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A NOVEL APPROACH FOR EARLY FLOOD WARNING USING ANDROID AND IOT

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ABSTRACT: *India has a sub-tropical monsoonal climate characterized by heavy rainfall which in turn causes massive flooding. To avert such situations, it is very important to monitor and receive timely emergency alerts about the flow of water and water level situation based of the riverbed. The main objective of this concept is to design an efficient flood pre-alerting system. This project predicts Floods in advance with the help of emerging technologies, such as MATLAN, Embedded and Internet of Things (IoT) This work develops an IoT-based prototype to collect hydrological data and meteorological data of river water. Hydrological data like water flow, water level, and water discharge along with meteorological data like temperature, humidity, wind speed, and wind direction are used to classify the flood type. In matlab software long short-term memory (LSTM) model is introduced based on calibrated data to yield alerts. Classifications like "no alert," "yellow alert," "orange alert," or "red alert."*

Index Terms: *Internet of Things, meteorological data, Temperature, humidity, wind speed, orange alert,", "red alert, long short-term memory.*

INTRODUCTION

In recent years, pollution, uncontrolled development and the consequent damage suffered by the environment in urban areas have led to unprecedented changes in the local climate. Consequently, these changes have increased the number and intensity of natural disasters such as landslides, flash floods and fires, and meant that they have now become a global problem As recently as 2013, 330natural disasters were documented and about 96.5 million people were affected, causing an estimated financial loss of US$ 118.6 billion around the world. In the case of flash floods, every year about 102 million people are directly or indirectly affected and this number is constantly increasing [2,3]. Flood refers tothe situation where excessive water flows into the residential area. So this effect can cause damage and incur loss to human life and. Occurrence of floods in river basins in recent years with the frequency graduallyincreased water pollution, flood control and management of water pollution control as the primary task of the network. In order to better grasp the characteristics of the river's hydrology, flood forecasting the advent of goodflood preparedness, real-time hydrological monitoring has become an important part of water pollution. Toavoid the drawbacks of manual monitoring developed a set of things based distributed real-time remote hydrological monitoring system. The system is using advanced GSM wireless communications, embedded and touches screen technology, the dam water network management to fully digital to provide a complete solution, with real-time monitoring and alarming, historical data, local and remote queries, hydrological trend forecasting and analysis and other functions. IOT is a combination of wireless sensor network technology, communication technology, sensor technology and network technology. It does work by a group of simple sensor. As the sensor's biggest advantage is low cost, low power consumption and more direct, it's more precise way closer to the comprehensive monitoring of environmental information, real-time accurately get monitoring area of detailed information. IOT has become a focus of research direction in many fields, such as industry, agriculture and hydrological monitoring, yet the research of IOT is at an early stage, technology and application are still not mature, energy supply mechanism is still not perfect, lack of unified communications standard, its system can't make corrections by itself. Network density of hydrology station is about 1.8 stations per square kilometer in United States. There are about 10240 existing hydrology stations, 2048 hydrology stations of river and lake, 32031 underground water stations, 9954 quality monitoring stations [1]. The way of hydrology monitoring mainly uses automated instrument collection and tour combined measurement. Sometimes, according to the actual situation, the way also uses the entrusted. Currently, there are more than 60% hydrology stations to transmit hydrological data by satellite in United States. Hydrological data such as water level, rainfall has realized automatic acquisition; it not only manages manpower and makes the hydrologic information more prompt, accurate, and reliable. China's instruments to rainfall, water level and flow collection are similar to American's, but obviously different in data collection, treatment, storage, etc. It is the following reasons cause to the United States realizes the hydrological data automatic acquisition: first, the level of river flow stable, sediment concentration is small, flow to small test to measure is given priority to, the hydrological data collection automation; second, the government and regions have a sufficient capital investment; third, the network density is great, the equipments used are advanced; Fourth, there are many strong hydrological instrument equipment company in United States; the company is have technical ability engaged in the research and development of hydrological professional instrument with the government, a close cooperation with high technology and new technology, production quality and reliable technology advanced, performance and stability of instruments and equipment.Therefore, China should be actively use successful experiences of foreign and advanced technology of excellent companies. First, hydrology department should actively get funds, speed up the hydrology infrastructure; second, accelerate the reform of the management system, and improve the quality of personnel and hydrological data from remember and tour the application level of the instrument measuring equipment; third, increase the hydrological instrument, introduction and promotion, choose a few have the strength of the hydrology instruments company, support the development of the research on the hydrological instrument, absorber foreign advanced instrument equipment technology work and make the biggest economic benefits.The worlds climate is changing drastically due to effect from human activities such as pollutions, cut countless trees, excessive gas emission etc. Floods are among the most common damaging natural disasters, that cause significant harm to life, property, and economy. Scientists estimate by 2030, if 4-inch sea level rise, it could potentially caused the severe flooding in many parts of the world [1]. Since Malaysia is located near the equator, the most severe climatic related natural disasters are monsoonal flood. It happens almost every year and causes a lot of damages, property loss, and not to mention the loss of life during the disaster. Recently in Jan 2018, two died and nearly 12,000 evacuated when flood strike in Pahang as reported in [2]. The worst flood in Malaysian history happened in 2014. More than 200,000 people were affected while 21 were killed. The major disasters happened in the several states on the east coast side of Peninsular Malaysia. The estimated cost of damages wasover RM1 billion as reported in [3]. The impact of the flood is huge and it is not happening in Malaysiabut all over the world. Floods are among the most common damaging natural disasters that affect millions of people across the world leading to severe loss of life and colossal damage to property, infrastructure and agriculture. According to the World Meteorological Organization, flooding remains the third biggest disaster in the world [1]. Due to climate change, scientists estimate a 4-inch sea level rise by 2030, which could potentially cause severe flooding in many parts of the world [2]. Based on a research conducted by the Institute of Environmental Studies, more than 60% of the world's cities will be vulnerable to flooding in the next 30 years due to effects of the sea level rise [3]. Internet of Things (IoT) is a core technology being used in flood early warning systems. IoT characteristics provide effective guarantee for ahead-of-time perception and precaution, advance to reduce the impact of disasters [4]. Despite the fact that IoT technologies cannot stop the occurrence of disasters, they are an exceptionally valuable apparatus for conveyance of catastrophe readiness data. Such data can be used for geographical flood simulation modeling [5], which aids in policy making in flood disaster risk management.

For real-time flood early warning systems, information delivery is key. Thus, there is a need to ensure that information delivery must be concise, right to the point, usable and in a timely manner. There are several factors that are attributed to the efficiency and effectiveness of real-time early warning systems for floods. These include the correctness of prediction of a flood occurrence, the amount of time needed to make a prediction, the reliability of the communication networks used in the early warning system as well as the deployment and maintenance cost of the systems. One major challenge for the future of IoT applications is that all data collected from end devices, such as IoT sensors has to be sent via the Internet to a central processing platform. This creates a scalability problem in IoT as there is an exponential growth of IoT devices which connect to the Internet for either receiving information fromthe cloud or delivering data back to the cloud [6].

LITERATURE SURVEY

Rashid et al. [4] presented in their survey, several applications areas for WSN, where we find energy systems, transport, health-care, gas, air, structures, and urban temperatures monitoring, among others. Despite presenting some works that present forecasts solutions, Rashid et al. [4] described the forces of nature as being brutal and unpredictable, causing material damage and death of millions of people, leaving the lack of energy, food, water, and communication failures for the survivors. Regarding WSNs application in natural disasters, Rashid et al. [4] listed a series of related works to surveillance, where WSNs were used for detection of transportation and smuggling routes of radioactive material as a long-term solution to nuclear material-based terrorism, and tsunamis detection and response, where WSNs were used for the prediction of tsunamis and floods, using prediction based on web services and neural networks. In addition, WSNs were used as systems to mitigate tsunami and floods effects, most of which, like ours, used water pressure sensors for data collecting and as input for their forecasting models. In addition, post-disaster actions help to save lives and, in this scenario, it is important to exchange information. Rashid et al. [4] presented works where WSNs were used or modified for this purpose, allowing a more efficient distribution of information among relief disaster teams and hospitals, enabling an improvement in the care of victims. Some of these solutions can be used in other situations besides disaster relief, such as in hostage situations and debris monitoring. In this way, Rashid et al. [4] confirm that the use of WSN is feasible and can achieve good results in the detection and mitigation of damages caused by natural disasters. In this scenario, wireless sensor networks (WSN) combined with new systems and technologies, such as Internet of Things (IoT), which is a natural part of smart cities and environments, is one of the most promising alternatives to help dealing with the problem of natural disasters in urban areas. It should be noted that in IoT, one of the most important factors is connectivity. It does not matter what the "thing" is but rather how much capacity it has to monitor environments in an architecture that allows the integration of the most wide-ranging objects and an interaction to occur between these objects in a smart way. One possible course of action is to follow the new trend and adopt sensor networks based on IP by using emerging standards, such as 6LoWPAN/IPv6, which allow the most diverse objects in IoT to be connected with each other [5]. The use of these standards makes communication possible between the WSN, the nodes of a WSN and the Internet, thus enabling the sensor nodes to be viewed as smart objects that form a link between the physical world and online systems [6]. In the management and forecasting of natural disasters, the data collected by means of the sensors can be analyzed together with data available on the Internet such as satellite-based forecasting or types of variables which the sensor nodes are unable to obtain. Moreover, a scenario in which the sensor nodes are connected to the Internet, makes it possible to use technologies such as Cloud computing and social networks to help in the forecasting and issue online warnings. In addition, this scenario also allows the sensor nodes to communicate with nearby devices which share the same technology and propagate the information and forecasts. The need for fault tolerance approaches is another important issue when dealing with natural disasters. This issue is partially addressed in Rehmani et al. [7], where a Cognitive RadioBasedInternet Access Framework for Disaster Response for inhospitable environments is presented. In its framework, Rehmani et al. [7] use the term Cognitive for devices that can modify their parameters on-the-fly, being able to adapt to environment changes and, thus, restore the communication between partially damaged networks. Despite addressing only communication, Rehmani et al. [7] make clear the challenges and the need for mechanisms that can recover systems damaged by natural disasters and thus keep their services available to the population. In the city of São Carlos, Brazil, there is a WSN deployed by the Institute of Mathematical Sciences and Computing (ICMC), University of São Paulo (USP), called REDE (WSN for monitoring urban rivers), the purpose of which is to monitor, analyse the data, detect flash floods, and present online information about rivers in urban areas [8]. The REDE system collects data on the rivers and rainfall in the area and uses two different kinds of technology to communicate, ZigBee and 3G. However, the REDE system does not envisage that this data will be used to forecast flash floods or that this information which is collected in the real world can be integrated with other information available in online environments. Additionally, the REDE system does not have any fault-tolerance mechanism, which is necessary in hazardous environments where the loss of nodes and communication is a common phenomenon. Some article such as [4] and [5] has reviewed on flood disaster and disaster management in Malaysia which highlight the importance of finding best remedies to prepare if disaster strikes. Futhermore, Leman et al. [5] also reviewed the current disaster management in Malaysia for proposing enhancement the effectiveness. They suggest four phases of action; preparedness,response, recovery and mitigation. Due to this phenomenon, several experts have studied over the years on ways to improve flood control, thereby reducing the aforementioned risks. Better understanding of the flood hazard phenomenon and its potential consequences in our society is crucial for the development of flood risk reduction projects, control policies and other types of flood management strategies. The adoption of IoT based-system has attract attention among researchers since data is collectively sensed by sensors to provide various services without human intervention [6]. Early work by Lo et al. [7] propose to automatically monitor the flood object based on the remote cyber surveillance systems. Image processing methods are being utilized to obtain instant flooding and waterlogging event feedback. On the other hand, [8] used pressure sensor to read the water level at every second, for detecting the level of water. In the occasion where the water level surpasses a user-defined threshold, an SMS is texted to the residence for warning and quick action. Recent from Jana Priya et al. [9] and Satria et al. [10] demonstrate the idea and implementation of a flood monitoring and alert system using measuring sensor. They proposed a system that measures the height of the water using ultrasonic sensor. While, [11] combine ultrasonic and water level sensor to monitor flood level conditions however it missing alert system. Inspired by the literature, this work aimed to detect flood with water sensor with different level of measurement with SMS alert. SMS is considered as the most effective way to the scenario Malaysia since smartphone has rapidly become the preferred device for most Malaysian to remain connected. According to the survey [12], the percentage of smartphone users continue to rise from 68.7% in 2016 to 75.9% in 2017. The increment trend shows that the majority of people in Malaysia use mobile phones and it is a good strategy to give an early warning to the society using an SMS via mobile phone. Earlier several researchers implemented flood monitoring and alerting system based on ARM7 processor and Arduino controller. But, ARM7 wasn't real time operating system (RTOS) [2-4], speed is very less and more expensive. Arduino is a controller and additionally it requires extra modules to interact with cloud like the global system for mobile communications (GSM), blue tooth, Wi-fi and LAN cable [5-7]. Several works like [8, 9] investigated a study on flood disaster and its management in the country of Malaysia, where they centered the significance of identifying best solutions to educate if there was a strike of disaster. In addition, author in [5] suggested four action states such as readiness, reaction, reconstruction and reduction. In this way, recent days most of the researchers tried to find out the mitigation of flood control and there by reducing the risks. Later, due to the easiness and wider range of applications in various field, IoT-based system attracts the researchers to implement an intelligent flood control and alert management system.

PROPOSED METHOD

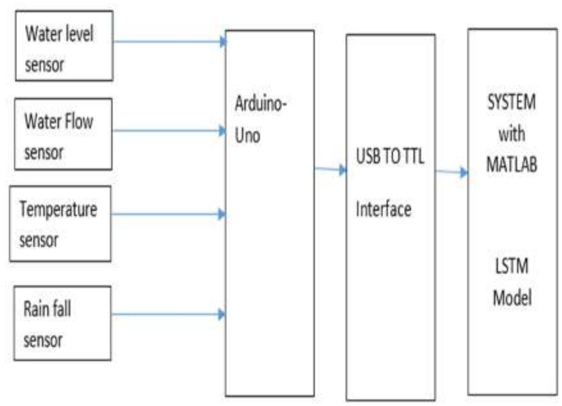

Fig1: Proposed Block diagram

Proposed method consists of total 4 sensors which includes both analog and digital sensors like "water level sensor" used to measure the level of water quantity in river/reservoir; Water flow sensor used to measure the water flow with which speed it is coming out or coming in; Temperature sensor is used to measure the hotness of water; Rainfall sensor is used to measure the rain falling quantity in mm.

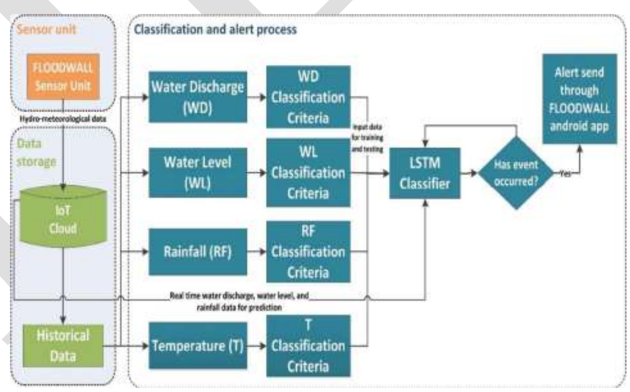

Fig2. Proposed diagram of flood classification system.

The system operates by deploying sensor node to capture both hydrological and meteorological data, as illustrated in Fig. The measured parameters are used as inputs to the LSTM model. The proposed system uses water discharge, water level, rainfall, and temperature as input parameters. Water discharge is computed using the water flow. The LSTM algorithm is used to identify flood occurrences at any particular moment, using water discharge, water level, rainfall, and temperature as inputs. It classifies the flood events into four categories:

1) no alert; 2) yellow alert; 3) orange alert; and 4) red alert.

The model gets test observations from the sensor unit and decides flood occurrences based on LSTM analysis. In LSTM, the cells add long-term memory in an even more proficient way by allowing for the learning of additional parameters. This makes it the most powerful neural network for predicting, particularly when our data have a longer term trend. LSTM algorithm has a significant advantage over other ML algorithms. It can learn selectively and recall or forget the required historical data. It learns the outputs from the training data for the given features and predicts the outputs from the test data for the corresponding features The model takes inputs as water discharge, water level, rainfall, and temperature and computes real-time flood status as an output.

RESULTS

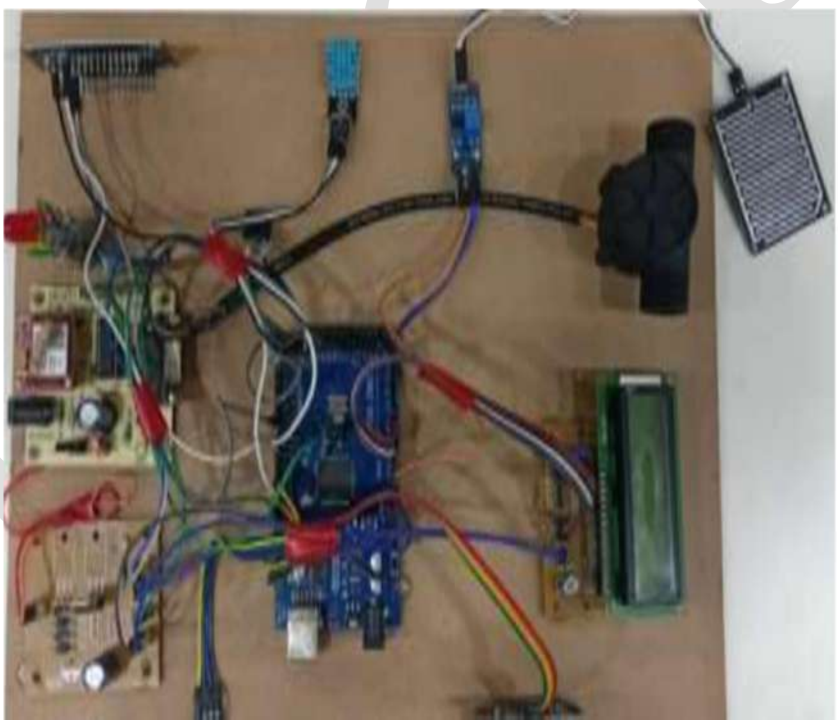

Fig a: Proposed hardware prototype

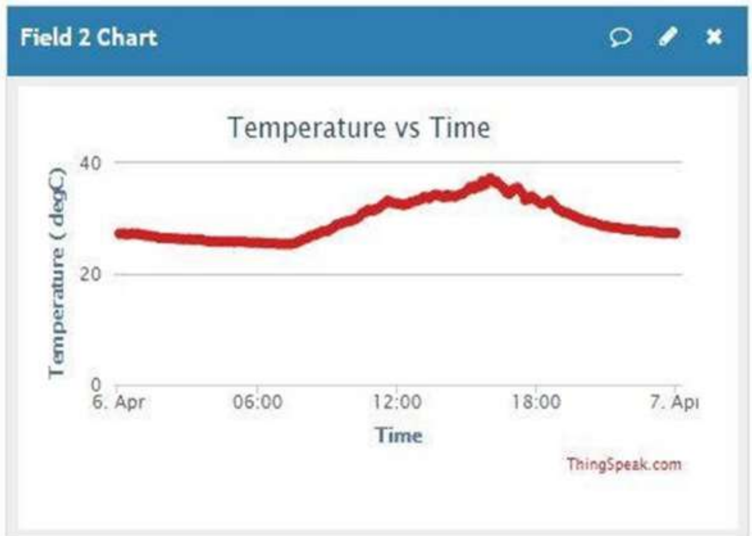

Fig b: Temperature monitoring in Thingspeak IOT

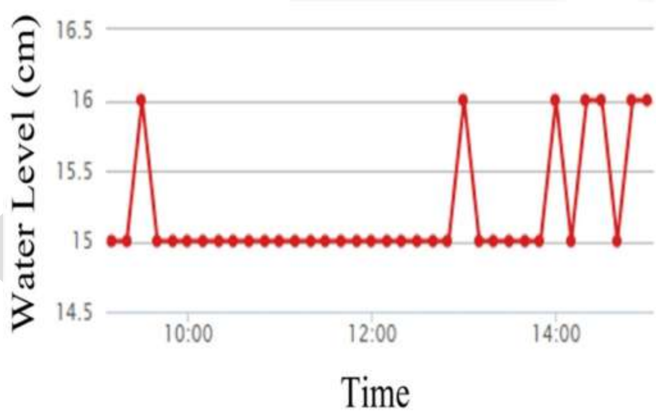

Fig c: Water level monitoring in Thingspeak IOT

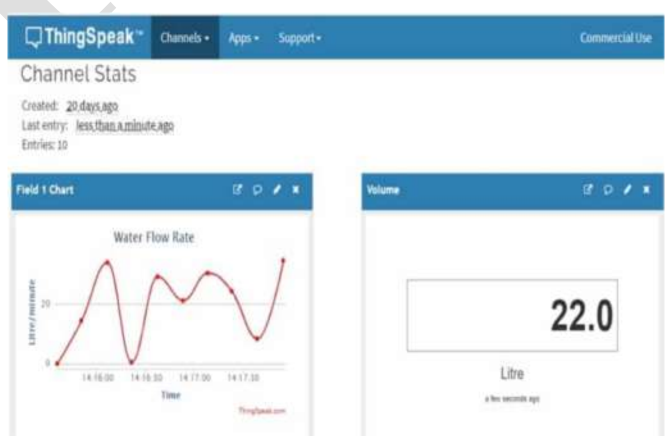

Fig d : Water flow rate monitoring in Thingspeak IOT

Advantages:

1.Cost-effective and reliable solution for flood warning

2.Easy to install and maintain

3.Versatile, suitable for different environments and conditions

4.Can be integrated with other systems, such as warning sirens and SMS alerts

5.Real-time monitoring of water levels

Applications:

1.Agricultural fields

2.Residential areas

3.Coastal regions

4.Urban areas

5.Industrial facilities

CONCLUSION

Finally, this project developed a realtime monitoring system for rivers to show the most recent hydrological and meteorological data, such as water discharge, water level, rainfall, temperature. Furthermore, on the basis of the data received, the system generates an alert to the users and local authorities when the values coming from the sensors are predicted the status of the flood event by using LSTM model, through IOT notifications. The proposed system is able to show historical and statistical information about different parameters of the rivers in the form of graphs and charts. Our low-cost and energy-efficient flood inundation IoT sensor unit is working on a sensor technology that monitors three remote flood-prone areas in real-time, where network availability is not so good. We have designed a mobile application "FLOODWALL" to retrieve data from the Google cloud by using APIs, which shows the most recent hydrological and meteorological data and generates an alert when the values coming from the sensors exceed the predefined threshold values. In this project, a real-time-based Flood Monitoring and Alerting System has been developed in Arduino UNO enabled environments using rigorous mathematical models. Internet of Things (IoT) is an emerging platform and broadly used worldwide, this system will display the data of the water parameters measured on thinspeak display. This device can save lives and properties and reduce hazards to a great extent.

Future scope:

The system provided a camera that will display the real-time image of the flood that can view via livestream. It includes Serial Communication to send warning text message with the content of date, time, water level and road accessibility. The system has three (3) modules which are Users, Logs, and Contact Numbers. It can be modify by the admin. The unit containing the sensor is suggested to be place in front of Our system. The position of the sensor must be placed perpendicular to the flood water; otherwise, there will be an imperfect reflection of ultrasonic waves and cause measurement errors. The sensor is suggested to be placed on a pole with a height of about 3 to 3.5 meters. The flood sensors and microcontrollers will be powered by a Solar Power Bank with 80, 000 Ampere Ampere-Hour (mAh) for the benefit of continuous operation of water flood height detection and network data transmission.

REFERENCES

1. Freitas, C.M.D.; Ximenes, E.F. Floods and Public Health—A review of the recent scientific literature on the causes, consequences and responses to prevention and mitigation. Cienc. Saude Coletiva **2012**, 17, 1601–1616.

2. Wallemacq, P.; Herden, C.; House, R. The Human Cost of Natural Disasters 2015: A Global Perspective; Technical Report; Centre for Research on the Epidemiology of Disasters: Brussels, Belgium, 2015.

3. Pozza, S.A. Identificação das Fontes de Poluição Atmosférica na Cidade de São Carlos SP. Master's Thesis, Federal University of São Carlos, São Carlos, Brazil, 2005.

4. Rashid, B.; Rehmani, M.H. Applications of wireless sensor networks for urban areas: A survey. J. Netw. Comput. Appl. **2016**, 60, 192–219.

5. Mainetti, L.; Patrono, L.; Vilei, A. Evolution of wireless sensor networks towards the Internet of Things: A survey. In Proceedings of the 2011 19th International Conference on Software, Telecommunications and Computer Networks (SoftCOM), Split, Croatia, 15–17 September 2011; pp. 1–6.

6. Zelenkauskaite, A.; Bessis, N.; Sotiriadis, S.; Asimakopoulou, E. Disaster Management and Profile Modelling of IoT Objects: Conceptual Parameters for Interlinked Objects in Relation to Social Network Analysis. In Proceedings of the 2012 4th International Conference on Intelligent Networking and Collaborative Systems (INCoS), Bucharest, Romania, 19–21 September 2012; pp. 509–514.

7. Rehmani, M.H.; Viana, A.C.; Khalife, H.; Fdida, S. A cognitive radio based Internet access framework for disaster response network deployment. In Proceedings of the 2010 3rd

International Symposium on Applied Sciences in Biomedical and Communication Technologies (ISABEL 2010), Roma, Italy, 7 10 November 2010; pp. 1–5.
[8] S. Azid, B. Sharma, K. Raghuwaiya, A. Chand, S. Prasad, and A. Jacquier, "SMS based flood monitoring and early warning system," ARPN Journal of Engineering and Applied Sciences, 2015.
[9] S. J. Priya, S. Akshaya, E. Aruna, J. A. M. Julie, and V. Ranjani, "Flood monitoring and alerting system," International Journal of Computer Engineering & Technology (IJCET), vol. 8, no. 2, p. 15, Mar 2017.
[10] D. Satria, S. Yana, R. Munadi, and S. Syahreza, "Prototype of google maps-based flood monitoring system using arduino and gsm module," International Research Journal of Engineering and Technology (IRJET), vol. 4, no. 10, Oct 2017.
[11] M. Madhumathi and R. Grace, "Flood alert management system using iot and microcontroller," International Journal of Innovative Research in Computer and Communication Engineering, vol. 5, no. 4, April 2017.
[12] Malaysian Communications And Multimedia Commission, "Hand phone users survey 2017," Tech. Rep., 2017.
[13] Syed Nazmus, Sakib M. Shamim, Kaiser. An intelligent Flood Monitoring System for Bangladesh using Wireless Sensor Network, ResearchGate, May 2016.
[14] Edward Udo, EtebongIsong.FloodMonitoring and Detection System using Wireless Sensor Network, ResearchGate, and January 2014.
[15] JagadeeshBabuMallisetty and Chandrasekhar V.Internet of Things BasedReal Time Flood Monitoring and Alert Management system, May 2012.
[16] JaymalaPatil, AnujaKulkarni.Wireless Sensor Network Using Flood Monitoring, IJCSMC, Vol. 2, Issue. 11, November 2013.
[17] RaihanUl Islam. Wireless Sensor Network Based Flood Prediction Using Belief Rule Based Expert System, Luleå University of Technology 2017.
[18] S. Yeon, J. Kang*, I. Lee. A Study on real-time Flood Monitoring System based on Sensors using Flood Damage Insurance Map, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLII3/W4, 2018 GeoInformationFor Disaster Management (Gi4DM), 18–21 March 2018, Istanbul, Turkey.
[19] W. M. Shah, F. Arif, A. A. Shahrin, and A. Hassan, "The implementation of an IoT-based flood alert system," Int. J. Adv. Comput. Sci. Appl., vol. 9, no. 11, pp. 620–623, 2018.

[20] S. I. Abdullahi, M. H. Habaebi, and N. A. Malik, “Intelligent flood disaster warning on the fly: Developing IoT-based management platform and using 2-class neural network to predict flood status,” Bull. Electr. Eng. Informat., vol. 8, no. 2, pp. 706–717, Jun. 2019.
[21] J. Al Qundus, K. Dabbour, S. Gupta, R. Meissonier, and A. Paschke, “Wireless sensor network for AI-based flood disaster detection,” Ann. Oper. Res., pp. 1–23, Aug. 2021.
[22] C. K. Khuen and A. Zourmand, “Fuzzy logic-based flood detection system using lora technology,” in Proc. 16th IEEE Int. Colloq. Signal Process. Appl. (CSPA), 2020, pp. 40–45, doi: 10.1109/CSPA48992.2020.9068698.