A Sudden Flood Alert System Based on a Mesh Network

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Abstract: - This paper aimed is the sudden alert flood system development. During its phenomenon that Thailand has been attacking by the global warming, natural disaster and unseasonal rain. Likewise, those phenomenons will always increase damages and frequency that human doing bring those causes. This research is purposed the sudden flood alert system and protect the unexpectedly losses by the water level detecting and velocity level sensing with processes via computer wireless network (Mesh Topology). In this case, the Xbee pro is a module for receiving and transmitting in 2.4GHz of frequency. The energy for a transmitting and receiving is 3.3 voltages that the photovoltaic cells are generated at 215mA and 55 mA for transmitting and receiving, respectively. As a result of experiment, the sudden flood alert system can distantly transfer via wireless network with real-time processing.

Key-Words: - flood alert, disaster, mesh topology, flow rate, xbee pro, current meter

1 Introduction

Natural disaster is the effect of hazard that leads to financial, environmental and human losses. However, human can protect or resist the disaster and its resilience. The damaged residential and commercial properties (such as buildings, rice fields, transportations, etc) must always be fully subsidized by governments of almost all countries, including Thailand. It is reasonably located in South East Asia and has constant rainfall during the year. This leads to exact forecasting; therefore, it gets slightly less distorted than other parts of the world. Moreover, this precise forecast becomes one of important tools for a suddenly alert flood system.

Flood disasters are an occurring due to water cause such as catact or other floods. Typically, they cause continuous heavy rain. It is caused by tropical cyclone, turbulence, or tropical depression. It might be the cause of landslides. It also leads to earthquake, dam break and floods.

This research involves a suddenly alert flood system based on the mesh network linked by the Xbee Pro II module. This system consists of sensors, transducers and centralized computer. The system has been installed in various stations in the north of Thailand and sends information via a 1.6-kilometer wireless network. In each station, the sensors and transducers are built in the rivers around the country. This system can be installed in a short period of time and warns them immediately. It can be categorized into 3 types: normal, preparation and critical announcement. As the water level in the rivers increases, the computer will stimulate, forecast floods and immediately alert people living along the river. A continuity of communication can absolutely be transferred among the stations while any failed stations will be disconnected.

2 Flood Situation in THAILAND

The flood situation in Thailand between 1989 and 2006, floods occur every year in 42 to 74 provinces. In 2002 the most damage happened in 72 provinces – 18,510 villages were flooded and 16704 million square kilometers of agricultural area was a 13385.32-million-baht of damage worth. On the other hand, the least loss in 1999 was a 1381.64-million-baht. In the year of 2006, flood problems covered 52 provinces; 17,298 villages were covered with water and 10816 million square kilometers of agricultural area was an 11131.93-million-baht of damage worth.

2.2 The tropical cyclone report in Thailand
According to the statistical records of the Thai Meteorological Department in the period of 56 years (from 1951 to 2006), there were 179 cyclones with 80.4 percent of probability in August, September, October and November (10.6%, 25.1%, 27.9% and 16.8%, respectively). The remaining is 19.6 percent in April, May, June, July and December (0.6%, 3.4%, 3.9%, 6.7% and 5.0%, respectively).
3 Type of Flooding

3.1 Riverine floods
Slow riverine floods: Run off from sustained rainfall or rapid snow melts exceeding the velocity of the rivers. The flood causes include heavy rains from monsoons, hurricanes, tropical depressions, foreign winds and warm rain affecting snow pack. Unexpected drainage obstructions such as landslides, ice, or debris can cause slow flooding upstream of the obstruction.

Fast riverine floods: Flash floods are brought about by convective precipitation (intense thunderstorms) or sudden release from an upstream impoundment created at the back of a dam, landslide, or glacier.

3.2 Estuarine floods
Estuarine floods are the result of a combination of sea tidal surges which is the effect of storm-force winds. A storm surge, from either a tropical cyclone or an extra-tropical cyclone, is included to this category.

3.3 Coastal floods
Coastal floods are due to severe sea storms, or as a result of another hazard (e.g. tsunami or hurricane). A storm surge, from either a tropical cyclone or an extra-tropical cyclone, falls within this category.

3.4 Catastrophic floods
Catastrophic floods are the consequence of a significant and unexpected event e.g. dam, breakage, or other hazard (e.g. earthquake or volcanic eruption).

3.5 Muddy floods
Muddy floods are caused by run off on crop land. They are produced by an accumulation of runoff generated on cropland. Sediments are then detached by run-off and carried as suspended matter or bed load. Muddy run-off is more likely detected when it reaches inhabited areas.

4 Motivations
Quantity and velocity of water in rivers are the most important conditions for the precaution and emergency alert system. At present, the unlimited communication can be achieved via wireless network system. Therefore, this research presents a mesh network for flood alert system with programmable engineering techniques. Both receiver and transmitter can excellently connect in less than 1.6-kilometer for outdoors (out of sight) and less than 500-meter for indoors. The communication system feeds back a main computer and will be displayed to alert in case of emergency, respectively. If the system is needed to send information rapidly, the stations must be improved all over the system.

5 Equations

5.1 Continuity Equation
This section presents the continuity equation. Consider the flow rate

\[ Q = A \times V \]

where \( Q \) is a flow rate. \( m^3/sec \)
\( A \) is a cross section area that is vertically measured between input and output flowing. \( m^2 \)
\( V \) is a velocity of water. \( m/sec \)

5.2 Cross Section Area
This section is devoted to determine an average cross section area. In case of the cross section area is an inequality; it must be divided into subsections because of the ground under the river with a deep slope in each period. It can be determined in following as

Fig. 1 cross section area of the river

- Select course that resembles a straight and not bent curve the river.
- Measure the river width by perpendicularly stretched rope from one side to another side.
- Divide into 10 subsections or 10% of the entire width and mark on the rope.
- Fathom from marked point on the rope.
- Calculate the average of cross section that is express by

\[ A = \sum_{i=1}^{10} W_i \times D_i \]

where \( W \) is a width of subsection. \( m \)
\( D \) is a depth of the river. \( m \)
\( A \) is an average cross section area. \( m^2 \)
5 Mesh Topology
Mesh network is a way to route data, voices and instructions between nodes. It allows continuous connection and reconfiguration on broken or blocked path by “hopping” from node to node until the destination is reached. A mesh network whose nodes are all connected to each other is a fully connection network. Mesh networks differ from other networks in that the component parts can all connect to each other via multiple hops and they generally are not mobile. Mesh networks are self-healing: the network can still operate even when a node breaks down or a connection does not work. As a result, this network is very reliable. Its concept is applicable to wireless networks, wired networks, and software interaction.
Wireless mesh networks are the most tropical application of mesh architectures. It was originally developed for military applications, but has undergone significant evolution in the past decade. As the cost of radios plummeted, single radio products evolved to support more radios per mesh node with the additional radios providing specific functions -- such as client access, backhaul service or scanning radios for high speed handover in mobility applications. The mesh node design also became more modular -- one box could support multiple radio cards -- each operating at a different frequency.

6 Designs
A sudden flood alert system Design, we always naturally consider information to apply in communication system (wireless network). In this research, the Xbee Pro is used to be a wireless transmission module at a 2.4-GHz of frequency that is seemed a mesh topology. It can be considered to prevent errors that might occur in communication systems between node connections. For computation, if the water level in the river is changed, the network is automatically built a modeling and forecasting from existing data what will be happening next. Likewise, if the water level in the river rapidly flows and continuously increases level, the sensor in the mesh network will be automatically alarmed by sending and receiving data via the wireless network to controlling officers who announce through the broadcasting hall or other precautions.

The geographic locations at current observations are conducted. These include ultrasonic sensors, current meters, recorder, and wireless modules. The water level can be mainly measured by the following equipment:

6.1 Current Meter
The cup-type current meter manufactured is a precise measurement of flow that is an essential prerequisite for rational assessment and distribution of available flow and for planning its utilization of all the methods used for measuring water flow. The most precise meter is the tool where the current meter is used because its important considerable research work has been done during the last five decades to bring about great improvement of the current meter. The current meter used in this project can indicate 3.0-meter a second. It can be properly adjusted based on the velocity of water. There are two ranges of a current meter: 1:1-ratio and 1:5-ratio, a revolution per pulse as well as a 5-revolution per pulse, respectively.
6.2 Ultrasonic Sensors
Ultrasonic sensors (also known as transceivers when they both send and receive) work on the similar principle to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high-frequency sound waves and evaluate the echo received back by a sensor. The sensor calculates the time interval between sending the signal and receiving the echo to determine the distance to an object.

![Fig. 4 ultrasonic sensor](image)

6.3 Program development
The centralized management was created by a 64-bit - visual basic 2008 that can support a new hardware and computer architecture for technology development. The computers can connect via a communication port (visual communication port for new architecture without communication port).

![Fig. 5 Graphic User Interface (GUI)](image)

6.4 Component of Equipment
The warning system is classified into 5 parts:

![Fig. 6 completed equipment](image)

![Fig. 7 position of a current meter installation](image)

1. The photovoltaic panels which an electrical source of a flood alert produces at 40 watts and 635 × 1245 mm. of panel size as show in Fig 5.

2. The photovoltaic supporter which is jointed both a photovoltaic panels and shaft.

3. The control unit which is placed electronic equipments.

4. The wiring tube is used to protect signal wires.

5. Current Meter and Ultrasonic
7 Processes and Wireless Communication

Data signals were received by sensors. It will be digitalized and sent by a PIC18F458 microcontroller which has already been programmed. There are three conditions as follows:

The first condition:  
0 – 29 percent is a normal state.
The second condition:  
30 – 69 percent is a risk state.
The third condition:  
70 – 100 percent is a critical state.

The resulting condition was automatically displayed and alarmed.

8 Problem Analysis

Natural disaster includes drought, flood and landslide. These disasters cause damage to lives and properties. Encroachment of human in the forest boundaries is the problem that people have made. However, if this problem has not been solved, a cumulative cycle of violence will occur. Human’s encroachment is the cause of the natural disaster in the first era. Flood and drought is boosted by unstable rainfall. They may occur when soil does not absorb water or its water retention was not sufficient. For this reason, rain suddenly flows on the soil surface to lower areas and causes a flood at the foot of the hill and the lower area. Consequently, the soil corrodes due to continuous heavy rain until the soil saturates with water. Moreover the storage layer of the soil has less water retention. This brings a weight of soil, water and trees that integration outweighs a tension force between particles within the soil layer or between the top layers of rock beneath the soil layer. This leads to landslide.

9 Conclusions

As a result of the experiment, transducers have been updated to be the smart transducers -- a current meter and an ultrasonic sensor -- are used for measuring the speed of the current flow and high water levels. They can communicate wirelessly, connect to be a mesh network and are controlled by a PIC18F458 microcontroller board. The system has sufficient speed for both receiving and transmitting signals. Accordingly, this network can be also extended to show at a control center located 10 kilometers off.

At the centralized computer, the graphic user interface (GUI) is displayed for control system and inherits from Xbee Pro directly to the system condition of the water level, speed and precision correctly by displaying the warning with graphics and voice, broadcasting through speakers.

These communications between transducers connected to the mesh can be used suddenly and precisely. This research is useful to the lives and properties of the people living near the rivers. Moreover, if the environment is still developed and forests are not damaged, it is possible to prevent the disasters. This will reduce the violence and make this world more livable.

Acknowledgement

We thank THEREC Corporation Ltd. for budgeting we have pursued in this work. We would also like to thank Thai Meteorological Department for flooding statistic. And many thank to Rajamangala University of Technology Phra Nakhon (RMUTP) for some budgeting and material.

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