring capacities. The project proposes an IoT-based Flood Monitoring System using easily accessible low-

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cost components like Arduino Uno, soil moisture sensor, LCD, buzzer, Wi-Fi module (like ESP8266) and the cloud platform ThingSpeak. The integration of these components aims to develop an all-encompassing system that can identify excessive soil moisture levels, indicate possible floods, and deliver instant notifications for proactive decision-making. The main aim of the system is to overcome the limitations of traditional flood monitoring methods by utilizing IoT technology. The use of Arduino Uno with sensors allows accurate and localized assessment of soil moisture content. This data is then transmitted wirelessly to the ThingSpeak cloud for remote monitoring and analysis. The dual warning system, with visual cues on an LCD and audio cues through a buzzer, guarantees that stakeholders are immediately notified if critical soil moisture levels are exceeded. The system is equipped with a Wi-Fi module for smooth connectivity and may be adapted to different deployment circumstances. The ThingSpeak cloud platform acts as a single repository for storing, displaying and analysing the acquired data. Users can visit the site to check real-time conditions and look at prior patterns. The platform also has the ability to set customized warnings based on specific soil moisture factors, which increases the adaptability and usability of the system. This IoT-based Flood Monitoring System provides a cost-effective, scalable, and accessible solution for flood detection with growing need for efficient environmental monitoring systems. The combination of open-source hardware, wireless connection and cloud computing makes this system a useful tool for early warning systems, disaster preparedness and informed decision making in the face of probable flood catastrophes. Floods are a persistent and deadly danger to people and ecosystems across the world, causing destruction and loss of life on a massive scale. Climate change is creating more extreme weather events like floods, and they're occurring more frequently and with more intensity. Conventional flood monitoring systems usually provide information that is not quick and accurate enough for efficient disaster response and mitigation. Traditional techniques of manual observations and centralized monitoring stations are not able to provide the necessary granularity for early identification of flood conditions and localized flood detection. Current limitations in flood monitoring are the absence of real-time data, poor geographical coverage and high cost of deploying and maintaining large sensor networks. Additionally, in many places, monitoring systems are not widely available or scalable, limiting their ability to provide timely notifications to communities and appropriate authorities [1]-[5]. Moreover, continuing urbanization and land use changes modify the dynamic of flood patterns, requiring adaptive and technologically sophisticated monitoring techniques. The urgent necessity of affordable, scalable and user-friendly flood monitoring systems to utilize the potential offered by IoT technology to deliver accurate and localized data for early warning and decision making is stressed. To overcome the above issues, this project has been proposed. The proposed project is an IoT based Flood Monitoring System which combines low cost and open-source hardware with wireless connection and cloud-based data storage and analysis. The system attempts to overcome the limits of existing flood monitoring systems, by providing an accessible and flexible solution that can be used to a wide range of environmental circumstances and geographical locations [6]-[10].

Including technology like apps, SMS or QR codes may be a useful way to get key information out to folks in impacted regions, and encourage them to stay safe and take needed measures. One of nature's inescapable disasters is floods. It happens too fast and impacts too many people and properties. Most earlier systems prior to this only worked on certain areas. Furthermore, most people cannot watch and do not know when the flood will come since they do not have access to weather information and data. We will try to overcome the weaknesses of the present system by building an IoT (Internet of Things) based smart flood monitoring system. This project presents an IoT based smart city flood monitoring and alarm system. This project is based on free source Arduino electrical platform. This system employs DHT11 and water level sensor. The water level was measured via water level sensors. This sensor will provide sound navigation and ranging. It works by transmitting a brief high frequency pulse, listening for the echo and calculating the level from there. DHT11 is an inexpensive digital sensor measuring temperature and humidity. If the water level is hazardous, an alert message is issued and an alarm is sounded for a flood alert. We use NODEMCU for monitoring the water level and rainfall intensity in the surrounding region of the stream. The lcd and led purpose is to indicate and signal the water level. The water level will be detected by a water level sensor and a notification will be sent instantly to the user's smartphone utilizing IoT technology through the Blynk application At now flood is one of the most

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catastrophic calamities in India. India is one among the top 10 food threatening countries of the globe. Flooding is natural phenomenon caused due to heavy rainfall created by monsoons, storms, cloud bursting and glacier melting beyond the capacity of water bodies [11]-[15].

II. PROPOSED SYSTEM

The system also has water level sensors with Arduino Uno to sense the increasing water level and raise sirens for timely notifications. The study was aimed at providing insight into the functioning of the system and its possible influence on flood resilience efforts by examining its efficacy based on characteristics such as accuracy, effectiveness, maximum distance detection and water level monitoring. The system is coupled with key components such as ultrasonic, capacitive and acoustic sensors to offer real time data on water levels. The study shows the usefulness of automated flood monitoring systems in reducing the severe impacts of floods, particularly in flood-prone areas. The project aims to utilize the Arduino technology and sensor capabilities to allow communities to quickly and effectively respond to flood catastrophes and protect lives and property. The important results reveal that the system is very accurate, effective, reliable and responsive in detecting flood and monitoring water level. The integration of the water sensor, LEDs and buzzer was very successful and there was no notable difference in the performance as compared to the conventional flood monitoring systems. This helps in the evolution of flood monitoring technology and enhancement of disaster preparedness techniques and provides useful insights for future study. Future studies can explore the use of technology such as applications, SMS, or QR codes that can efficiently provide crucial information to people in impacted areas to help them stay safe and take the appropriate measures. Flooding is the most frequent natural hazard that causes serious harm of life, property and critical public health infrastructure. It has a big influence, with around 40% of the road network suffering from waterlogging or inaccessibility, and circulation is greatly affected by large drops in vehicle speed, longer journey times, and more miles traveled in and around the afflicted region. The Philippines faces regular typhoons and monsoons, with heavy rain that turns streets into rivers and raises fears of flooding. The complete volume is full of water during the rainy season, causing the river water to overflow and unable to hold the extra volume of water. When a typhoon comes, it delivers heavy rain, causing rivers to flood, soil to get saturated and landslides to occur in steep places. The repercussions are severe and wide-ranging, including loss of lives, relocation of populations, damage to infrastructure and crops. Flooding in the Philippines is an ever-present problem, and we need to find new solutions such as flood water level monitors to decrease the effect of such tragedies and protect our people and resources. There is a need to create an effective flood response operating system to coordinate all actions during a flood. The importance of flood water level monitors cannot be overstated. They enable rapid allocation of resources and monitoring of water levels in urban drainage systems, rivers, lakes, reservoirs and lakes. These sensors also support communities in planning for flood catastrophes and reducing their impacts by assisting in the development of accurate flood models and predictions. The increased frequency and severity of floods globally due to climate change underscores the need of early warning systems and flood monitoring technology in disaster planning and response efforts. A novel solution to this problem is the incorporation of flood water level sensors with Arduino microcontrollers. Arduino is an open-source electronics platform that has acquired immense appeal among enthusiasts, academics and professionals because to its diversity, ease of use and low cost. When paired with flood water level sensors, Arduino offers a low-cost, configurable way to monitor water levels in rivers, lakes, reservoirs and urban drainage systems. This integration enables people and communities to create their own flood monitoring systems and provides a pathway for research, innovation, and the creation of localized flood resilience methods. Flood water level sensors using Arduino are an interesting area to study since they have the potential to democratize the technology of flood monitoring. Usually these sensors are of ultrasonic, pressure measurement or capacitive kind of measurement.

The things which are around us are called environment. By nature, all living and non-living lives. We are surrounded by various natural components like land, water, air, atmosphere and also live elements like plants and animals. Therefore, it is vital to engage with all the factors. The environment also has numerous additional characteristics like contaminants which causes the human to harder to live in. Therefore, as the ratio of pollutants increases, it is difficult

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for a human to distinguish the type of weather. Thus, monitoring of the environment is crucial as it enables us to track the weather conditions. This may be done using many sensors which will gather all the data from the environment like temperature, pressure, humidity, rainfall and will transmit to the gadget which will enable us to know the weather appropriately.

Because of the rising temperature of the planet, there is a rise in global warming throughout the earth. Because of this the weather and climate of the planet is not predictable. So, we need a model that can anticipate climate change, and also monitor climate.

So, we need to make flood level sensor gadget which would detect the water level. The system is interfaced to the microcontroller board which will aid to communicate the data once the water crosses the threshold value. Water level detection is done by using ultrasonic sensor. The raspberry pi module will assist you connect to the internet and retain the data on a regular basis. The data will be saved in cloud using Raspberry pi module. When the water level above certain threshold value, consumers will get alarm messages on their phone with the help of android applications. And LED and Buzzer may be utilized to alert the peoples. For this purpose, prediction algorithms will be used. Machine learning may be used to forecast. Moreover, this method may potentially forecast the likelihood of flooding before it happens. Rainy season in India starts from June and ends till September every year. As it rains this month in our nation every year. So, there is a possibility that when the river basins are inundated by water the flooded water may rise and may submerge the whole city. The shift in climate has resulted in global warming and thus there is a rise in natural calamities like flood, volcano eruptions, earthquakes etc. Flood prone areas in India accounts for around 12.5% of the nation. States like West Bengal, Orissa, Goa, Kerala, Gujarat, Uttar Pradesh, Andhra Pradesh and Maharashtra are recognized as flood prone.

Humans have attempted to forecast and to stop the harm caused by the natural catastrophe but we are not able to accomplish that so. This makes it more difficult for humans to recover from the devastation inflicted by the flood or any other natural disaster. Therefore, we require a model or a prototype which is able to foresee the flood that could occur.

The IoT device used in the model is Raspberry Pi, many writers have utilized this device since this device is a little single board computer that operates on Linux.

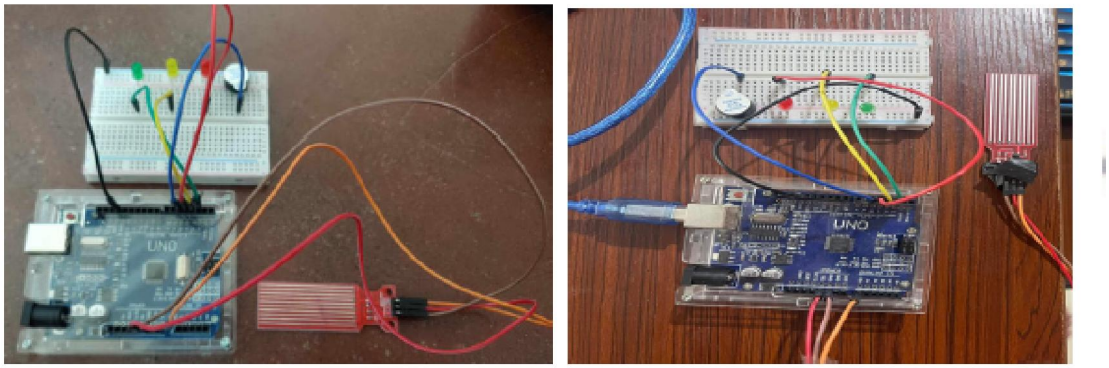

Figure.1. Hardware Model of the Proposed System

From the review of findings, the following conclusions were formed with respect to the research problems: In flood detection and water level monitoring, it showed great accuracy, efficacy, dependability and responsiveness, thereby becoming a helpful tool to improve flood risk management efforts. The combination of water sensor, LEDs and buzzer has been very useful in consistently identifying and alerting people to flooding disasters. This Automated Flood Water Level Sensor and Alarm System monitor the rising water level and notify people to make appropriate actions for

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possible flood situations. The current flood monitoring approach does not vary much from the Automated Flood Water Level Sensor and Alarm System in terms of the detection of floods is shown in Figure 1. The researchers suggest the following: To further increase accuracy, the customers or users should calibrate the water sensor to guarantee the data are accurate on a frequent basis. A calibration method at pre-determined intervals would aid in ensuring consistency and reliability in the flood level detection. To improve flood risk management efforts, the Local Government Unit (LGU) should explore increasing the deployment of automated flood water level sensors and warning systems in additional flood-prone areas. The LGU may also include remote monitoring elements to the system to allow for real-time monitoring of water levels from a single location. This will allow for rapid reaction actions and coordination during flood occurrences, enhancing the overall responsiveness and management of flood risks. Future researchers are encouraged to keep testing the usability and cost-effectiveness of the Arduino-based system for its wider adoption in the flood-prone areas. National Disaster Risk Reduction and Management Council (NDRRMC) may include a gadget to educate those impacted by floods. Sounds like a proactive approach to disaster management.

III. CONCLUSION

In conclusion, the IoT based Flood Monitoring System is a potential approach for early detection and monitoring of floods, using a combination of cost-effective hardware, wireless connection and cloud-based data storage. The successful installation of the system showed the usefulness of the system in delivering real-time soil moisture data and giving timely alerts such that the ability for proactive decision-making in the face of probable flooding occurrences was enhanced. The suggested system is scalable and cost effective which makes it a feasible alternative for implementation in different geographical regions and contributes to better catastrophe preparedness and community resilience. Future scope of the project includes additional refining and optimization based on experience and input from real-world implementation. The system will be more resilient and reliable with continuous monitoring and validation under different environmental conditions. Also, the use of sophisticated machine learning algorithms may enhance the accuracy of flood forecasts, resulting in more precise and timely warning systems. The system would be more successful on a larger scale if it could work with meteorological agencies and local authorities to share data and provide a thorough evaluation of flood danger. Moreover, the ability of mobile applications to directly inform end users, and community involvement efforts will be key to realizing the maximum impact of the system. In conclusion, the continual improvement of an IoT-based Flood Monitoring System has enormous potential to change the ways flood management is handled and help build resilient communities

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