Outpouring Descern Barebones by Arduino and Wireless Sensor Network

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Abstract – This project mainly focuses on saving the human life and reduces the loss of properties. Our society relies on embedded systems for day-to-day activities. Nowadays, Wireless Sensor Networks (WSN) are widely used almost everywhere, including both residential areas and rural areas near the river. Therefore, embedded systems can reduce risks due to a change in climate with impacts of outpouring on local communities. The WSN technology has been applied in monitoring natural disasters. This project further proposes an innovative and inexpensive framework designed to provide early warning for natural disaster via a charmer. It works by continuously recording and transmitting sensor data to the main server. The server processes the data and then provides the warning, so that vulnerable residents can be intimated before the outpouring around their areas, especially in high risk zone.

Index Terms – Embedded system, Arduino, Wireless Sensor Network, Early Warning System, Climate change.

1. INTRODUCTION

Embedded system plays an important role in real time response. An embedded system is one that is made for a particular task instead of general multiple tasks. Such systems can be applied to solve various issues in rural areas. The availability of technologies for rural villages near and a little bit far away from the river, with no access to electricity, is spreading only slowly. Therefore, citizens are mostly affected by frequent river flooding, flash flooding due to heavy rainfall and lack of real-time early warning system. The identified issue is shown in Fig. 1. The main goal of our project is to minimize the loss of properties and to save the human life.

It is a big challenge for the Government to move everyone from high risk zones to safe places, since it is too expensive; and it may take a long time for the Government to implement such kind of projects. In that regard, we propose an innovative framework that is comprised of affordable Arduino embedded computers and other inexpensive wireless sensor network devices to continuously detect floods and send an alarm warning voice through the charmer.

People will get out of their vulnerable houses, and then move to a safe place. The government will be able to expand the installation of those wireless sensor networks, since it is cost effective and easy to maintain. In this paper, we introduce an advanced innovative framework design to keep detecting the level of water in case of floods near the river, then send the data through Arduino which that has the control program. An Arduino is used as a main component that facilitates the main functionality of the system. The communication is facilitated by both GSM Protocol and wireless networks.

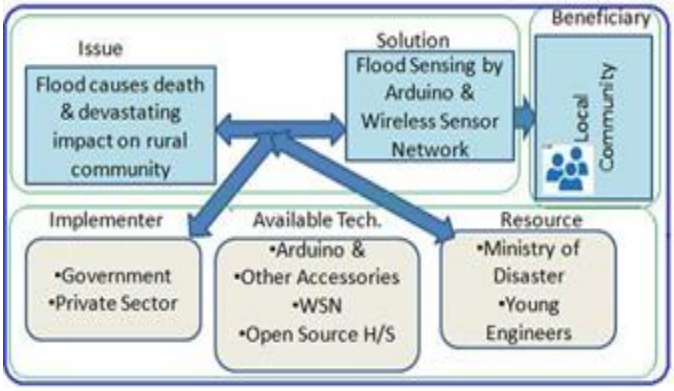

Fig. 1. Analysis of the problem

2. FLOOD EARLY WARNING SYSTEMS

Climate change seems to be a major challenge in today's global changes, whereby rural areas are affected by floods after heavy rainfall in the rainy season.

There are many factors, including the lack of ICT technologies appliance in some of the particular situations [7] in rural area. Usually, disasters occur in a very short time and it is not easy to stop them, but we can reduce the risks and the time delay by applying cheap available technologies [8]. Floods continue to affect economic development and social welfare of people, since there is no easy way to send an alert message before disaster occurs. Every year in the heavy rainy season, floods affect our people and their properties in the local community. The destruction of vulnerable houses is a major challenge, since a high number of victims are poor people in rural areas [9]. The number of losses of properties and lives can be reduced by applying today's new technology like Arduino and other cheap wireless sensor network devices. Protective methods must be taken before the flash flood occurs. The most probable outcome is that flood surrounds the houses until they are demolished while people are inside, without having any noticeable alert. Since there is a lack of infrastructure to detect floods before vulnerable houses are destroyed [10].

In this case, some of the ICT Tools are needed to be in place, so that people can be informed through charmer. It will help and improve the possibility of using available cheap ICT tools in an isolated place by humans, especially for people who are living around and far away from the river.

3. ARDUINO AND WIRELESS SENSOR NETWORK IN HIGH RISK ZONES

3.1. Overview

In this innovative framework, we propose an embedded system that includes open hardware component and software (see Fig. 3); the framework will continuously detect the presence of floods and send an early warning voice through charmer. There is no need for people to periodically operate the system, since it interacts directly with the real world as an automatic and autonomous functioning system. It is reliable and dependable in its safe environment. It is very cheap and can learn how to program it. If we hook it up with the right electronic parts, we can actually use it to build objects that are essentially able to interact with people and interact with what's happening around them [13].

The framework in this project is basically built upon the Arduino Uno. Arduino Uno board is a micro-controller based on the ATmea328P [14]. The open hardware and software is flexible for developers and other stakeholders who are not engineers. The Arduino board has digital and analog ports that will allow us to plug various devices including sensors within the framework. Therefore, it will be a good opportunity to make a small network near the river, which will facilitate water level detection by sensing floods. All components will interact with a zero delay communication and be aware of where they are, thus they can detect whether or not water surpasses the expected limit boarders. Wireless sensor network in today's world seems to be everywhere as an enabling technology [15], especially in disaster risk reduction management and agriculture related activities. The system structure simply shows a deployed system on the field sensor is connected to Arduino that communicates via the GSM and wireless communication with the wireless router. The GSM protocol within the embedded system will help data capturing without delay and improve transmission of receiving data by sensors [17]. The system can also be connected optionally to the internet to facilitate communication between villages, or to a central monitoring station. Fig. 2 shows the overall system framework that should be deployed on the site, just near the river.

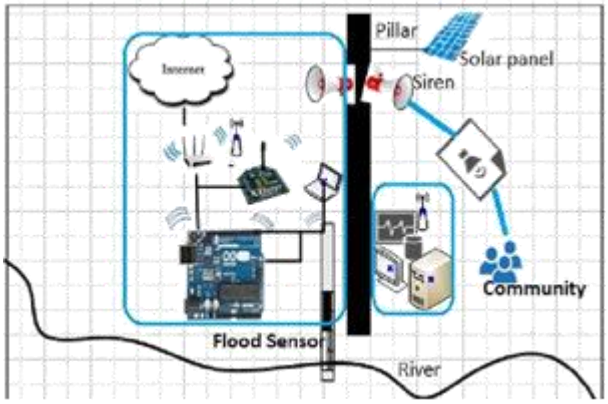

Fig.2. Overall system

This innovative framework attempts to solve a real social-challenging situation in rural areas, by providing a real-time monitoring method of floods near the river. The framework has one or more Arduino, Arduino shields connected to the water level detector (sensor), USB power plug (optional), solar panel, a chargeable battery, server computer, MicroSD card for storing data, socket for GSM, breadboard with wires and LED for signal testing [18], charmer, data and graph screen display are the strong pillar to hold (solar panel, Arduino and other small components of wireless sensors network) and protect Arduino for security purpose [19]. The solar panel in this proposed framework is the most important part. In addition, it is the main source of power supply for all devices. Solar panel thus benefits villagers, because of a limited access to electricity. The sensor network has a large set of small nodes, which communicate through wireless transmission. In this framework, the Arduino board is programmed to capture data, and then send signals whenever the water detector senses the presence of an increase of water compared to normal river flow level. There will be a computer screen to display an analyzed

(numerical and graph) result [17]. Real-time data transmission in this framework will be also being assisted by a WI-Fi protocol and other different internet protocols. All devices mentioned in the framework are powered by a solar panel. The overall flow diagram (see Fig. 3) is shown below.

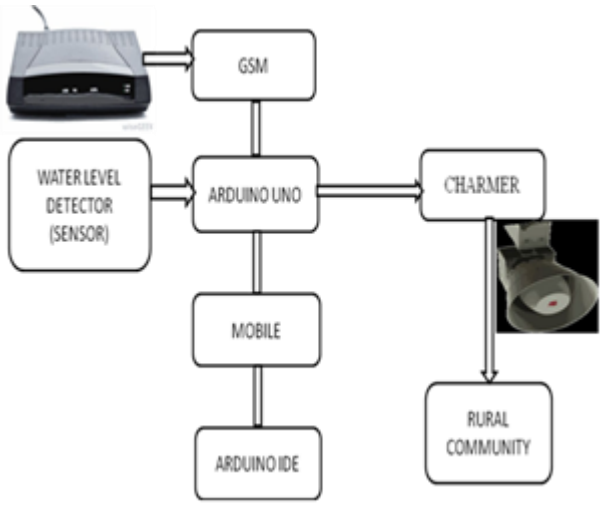

Fig.3.Process model on the side of young engineers

It simply clarifies the embedded model of the physical system in the framework. On the other hand, water level detector (sensor) working together with other micro-controllers which are considered as sensors to Arduino and they are talking through GSM protocol and wireless in the framework. There is a router that is mainly connected to the internet for allowing other communication between devices. They sense the presence of an increase of water as inputs near the river (the left side was named: interactive part of the process model). The software system that includes all instructions and it tells an Arduino how to sense, receive inputs and then processes them until the real output. The system will only send an alert warning voice to the local community when the water level surpasses the normal level to the danger level.

3.2. System Security and Operation on the Site

The system will be deployed and maintained by the Ministry of Disaster Management and Refugee Affairs (MIDIMAR) in partnership with Knowledge Lab (KLab) and local community.

1) Safety: The system maintenance does not require many staff, and cost is effective to replace devices like Arduino. In case of maintenance, MIDIMAR will intervene financially. A notification will be sent to the person in charge, just in case the system stops working accidentally.

2) Reliability: This proposed innovative framework is reliable, due to its accurate information and delivery mechanism on time. There is an expectation of less system failure due to its simple connected hardware and software.

3) Flexibility: An Arduino board is available on the market, with an affordable cost for our young engineers to buy and implement things as mentioned in this framework. With its high flexibility, it will be easy to change the circuit and develop system software that which depends on local unique needs.

4) Security: All devices on the site will be fixed on the top of a strong pillar/ pylon. This guarantees a protection from harm. Thus the installation of the Arduino and other wireless sensor network components will be outside near the river, it will not be possible to destroy the entire infrastructure.

Another issue is protecting the monitoring equipment from theft, vandalism, and damage from natural causes. In addition to developing a robust enclosure and installation layout, we want to try some of the following methods:

- The warning charmer can be sounded if tampering is detected.
- The resale value of the equipment can be reduced by marking e.g. the Arduino boards painted with bright orange etc., or we can disable such features that are not used here, but would be required by prospective buyers (the USB port etc.).
- People should be educated about the importance of protecting the system and helping with its maintenance.

3.3. Open Source Hardware

Arduino is the main component in this framework, which has open source hardware and source codes with the Arduino Integrated Development Environment (IDE) This is very helpful for us to implement an amazing interactive flood early warning system.

3.4. Wireless Sensor Network

This framework has small wireless sensor network component (see Fig. 2), that has the capability of communicating through wireless. The flood level detector can sense the presence of an increased level of floods when it comes to the danger level. Both wireless and USB connectors allow the interconnection of the devices in the framework.

3.5. Embedded System

Embedded systems are central to this proposed framework, especially since the Arduino board having many parts that allow interconnection. As such, embedded system on Arduino board controls all devices as they are connected together. An Arduino board in the framework will be connected to sensors communicating through GSM and wireless mode; there is a router that is linked to the internet (See Fig. 2) to enhance communication between devices.

4. CONCLUSION

In this paper, we described a proposed innovative framework

that covers both Arduino-based technology and other inexpensive wireless sensor network components to detect flood and send an alert to the local community. The main long-term purpose is to reduce the cost of flooding damage and save the life of the population in rural area, those whom live in a high risky zone. The particularity of this framework aims to propose and encourage the government to implement such kind of advanced technology (i.e.: flood sensing by using inexpensive devices, open source hardware and software) to reduce the cost of damage due to disasters. This will not only improve safety in the rural areas, but also will enhance skills and knowledge between young engineers. For covering very wide areas which are threatened by floods, it might be necessary to increase the range of the wireless communication devices, by employing long-range transmitters [20], repeaters, or using TV White Spaces (TVWS) communications [21]. A further option is to enhance the efficiency of warnings by employing "disaster prevention radio" broadcasts.

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