Natural Disaster Alert system using GSM Network

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Abstract

Natural disasters like floods & earthquakes are the great threats towards the mankind which cannot be prevented but careful planning of the emergency measures by 'alert' system can often reduce disastrous consequences.

Recent technological advances in communication made new trends in the disaster monitoring system. The system focuses on monitoring water level & earth vibrations via sensors, & generates alert signal when water level or level of earth vibrations crosses a threshold. Alert message is Voice Message Service to the concerned authorities through their mobile phones. It also includes Public address (PA) system to broadcast the messages to the local people, nearby the river side. The module can also send status of water elevation to anyone who knows the system's modem number.

This module would be beneficial to the community and act as a precautionary action to save lives in the case of flood or earthquake disaster.

1. Introduction

Flood & earthquake become one of the major problems in most of the countries around the world. Floods are common in some countries in Asia, especially in Indonesia. These disasters cannot be eliminated, *i.e.* it is not possible to control the flood, however this condition can be prevented if the authorities always know   the current state of the water level or earth vibrations level. The Disaster Alert systems have been introduced to notify people in the early stage about the possible threat so that safety precautions can be taken to avoid any mishap.

Natural Disaster Alert system using GSM Network will give prior intimation on the mobile of concerned persons, in the form of voice message who will be taking precautionary measures against the flood & thus

life of people and animals can be saved by quick shifting them to safe places, before situation becomes critical. The warning messages can be delivered by media such as television and radio etc.

But if the warning arrives late at night when people are asleep then it will be of no use. The biggest advantage of the proposed system is that it gives alert message on the concerned mobile by ringing the call bell of phone so that the voice message can not be left without attending.

Any warning in the form of human voice which is previously recorded, is sent over GSM network to alert the concerned authority.

Also the system includes public address PA system to alert the local people at the flood prone location.

2. System Design

The Natural disasters alert is divided into four main systems: the input system in form of sensor system, the data processing system in form of microcontroller, the output system in form of GSM modem & public address (PA) system.
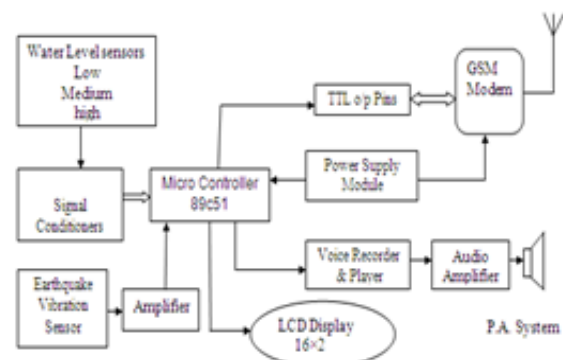

Fig.1.Block diagram of the system

The system consists of the following elements

2.1 Water level & vibration sensors:

System uses carbon rod as a water level sensors. There are number of water level sensors, but for this system carbon rod type is used because of it's noncorrosive property. It also uses piezo-buzzer as vibration sensor to detect earthquake vibrations.

Fig.2 Carbon rod electrodes   Piezoelectric Sensor

Piezoelectric sensor or piezo-buzzer is a versatile & reliable device that uses the piezoelectric effect to measure vibrations for machinery, pressure, acceleration, strain or force by converting them to an electrical charge.

2.2 Signal conditioner:[Schmitt Trigger CD40106BC]

One of the most useful devices, which is performing signal conditioning operation, is Schmitt trigger. The output of sensors are given to it, which converts analogue output of sensors to digital signal as required by microcontroller for further processing.

2.3 Audio amplifier & PA system:

An audio amplifier is used to amplify the signal generated by the microcontroller and match the speaker for maximum power transfer.PA system is any sound reinforcement system. It is an electronic amplification system used as a communication media in public areas. IC BEL 1895 This is an 8- pin, 1W audio amplifier IC generally used in radio circuits. No driver circuit for loudspeaker is needed with the facilities of wide range of supply voltage (V_{SS}) 3V to 10 V. This IC is wired in noninverting amplifier configuration.The o/p is available from pin 2 of BEL 1895.

2.4 GSM Modem

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone.

The GSM modem used is SIM 300C, which is controlled by microcontroller through AT-command

The layout picture of SIM 300C modem can be seen in Figure

GSM modem receives and sends messages from mobile device by using radio waves. Microcontroller and GSM modem interface are using AT commands for sending and receiving message.

AT commands are a special set of commands that are recognized by many GSM modems available in market. The SIM 300C modem works in 3.5- 4.5 voltage. In this design, the microcontroller communicates serially with the SIM 300C modem to read and send short message. The most important parts of data communication in SIM 300C are DTR (Data Terminal Ready), RXD/TXD (Receive/transmit data), RTS (Request to send), CTS (Clear to send), RI (Ring Indicator), and DCD (Data carrier detection).

Two ways to interface, microcontroller with GSM modem:

- Connect the SIM300 UART lines directly to microcontroller, as modem & microcontroller are placed nearby. Even though the SIM300 specifications say that its maximum operating voltage is 4.5V, SIM300 UART lines work with microcontrollers operating at 5V. You can connect your SIM300 GSM modem TX and RX lines directly to 5V microcontrollers TX and RX lines.
- To play safe, use two MAX232 RS232 line drivers. The first MAX232 to convert from GSM voltage levels to RS232 voltage levels. Second MAX232 to convert from RS232 voltage levels back to microcontroller voltage levels.

2.5 Voice recording Playback device (APR9600)

It is Single-chip, high-quality voice recording & playback IC The device supports both random and sequential access of multiple messages. This device is ideal for use in portable voice recorders, toys, and many other consumer and industrial applications.

Functional Description of Recording in Random Access Mode

On power up, the device is ready to record or play back, in any of the enabled message segments. To record, /CE must be set low to enable the device and /RE must be set low to enable recording. You initiate recording by applying a low level on the message trigger pin that represents the message segment you intend to use.

The message trigger pins are labelled/M1_Message - /M8_Option on pins 1-9 (excluding pin 7) for message segments 1-8 respectively.

When actual recording begins the device responds with a single beep (if the BE pin is high to enable the beep

tone) at the speaker outputs to indicate that it has started recording. Recording continues as long as the message pin stays low. The rising edge of the same message trigger pin during record stops the recording operation (indicated with a single beep). If the message trigger pin is held low beyond the end of the maximum allocated duration, recording stops automatically (indicated with two beeps), regardless of the state of the message trigger pin.

Functional Description of Playback in Random Access Mode

On power up, the device is ready to record or playback, in any of the enabled message segments. To playback, /CE must be set low to enable the device and /RE must be set high to disable recording & enable playback You initiate playback by applying a high to low edge on the message trigger pin that representing the message segment you intend to playback. Playback will continue until the end of the message is reached. If a high to low edge occurs on the same message trigger pin during playback, playback of the current message stops immediately. If a message trigger pin is held low, the selected message is played back repeatedly as long as the trigger pin stays low.

3.CircuitDiscussionAndResult:
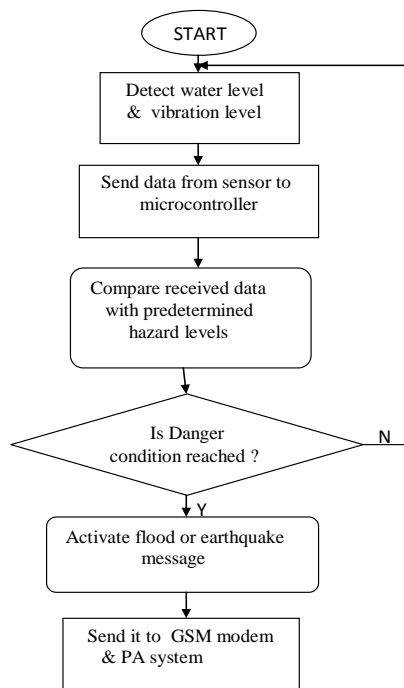
. **Fig.3. Generalized Flow Chart of the system**

The flowchart given in Fig.3 explains the communication between sensors, microcontroller & GSM modem for sending the alert message.

The microcontroller as the brain of the overall system , processes the data received from the sensors according to the predetermined levels & route it to the GSM modem in the form of pre-recorded voice message (VMS).

The height of the water level sensors varies depending on the water level that is expected during normal and abnormal periods, and based on this alert levels are decided.

For instance, if the high-point for the river is considered to be 10 meters, then following levels will be set:

- Up to 2.0 m – low level
- Between 2.0 – 6.0 m– medium level
- Between 6.5 – 7.5 m–high level or danger level

Sensors are installed at each level, and when the water level touches the sensor, automatic updates are sent to the Microcontroller.

APR9600 is a voice recorder and player IC configured in random access mode, in which any

Warning in the form of human voice is recorded and then according to the status of system it is used to alert the concern authority.

All message trigger pins M1 to M8 of APR9600 are active low and are connected to port $P_{0.0}$ to $P_{0.7}$ of 89c51. At pin M1 flood alert message is recorded. & earthquake alert message is recorded at pin M2. Microcontroller is programmed such that when sensor detects high water level then it sends logic 0 to M1 pin of APR9600. Now message M1 will be activated. When earthquake is sensed message M2 will be activated.

Output of piezo-buzzer is given to comparator IC which compares the output voltage of piezo-buzzer with some predetermined value of vibration level. When vibrations at piezo exceed this value, the comparator gives high output voltage to microcontroller. Now microcontroller will activate M2 pin of APR9600 Thus immediately flood alert or earthquake alert message will be send to GSM modem and PA system simultaneously An audio amplifier is used to amplify the signal generated by microcontroller and match the speaker.

The Public Address (PA) system is installed near the disaster alert system at the river side.

It is used to broadcast the alert message to the nearby local people.

SMS Format to register mobile no. into the system to get the alert messages:

Message: MOB <space> 1 <space> Mobile Number.

To: system's modem number

Send this SMS on SIM of GSM modem of the system. This disaster alert system is also designed so that it can transmit water level in case one wants to know the status of water level.

Snap shots below show the status on display unit of system indicating flood and earthquake.
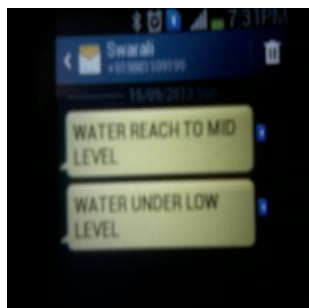

Fig.4 System display indicating flood

Fig.5 System display indicating earthquake

The module can also send status of water elevation to anyone knowing the system's modem number.
The Text sms received can be seen in the figure below.

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Fig.6 Text SMS received

4. Limitations:

1. This system will not work for Tsunami.
2. Congestion problem of GSM network in any emergency situation is the major weakness of the system. But public address (PA) system works well & gives alert to the local people nearby riverside.
3. The system does not include any seismic network
4. It does not include any false alert debugging

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