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Design and Construction of an Automated Flood Intimation System

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A B S T R A C T

Flooding is a crucial concern for creating substantial economic and social impacts for different regions of Bangladesh. The country's geographical location makes most of the area highly vulnerable to floods. Despite people's suffering during flood conditions, comprehensive research on developing an automotive flood intimation system is inadequate. Flooding is the inundation of water onto land that is normally dry, followed by rain, snow, coastal storms, storm surges, overflows of rivers, and dam failure. Early detection of rising water levels may reduce the damaging impact of floods and also allow adequate time to develop integrated flood adaptation and management mechanisms. Therefore, this study proposed an automated flood intimation system using Arduino. The system integrates the feature of determining three distinct parameters involving temperature, humidity, water level, and wind speed. The design emphasized the early detection of rising water levels and provided the necessary acknowledgement to reduce the impact of floods. Post-flood effects involve water pollution, water-borne diseases, and other epidemics in flood-affected communities. Hence, the proposed system might be helpful for proper support management during natural calamities like floods to reduce the suffering of people.

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INTRODUCTION

Bangladesh is the most susceptible country due to climate change, which is a fact. Parallel to climate change, globally, the extent of natural disasters has grown drastically [1]. The dramatic weather variations of today have a huge impact on disasters like flooding. Weather is simply one factor that affects floods; another is human activity that harms the forest. Preparing for the impending flood is necessary to reduce the number of casualties [2]. Bangladesh is the sixth most susceptible country to flooding due to its topography and the negative effects of climate change [3]. It has 405 rivers that are components of the Ganges-Brahmaputra Delta. Because it is an agricultural country, 20–25% of the monsoon flood is thought to be beneficial [4]. However, over-inundation harms both people individually and society as a whole.

Generally, Bangladesh experiences floods every year, from little flash floods to massive ones that devastate vast portions of the nation. Many undecorated floods (for example, floods in 1987, 1988, 1998, and 2007) happened in this country as a result of heavy monsoon season rainfalls in the Ganges-Brahmaputra-Meghna basin area [5]. Additionally, from 2009 to 2014, floods had an impact on 4,361,261 households [6]. Studies have shown that aspects including socioeconomic structure, consciousness, house structure, etc. are strongly associated with this considerable damage. [7], [8], [9]. It is possible to reduce future risk by adopting precautions if the damage is correctly predicted and the damage factors are identified.

Finding floods and taking action to prevent them frequently costs a lot of money. The conventional designs significantly increase the complexity by requiring very expensive utilities and intricate computations. The flood alert systems employed in developed nations are quite expensive, and monitoring and maintaining them requires a high level of technical skill. But it is not practical in developing and underdeveloped nations [10]. Floods significantly damage both people and property [11]. People in rich countries adjust well to change, while people in underdeveloped countries take much longer to recover since the losses they experienced will cost them a lot of money and take a lot of time to go back to normal.

Numerous technologies have been created to forecast, manage, and stop flooding. But implementing flood intimation systems in rural regions is the true challenge. These places lack a lot of amenities, including qualified personnel, readily available energy, and financial support.

LITERATURE REVIEW

Scientists have developed many flood intimation systems to be alert in advance. These systems may control and reduce the adverse effects of floods and human losses. The first iteration of a prototype intelligent system for flood prediction and real-time monitoring is presented in [10]. A Marvell 88F6281 microprocessor from the ARM family is used to implement the system, and the Free UnixBSD operating system is used to implement the user interface. Moreover, the system incorporates a knowledge base. The decision-making factors receive the real-time alert via a communication channel (such as the internet, a mobile phone, or radio communication). The study also discusses a few of the experimental findings so far.

The researchers recommend an active flood alert system that can overcome the disadvantages of all the intended systems [12]. They have proposed an independent plan that does not deal with mobile towers to get an alert message. It is a low-power scheme that works well even if the internet is not available. Besides, it transmits direct messages to civilians to avoid delays and complex calculations. Flood perceivers contain different sensors and need information from the environmental forecast, flood perceiver, and observer. It is essential information to determine the intensity level of a flood. Rehman et al. [13] have demonstrated a CP-Nets-recognized model. They also did exhaustive verification of their projected model for liveness and safety properties of precision.

Suresh et al. [14] have built a tentative project through a small-scale demonstration that contains a water level estimation sensor. It shuts down when the level reaches the water, meeting the resistors at different heights with the increment of the water level. In order to identify floods early and notify the community, Basha et al. [15] provided a brief overview of how the sensor network was deployed in Honduras. They have examined the value of sensor networks for flood detection, sensor networks for use in underdeveloped nations, and currently existing operational systems for flood detection. They investigated Honduras's issue with flood detection and made a suggestion for a fix. They separated the problem into four tasks—event prediction, authority notification, community alarm, and community evacuation—and assigned each to CTSAR (the name of the organization) and themselves using wireless sensor networks (WSN).

In [16], the flooding problem is predicted and prevented using wireless sensor networking (WSN) technology. This research paper conducts a survey on wireless sensor networks for flood prediction and prevention. In this study, Chandra et al. propose a web-based Rescue Alert System (RAS). RAS collects data from different locations of the affected site and analyzes the data to detect the disastrous situation. After knowing the location of the affected area, the RAS finds out the shortest path from the affected area to the current position of a rescue team and provides the approach to the rescue team [17].

Patel et al. [18] have presented the swamping concern by the flood intimation system. It indicates advanced signs of danger to increase the survival chance in the flood-affected areas. This scheme points out the exact locations of the victim's place to protect valuable assets. Moreover, the authors have proposed a WSN-based IoT system. It distributes the water level sensors over an area to monitor the water level. Another research paper [19] illustrates a system that can inform disasters like the flood in advance. Such a system is connected to the internet and uses the cloud through IoT to communicate the data.

A system is designed and developed in [20] that intends to monitor and detect using sensors and broadcast early warning data to catastrophe risk reduction centers via wireless telemetry. By providing early warnings when flooding is approaching, CBFEWS is a technology created to help save lives and property. Four different station types make up the CBFEWS network: the rain gauge (RG), water level sensor (WL), repeater (RP), and data center (DC). An early warning system [21], using an Arduino board to manage the entire system and GSM shields to transmit data, is proposed. Float switch sensors are used by the model to assess the water level. After collecting the data, it analyzes it to identify the type of risk that exists. An alert message is translated from the detected level and sent to the user. SMS is used to connect the various system components over the GSM network.

METHODOLOGY

Flooding is a natural calamity, depending on some immoderate criteria. Such criteria involve geographical locations, heavy rainfall, etc. But early detection of floods could be helpful for reducing the impact of disasters due to floods. Therefore, the detection of flash floods involves the rise in water level and the ambient air speed. In the view above, an Arduino based system is proposed, including two distinct major portions. These portions are:

a) Water level measurement

b) Ambient air speed measurement

The system also includes features for measuring temperature and humidity. The figure given below (Figure-1) illustrates the basic block diagram of the system.

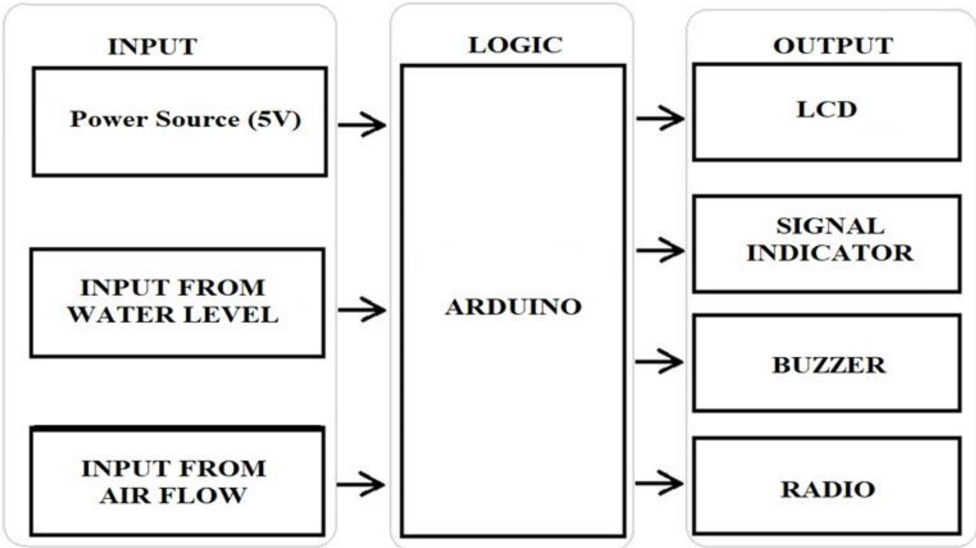

Figure 1. Basic Block Diagram of an Automated Flood Intimation System

The proposed design evaluated four exemplary levels: Level 0, Level 1, Level 2, and Level 3, to measure the rising water level. Each level is vertically separated from the others. Level 0 is the general level, or safe stage; Level 1 is the lowest level; Level 2 is the medium level; and Level 3 is the highest level, or danger level. Below the lowest level, there is a 5V supply power line. When water makes contact with the lowest-level wire, the circuit is complete. After that, a signal is sent to the Arduino via digital pin 3. The output is displayed by the Arduino; the LED will glow green; the radio will be turned on; and the LCD will display "Level 1" as output. We followed a similar technique for the medium and the highest-level wire. The outputs are labeled "Level 2" and "Level 3," respectively. The medium and highest-level wires are linked to Arduino digital pins 4 and 5, respectively.

To monitor the ambient air speed, a cup anemometer with an IR sensor is designed. The cups were mounted on top of an aluminum steel pipe connected with a motor, ensuring they were the same distance apart. The IR sensor is located directly below the spinning arm of the cups. When any of the rotating arms crosses the IR sensor, the count begins. We used the following calculation to calculate the air speed in RPM (revolutions per minute) via the four arms of the anemometer:

$$\text{RPM} = \left(\frac{rev}{time}\right) * \frac{60000}{4}$$

The IR sensor's output was attached to Arduino digital pin 2. The output has now been displayed on the LCD. For air speed, we considered three stages, i.e., the lower stage, the medium stage, and the higher or danger stage. Besides measuring water level and ambient air speed, our proposed system can also measure ambient temperature and humidity through the DHT11 sensor. The output pin of the DHT11 sensor and the digital pin 6 of the Arduino are also connected, whereas the LCD displays the measurement.

RESULTS

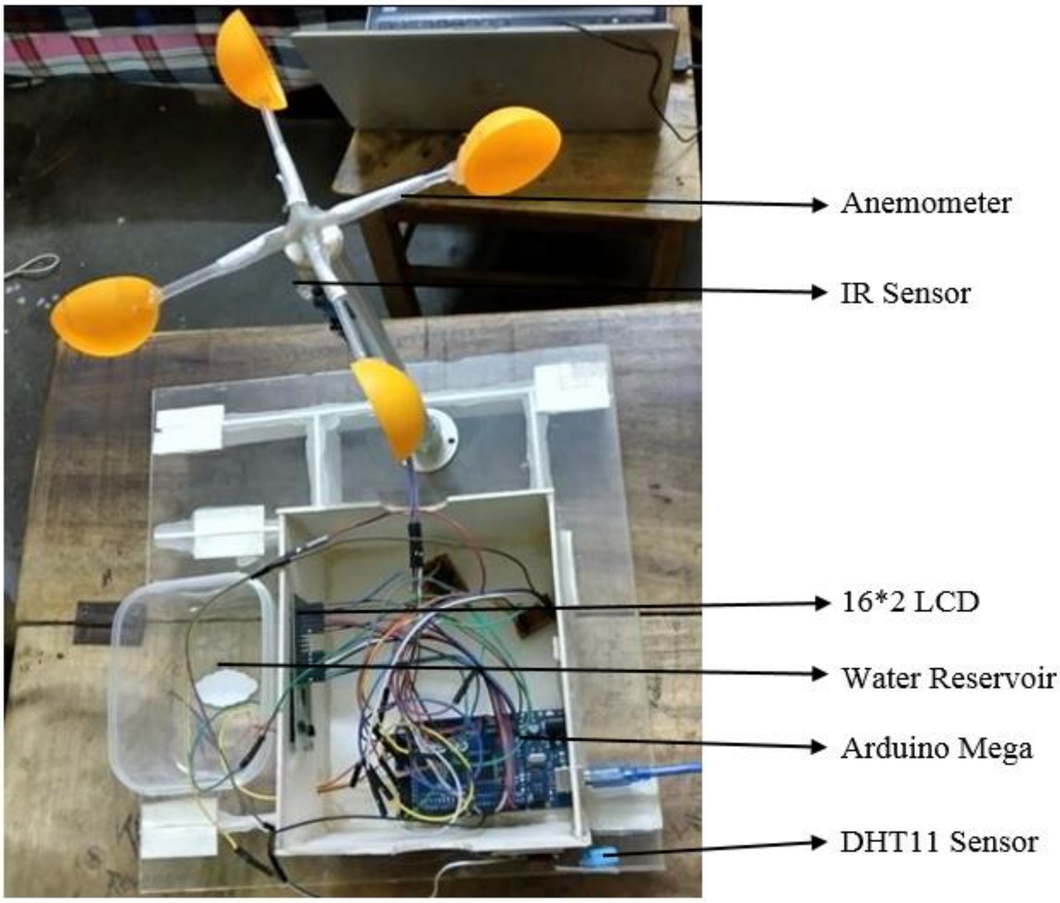

Figure 2. Experimental Setup of an Automated Flood Intimation System

The figure given above (Figure 2) demonstrates the experimental setup of the developed automated flood intimation system. Therefore, the exemplary conditions for water level were examined, and the observations are demonstrated in the following tabular format:

Table 1. Condition for Water Level

Input	Output		
	Signal Indicator	**Radio/Buzzer**	**LCD Display**
General Level	Blue	-	Level 0
Water Level Low	Green	-	Level 1
Water Level Mid	Yellow	Radio On	Level 2
Water Level High	Red	Buzzer On	Level 3

Moreover, ambient air speed is measured through the cup anemometer with an IR sensor. When the air speed is counted, a signal is sent, and the LCD displays different levels as output.

Table 2. Change in Air Speed

Input	**Output**			
Induced Voltage from the Generator (DC)	**Level**	**Signal Indicator**	**Radio/Buzzer**	**LCD Display**
0.5 Volt	Low	Green	-	Level 1
1.0 Volt	Medium	Yellow	Radio On	Level 2
1.5 Volt	High	Red	Buzzer On	Level 3

CONCLUSIONS

Real-time detection of water level and measurement of air speed is an effective method for forecasting floods. Such a system will be a comprehensive development of technology for an effective flood management system. The system makes use of sensors to monitor weather parameters, including water levels, and an Arduino to analyze the data and notify the appropriate parties. With the implementation of this technology, flood situations can be predicted and handled quickly and accurately, potentially saving lives and reducing property damage. The illustration is a prototype configuration that can be further developed by incorporating wind turbine technology for the generation of energy. Furthermore, the integration of all the weather parameters and the devilment of the warning system in accordance with the precise danger signals defined by the concerned authority will provide an absolute weather monitoring solution. Overall, the implementation of Arduino-based automated flood warning systems is a viable strategy for managing floods and responding to disasters, and it has the potential to have a big impact in flood-prone areas.

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