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AN ADVANCED FLOOD MONITORING SYSTEM USING SPREAD SPECTRUM BASED LORA TECHNOLOGY

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ABSTRACT

All over the world flooding are a natural phenomenon and a serious issue for consideration. Hence the flood monitoring system is very much essential & significant. In this framework of the project, we use Lora (low power long-range protocol) as a method of data communication in a wireless network. LoRa is essentially a spread spectrum regulation strategy got from chirp spread range (CSS) innovation. The overall project system involves the deployment of various Water level sensor nodes at specific flood vulnerable remote locations for real-time flood monitoring and detection with an efficient and optimized transmission power of essential data in the hydrological network.

Keywords: Wireless Sensor Network, Internet Of Things, Chirp Spread Spectrum, Line Of Sight.

I. INTRODUCTION

Among the new driving innovations around here, we consider LoRa, in light of the Chirp spreading spectrum (CSS) strategy. This innovation stands apart for its simple use, its high energy proficiency, and its phenomenal presentation in conditions where the signal-to-noise ratio (SNR) is low. WSN structures are especially valuable in natural marvels checking, particularly in situations where the event of an occasion can prompt critical security issues. Flooding is a typical occasion in provincial and metropolitan conditions where the presence of water is expected both to topographical highlights, like streams or lakes, and to the nearness of delicate metropolitan components. Flooding can introduce an undeniable degree of hazard. For instance, the flooding of streets can harm the foundation. Other than imperiling public wellbeing, this can have monetary and social repercussions. Flooding can be brought about by unfriendly downpour conditions, wind, temperature changes. A gauge dependent on a hypothetical way to deal with this occasion is unpredictable and frequently not quickly possible; accordingly, the advancement of early notice frameworks is valuable and vital. In this work, a flood-checking framework was created, intended for the establishment and use in metropolitan and non-metropolitan settings, to get an early admonition of the conceivable marvel. This would empower the execution of countermeasures that would educate the client regarding the potential dangers or, in case of administration interruption, the execution of goal techniques. It incorporates the information assortment and transmission capacities and another significant determination is the particularity of the setup which will be examined later. The executed framework is shaped by a sensor hub dependent on a low utilization microcontroller, outfitted with a LoRa remote module for data information transmission. Utilizing this methodology, it was feasible to get a decent energy execution, while keeping up the chance of getting a wide inclusion range for radio correspondence. This paper is coordinated as follows a diagram and assessment with related works. Toward the start, an outline of LoRa module is given. In a later section, the overall engineering of the framework is depicted. Then, at that point the plan and the reasonable execution of the equipment structure that makes the WSN sensor hub, just as the association and depiction of the web area for information control, are introduced. At long last, it is shown that the framework can be utilized to deal with the distantly gotten information, on which the early admonition can be carried out.

II. RELATED WORKS

In the field of IoT devices today, there are lots of different-different communication devices available for our specific requirements, but apart from these, the most popular among them are only Bluetooth and Wi-Fi.

However, the issue with Wi-Fi and Bluetooth innovation is high energy utilization. They similarly have various limitations like confined reach, limited paths, etc. Cell networks also have comparative issues of high energy usage and both LAN and Cellular associations are exorbitant to cover a wide district. The IoT undertakings introduced loads of developments; in any case, none of them was ideal for IoT contraptions, as they expected to convey fundamental ongoing information to critical distances without using a ton of energy until the LoRa advancement was introduced. Lora (Long Range) is a far-off progression that offers low-power, long-range and secure data information transmission for IoT applications. LoRa is a spread range tweak innovation that is gotten from tweet spread range (CSS) innovation. LoRa Technology can perform amazingly long-arrived at transmission with low power use. We use the LoRa Ra-02 Sx1278 model for this project framework purpose having an open-air Frequency band of 868Mhz with up to 15km range of data transmission. On another side, old technology is various drawbacks related to power consumption, cost, complex encryption, channel bandwidth, and so many other things

Table 1. Comparison of Communication Technologies

SN.	Parameters	Wi-Fi	Bluetooth	GSM	LoRa
1	**Band Regulation**	License free ISM BAND	License free ISM BAND	Expensive Dedicated frequency channel	License free ISM BAND
2	**Range Category**	Up to100m Middle Range	Up to10m Short Range	Up to 35km very long Range	Up to 15km long Range
3	**Output power**	0.1W	0.003W	2W	0.025W
4	**Frequency Band**	2.4 & 5GHz	2.4GHz	900-1800MHz	433,868,915MHz
5	**Data Rate**	100Mb/s	1Mb/s	9.6- 14.4kb/s	0.3- 100kb/s
6	**Operating Cost**	High	Low	Very high	Very low
7	**Power Consumption**	31-100mW	1-10mW	30-100mW	0.01-300mW

III. OBJECTIVE

1] To develop a framework that presents flood issue avoidance by interfacing improved spread spectrum innovation-based LoRa device with proficient water level sensor. [2] To determine the best predictive performance analysis model for Lora Device in the hydrological network likewise limiting the energy utilization by project framework parts Further the out of the works executing the Real-time flood checking framework to facilitate the flood issues.

IV. LITERATURE SURVEY

I did a writing study wherein I discovered different papers proposing various frameworks on similar grounds which are followings, [1] Shahirah Binti Zahir1, Phaklen Ehkan2, Thennarasan Sabapathy, Muzammil Published Smart IoT Flood Monitoring System" It provides flexibility and smartly operation of flood monitoring with the help of microcontroller-based IoT system. [2] Konstantin Mikhaylov1, Marko Pettissalo2, Janne Janhunen1, and Jari Iinatti1 Published Performance of a low-power wide-area network based on LoRa technology: scalability, Doppler robustness, and coverage. it provides a low power consumption. LoRa has been manufactured by Semtech, also it uses advanced spread spectrum technologies. [3] Dola Sheeba Rani, Dr. Jayalakshmi G N, Dr. Vishwanath P Baligar Published Low-Cost IoT-based Flood Monitoring System Using Machine Learning and Neural Networks It evaluated the accuracy of artificial neural networks based smart decision support system during flood condition.

V. PROPOSED SYSTEM

In Figure 1 the general project framework of the proposed advanced flood-monitoring system is presented. The implemented system is formed by two sections i.e. Transmitter section and the Receiver section. In the transmitter section an ultrasonic HC-SRO4 water level sensor module to measure the water level height of the

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river according to our predefined conditions in Real-time, Arduino atmega328 microcontroller that will gather all the sensed data information from the sensor and analysis the data with our predefined set of rules and measurement method for transmission purpose and LoRa RA-02 sx1278 spread spectrum based wireless module equipped with Serial Wireless Gain Antenna for data transmission wirelessly according to our configuration setting to achieve required distance and power consumption.

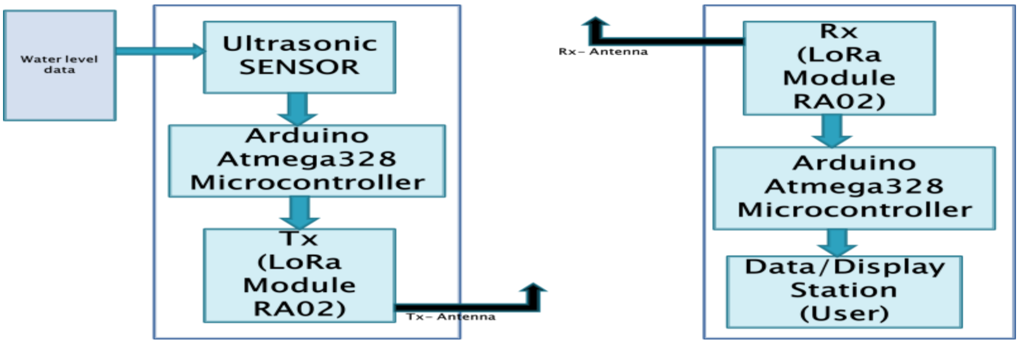

Figure 1: Block diagram of flood monitoring system

Apart from this at the Receiver section side, there is also LoRa RA-02 sx1278 wireless module with an antenna to receive sensed water level data, Arduino atmega328 microcontroller with an Observer user data station display and controlling area equipped with buzzer, LCD screen, and Led Indicator.

VI. METHODOLOGY

This proposed project framework of an advanced flood monitoring system involves hardware component setup with our spread spectrum based LoRa module in figure 03 with software coding or programming in IDE in figure 02 according to our predefined algorithms and flow chart in Figure 04. In the software section, we use the Arduino Integrated Development Environment (IDE) to configure the LoRa module and all hardware components such as Microcontroller and sensors. The algorithm we used in this framework according to our flowchart having the following steps:-

[1] At Transmitter section- When setup is started, the ultrasonic water level sensor measures the river height continuously in centimeter (cm) and gives the sensed data information to atmega microcontroller unit, where the system analyzes the data information continually according to our predefined program i.e. if the measured water level is greater than equal to our optimum standard reference value during flood condition then the system forwards the data to LoRa module for wirelessly transmission purpose else it will measure the water level data through sensor again and again in Real-time. We configured the spread spectrum-based LoRa SX1278 module through our coding by a set of some predefined commands in the Arduino IDE platform in Figure 02 to achieve the best possible range for communication purposes on the receiver section side.

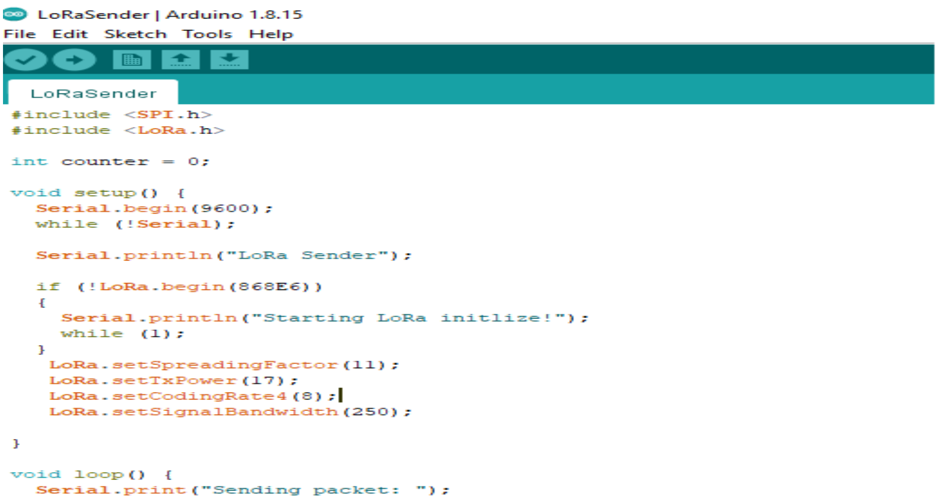

Figure 2: LoRa Configuration setting

[2]At Receiver section- Another frequency-matched LoRa SX1278 module receives the water level data digitally and send it to the Arduino microcontroller unit for further analysis i.e. if the measured water level data is high, it will indicate the user station by buzzer alarm & displaying an alert message in LCD for further controlling and required action purpose. In this way, the system will work continuously in Real-time for effectively monitoring flood conditions. In our project framework, we consider the flooding condition measurement of whole water body of river has been categorized in three major section/ zone according to their water level height i.e. normal zone/ safe zone, critical warning zone, and last Red alert dangerous zone by our predefined set of coding commands during the programming, for getting best result during flood condition.

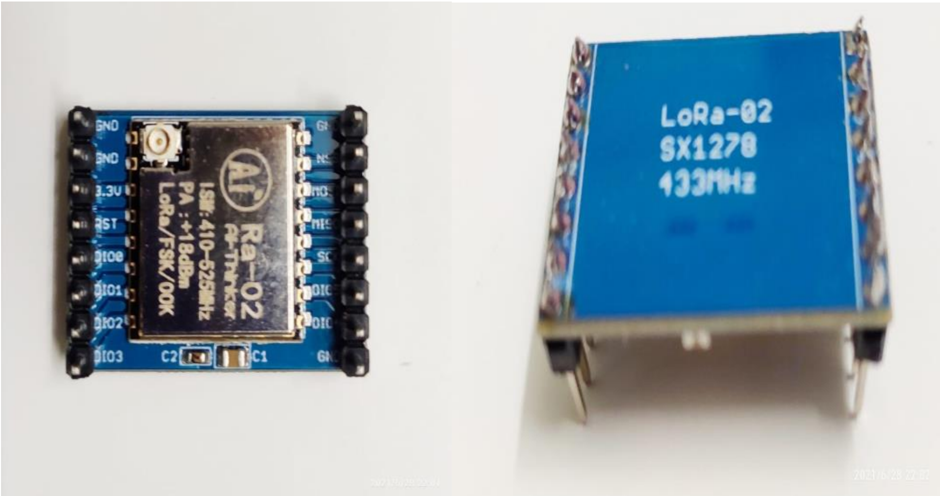

Figure 3: LoRa Ra-02 SX1278 module

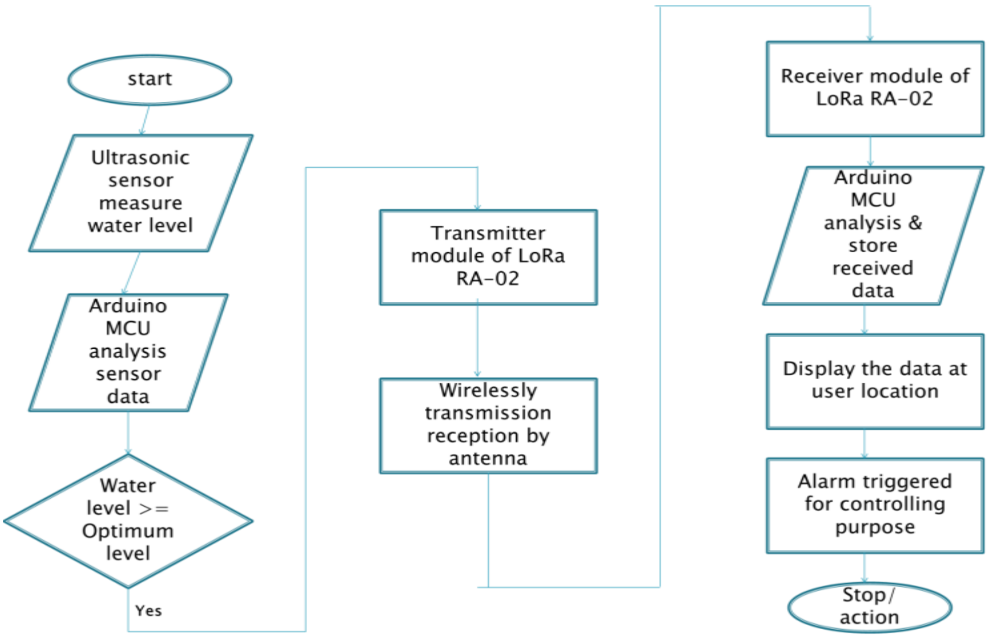

Figure 4: Flow-Chart

VII. RESULT AND DISCUSSION

In my project framework I have modulated the followings configurable factors or parameters in LoRa device which varies LoRa data communication performance and signal transmission effectively according to our site location and necessary condition, such as Carrier Frequency (CF), Spreading Factor (SF), Transmission Power (TP), Coding Rate (CR) and Bandwidth (BW). I have done this configuration setting during coding time in the Arduino IDE platform. To achieve modulation in Transmission range and energy consumption, observe the behavior of LoRa device communication for accuracy of my project framework in the Line of sight (Los) and Non-Los area.

Table 2. Performance Evolution by configuration setting in LoRa

Configurable Factors	Allowed Range	Variation in Distance	Power Utilization	Output Data rate
Bandwidth(BW)	41.7,62.5,125,250,500 kHz	Decrease sequentially	Wide BW increase more power	Increases sequentially
Tx power output(TP)	2 to 17dBm.	Increases sequentially	More power utilize as increase TP	Increases sequentially
Code rate(CR)	4/5, 4/6, 4/7, 4/8	Increases sequentially	Large CR increase more power	Decrease sequentially
Spreading Factor(SF)	6, 7, 8, 9, 10, 11, 12	Increases sequentially	As SF increases more power utilize	Decrease sequentially

Table 2 presented variations in different configurable factors in the Los region. Through my observation and experimental condition, I have seen that the **SF- 10 & 11, BW-250kHz, TP- 17dBm, and CR-4/8** give the best reliable data transmission in the LoRa device for Flood monitoring purpose. Apart from this also observed that the Non-Los region dramatically reduces the distance of data transmission. Overall summary in result discussion to improve the reliable data transmission Flood monitoring in Remote location, best matching Configurable Lora device parameter is must be required.

VIII. CONCLUSION

Through my Project framework, a preliminary idea for result-oriented work is to obtain for flood monitoring system through LoRa communication device because the occurrence of flood due to dam breaks, heavily rainfall briefly delivering gigantic gallons of water. The outcome is that a large part of the water gets into the dirt, prompting stagnation and causing flooding in the space inclined to flood. Execution of flood observing and cautioning framework prompts minimization to flood openness, having time left to clear the region, getting time and help to flood control structures. Different perceptions of information through low force, minimal expense LoRa convention are seen which helps in executing the methodologies for expectation. An observation indicates by implementing system framework models that work well for the prediction of fluctuations in River water level due to excessive rainfall. In any case, this proposed strategy can be utilized for a forecast for any territory of India, with the given information. Planned and carried out the flood observing and alarming framework and assists with foreseeing future activity and the board for the avoidance of misfortunes by flood effectively.

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