To design an Architectural Model for Flood Monitoring using Wireless Sensor Network System

[1]Saurabh Shukla [2]Dr.G. N. Pandey

[1]*RGIPT, Rae-Bareli, India,*
[2]*Arunachal University of Studies, Namsai, Arunachal Pradesh, India,*
[2]*IIIT, Allahabad, India*

Abstract- One of the major disasters occurring in the world is flooding. To monitor the water conditions such as water level, flow and precipitation level, wireless sensor network system architecture for real time monitoring has been developed and presented in this paper
The objective of this system is to send real time information of flooding to the regulatory and welfare authorities so that suitable action could be taken. This system architecture is composed of sensor network, processing/transmission unit and a server. This wireless sensor network system could remotely monitor the real time data of water condition in the identified areas. For wireless sensor networks, the systems are wireless, have scarce power, are real-time, utilize sensors and actuators as interfaces, have dynamically changing sets of resources, aggregate behaviour is important and location is critical. In this system a communication is done between the server and remotely placed sensors. The server gives the real time water conditions to the welfare authorities.

Keywords- Sensor, Wireless sensor network, flood, flow and flow level.

I. INTRODUCTION

Now a day's flood has become a major problem in across the world, for example coastal areas across the world especially in Indian subcontinent of the areas in Indonesia, Malaysia, Singapore, Thailand, USA, UK especially Ice Land etc through satellite images we can able to forecast rainfall or track storm actions. To perform flood prevention it is necessary to make an instant and real time decision on the required water conditions. Flooding affects the vegetation especially adjoining areas. Damage to livelihood and infrastructure occurs every year in India. This affects economic development and local agricultural production.
The major causes of flooding are reduction in forest area extensive cutting of trees, extensive area reduction and unusual heavy rainfall with no proper drainage and reserve system to utilize that rainfall water. Due to reduction in forest areas the flood travel more rapidly and quickly to produce higher damage and risks with in a small time in populated areas. [20] Insufficient drainage heavy rainfall, the flood has cause deaths and large estimated loss of vegetation and population. Due to this flood management is a crucial challenge. This system need to provide accurate, real-time, timely filled related information to respond the flood event. Losses done by flooding can be reduced by real-time monitoring of sensors, forecasting, simulation and analysis.To

issue a real-time warning and information's in the prediction of flood occurrence an efficient flood warning system is needed which can automate the system for data acquisition, along with the analysis of the key data i.e., water level, water flow and precipitation.. Real-time accurate data collection is essential for this use, and sensor networks improve the system capabilities. Since these days flood has become the most destructive disasters in the world, causing tremendous structural, economical, Environmental and human losses. Floods are generally accompanied with natural phenomenon such as tides, typhoons and excessive rains, ice melts, tsunamis. They account about 30% of the world's disaster each year. Floods could harm any type of structures, and their frequency is increasing day by day. Much of this increment in disaster made by flood is due to deforestation, and climate changes caused by the global warming. Due to imbalance growth and development required to meet the requirement of ever-growing population. This is likely to cross nine billion by 2050.
The primary ill impact of floods is physical damage of city facilities such as dams, roadways, railway tracks, sewage systems and electricity. It adversely affects the transport including the roadways and railways. The movements of cars, buses and trains are also affected by this. Floods could give rise to various diseases like malaria, cholera as it affects on sewage system which may cause sewage system to back up into the homes, contaminated drinking water .This may also lead to interrupted water supply. The objective of this system is to send real time information of flooding to the regulatory and welfare authorities so that suitable action could be taken. This wireless sensor network system could remotely monitor the real time data of water condition in the identified areas. The objective of this system is to send real time information of flooding such as flood flow; flood level and precipitation level to the regulatory and welfare authorities so that suitable action could be taken.

II RELATEDWORK

Monitoring; controlling, relieving, and assessing natural disasters, especially flood disaster Integrated use of wireless sensors and web based applications has played an important role (Zhang, 2002; Sapphaisal, 2007).
Under various considerations flooding has been studied such as wireless sensors network (Chang,2006;Hughes,

2 0 0 6 ;DeRoure,2005), embedded system with middleware (Hughes,2006;Chen,1990), A real-time internet based having a data acquisition system (Chang,2002), forecasting and modelling flood warnings (Creutin,2003;Sapphaisal,2007;Zhang,2002). For accuracy improvement other than this space and satellite data technologies have been used (Manusthiparom, 2005; Veijonen, 2006; Louhisuo, 2004). An adhoc wireless sensor network which is widely used (Chang, 2006; Hughes, 2006; DeRoure, 2005). Chang (Chang, 2006) has used the tiny wireless sensor station, called MICA for flood monitoring (Crossbow Technology, 2007).It consumes 54mW during its active state and with small batteries long periods of operation is allowed and it has a CPU with a low-speed. Previous research works (Hughes, 2006; DeRoure, 2005) have employed network which is grid based in their studies and reserach. Another important example of using the grid-based wireless sensor network technology has been presented in(Rodden, 2005). The schemes which were proposed by Hughes *etal.* (Hughes, 2006) could be performed by remote sensors; therefore, the local processing power could be employed to provide flood-related computations.

III CASE SUDY

One of the worst flood-affected countries in the world is India. It accounts for one fifth of global death count due to floods. The south west monsoon period is the peak time for flooding .This season starts from June to September. As per National Flood Commission about 40 million hectares of land is flood prone. About 18.6 million hectare of land area annually affected due to flood and about 3.7 million hectare of crop area is affected. The Brahmaputra, Ganga and Meghana River basins in the Indo-Gangetic-Brahmaputra plains in North and Northeast India, are the most flood-prone areas in India. Which carry 60 per cent of the nation's total river. [23] By providing space as well as aerial remote sensing based services and products, ISRO is playing a vital role in supporting the flood management activities being assessed. For the past one decade operationally using satellite data from Indian Remote Sensing Satellite (IRS) System and from foreign satellites, the impact of floods in the country is accessed. [24]

Figure 1 shows the flood prone areas of India. The marked green color shows the states of India which are affected by floods.

A peninsular country like India, surrounded by the Arabian Sea, Indian Ocean and the Bay of Bengal, is quite prone to flood. As per the Geological Survey of India (GSI), the major flood prone areas of India cover almost 12.5% area of the country. Every year, flood, which is now become the most common disaster in India causes immense loss to the country's property and lives. West Bengal, Orissa, Andhra Pradesh, Kerala, Assam, Bihar, Gujarat, Uttar Pradesh, Haryana and Punjab are the states falling within the periphery of "India Flood Prone Areas". The heavy and intense monsoon rains from southwest causes rivers like

Brahmaputra, Ganga, Yamuna etc. to swell their banks, which in turn floods the adjacent areas. [23]

Figure 1: India Flood Prone Areas [23]

IV SYSTEM OVERVIEW

We have first define the system architecture then followed by discussion of the sensor implementation network. After this data transmitting and processing unit implementation is done along with database and application server.

A. System Architecture

Under this section we have described our proposed flood monitoring system that uses sensors which are remotely placed.
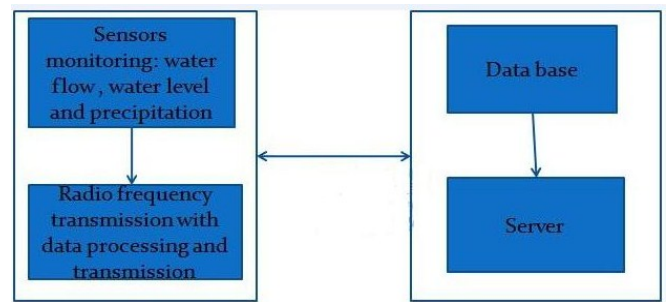

Figure2: High level system architecture

To support the data acquisition in a real time environment, system consists of four major modules. The first module consists of sensors for measuring water level, water flow and precipitation. The module second is used for transmitting and

processing of data of which is located on remote sites. Sensors forms a cluster to send the required data to the cluster head and after this the cluster head send the data to the routers and then routers send the data to the server. This is our third and fourth module. The third module run as a data base which stores the data then the data is compared to the values of comparator and after this data is accessed by the application server which gives the required and current water conditions to the expert authorities after processing it.
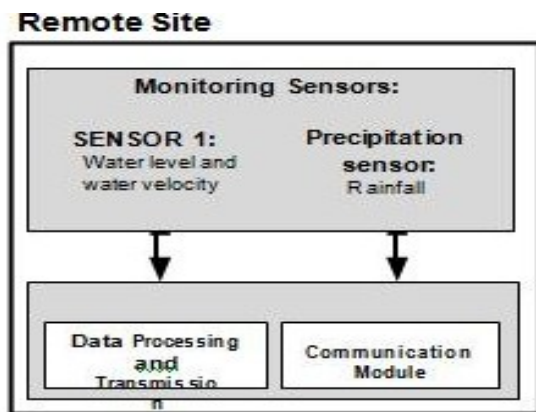

Figure 3: Sensor communication architecture [20]

B.   Monitoring Sensor
This sensor will measure the flow of water and also measures the water level. The Starflow Liquid Crystal Display (LCD) Module interfaces with the Model 6526 Starflow Ultrasonic Doppler Instrument. It displays the values obtained from the most recent scan. The Starflow's scheme defines which parameters will be displayed. For example, one of the supplied schemes displays water temperature, battery supply voltage, total flow and logging status.

Figure 4: The Starflow Liquid Crystal Display (LCD) Module [12]

1)   Hardware components [12]
Dimensions (HxW): 115mm x 105mm.
Display Format: 4 lines x 16 characters.
LCD Type: Supertwist (STN), yellow-green. no backlight.
*Optimum Viewing***:** 6 o'clock.
Power Supply: 8 to 18 VDC @ 20mA.
Operating Temp: 0° to 50°C (32° to 122°F).
Storage Temp: -10° to 60°C (14° to 140°F).
Connectors: Type II Connectors SQL 7 pin connectors (pass through – 1 x male, 1 x female).
Serial Signal: HSIO Standard Synchronous Protocol – RS232 also available.
*Serial Protocol***:** ASCII text with special commands for formatting.[12]

2)   Jumper settings and power consumption
There are two jumper settings on the PCB, one selection is ON and the other selection is OFF.
ON (Active Mode): This jumper setting allows the LCD to be ON all the time without being turned off, the power consumption in this state is around 3.5mAcontinuous. [12]
OFF (Sleep Mode): This jumper setting allows the LCD to be switched OFF after 10 mins which has a power consumption of about 60micro Ampere and 3.5 Ma when ON
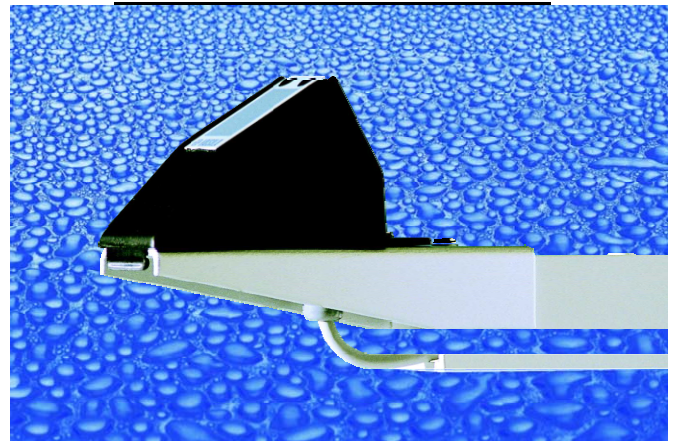
DRD11A RAIN DETECTOR SENSOR

Figure 5: DRD11A RAIN DETECTOR SENSOR [5]

Rain and snow are quickly and accurately detected withtheDRD11ARainDetector.The DRD11Aoperates via droplet detection rather than by signal level threshold.
Properties:
  Fast and accurate precipitation detection (ON/OFF)
- Rain intensity measurement with processing unit
- Maintenance free
- Heating element for keeping sensor free of snow and condensed moisture, and for quick drying [5]

A special delay circuitry allows about two-minute interval between raindrops before assuming an OFF (no rain)

position. This enables the sensor to accurately distinguish between rain cessation and light rain.

TheDRD11A also features an analog Rain Signal for estimating rain intensity. Since this signal is proportional to the percentage of moist or wet area on the sensor plate, rain intensity has a direct impact on the amplitude and variation of this analog signal.[5]

Hardware Component

1) Sensitivity of Rain detection

Minimum wet area: 0.05 cm²

OFF-delay (active) <5min [5]

2) Physical

Sensor plate: 7.2cm^2

Sensing area Angle: 30 degree [5]

3) Electrical

Supply voltage: 12 VDC   10 %

Supply current

   Typical less than: 150mA

   Maximum: 260mA

   Heater OFF: 25Ma [5]

Output

Rain ON/OFF

Open collector, active low signal corresponds to rain.

Maximum voltage: 15V

Maximum current: 50mA

Analog output: 1...3V (wet...dry)

Frequency output: 1500...6000Hz,

Non-calibrated [5]

4) Input

Control to switch heater OFF

Open circuit input enables the heater. Connection to GND disables the heater.

Contactratingmin.15V, 2mA [5]

5) Temperature Range

Operation: -15...+55 C (+5...+131 F)

Storage: -40...+65 C (-40...+149 F) [5]

C. Data Transmission and Processing along with data transfer to application server

The goal of the flood monitoring system is to maintain a reliable communication between the sensors so that real-time information can be accessed. This algorithm has three phase first phase is cluster localization phase, second phase is cluster optimization phase and third phase is cluster transformation phase. Here time synchronization is important for routing and power conservation In this network sensors form a clusters and having a radio frequency wave communication after this they form a cluster network architecture having inter cluster and intra cluster communication. Here in a cluster each node sends its data to the cluster head in aggregated form by the use of directed diffusion algorithm. The sensor communicates among them by the use of sensor network query processing algorithm. After this cluster head transfers its data to the routers and routers after processing, sends the data through gateways to the application server. Here the sensor can be in

sleep mode in round robin fashion. In this algorithm network services includes data compression and data aggregation. Since it is a real time system so we will follow Trace-Driven simulation which is also low in cost and the simulation tool will be OMNET++ which operate on Tiny OS and support MAC which help in energy conservation.
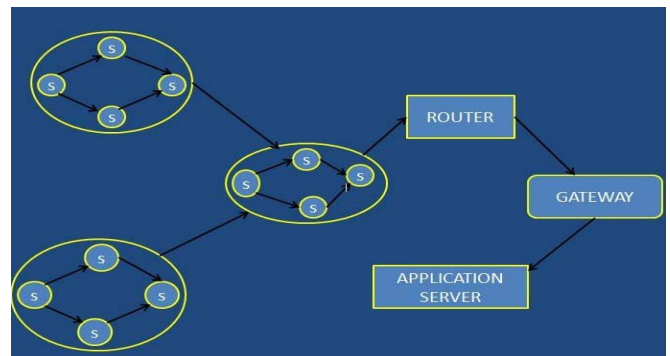

Figure 6: Application of wireless sensor network system in a flood management

Here the role of the sensor is to measure and monitor the data with reliable flow and connectivity among sensors. This technology is cluster based. In the above figure sensors displayed in small circles are called as ordinary bottom nodes and the ones in large circle are cluster heads. Here data fusion and data packet transmission is done. Data information can be transmitted to routers by wireless communication. When receiving data, routers establish a local database and then transmit the data to the application server. This application server provides the information to the welfare authorities this information include the real time data of water which include water level, water flow and precipitation level i.e. the intensity of water. Upon receiving this information the welfare authorities could take suitable action for the flood prevention.
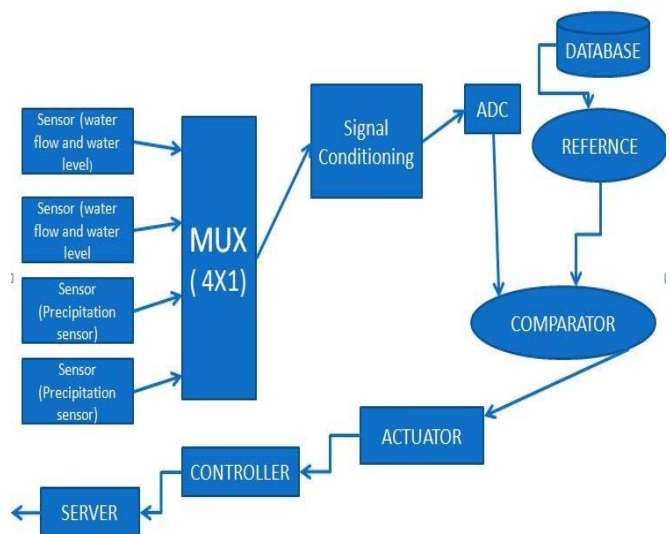

Figure 7: Wireless Sensor Network System Architecture for Flood Monitoring

V. CONCLUSION AND FUTURE PERSPECTIVE

In the beginning data for 1 to 2 yrs especially for water flow, water level and precipitation be considered and based on that data the entire area will be divided into three zones, green where there is no possibility of flood, Red- where there is every possibility of flood to estimated area, the intensity of a wireless sensor will be intensifier and based on the annual data for water flow, water level and precipitation, the area prone to flood will be narrowed down and where vey specific arrangement with regard to number of sensors or frequency to keep the sensors in active mode will be decided. The rest of the area will be yellow where sensors will be laid on the basis of data for water flow, water level and precipitation. Over a period of time, warehouse of data for water flow, water level and precipitation prevailing in the area prone to flood will be developed. In the beginning all the data available will be place in the ware house, as per as possible in public domain and where such data are considered sensitive, such data could be placed in the ware house specially developed for this purpose, this flood prone area could also be divided into Green, Red depending upon climate zone in which the area is located.

The average distance between sensors should be of about 200 to 330m. Linking of sensors is through wireless communication module which is responsible for communication with other nodes and exchanging control information and receiving or transmitting data. The power module supplies power for the other three modules and drives the nodes, making it the key factor for the effective operation of the network.

1) Green State: This is the lowest risk level for a possible flood danger. In this initial level, the sensor node sensing periods are longer compared to other levels.

2) Yellow State: This is the medium risk level. This state may have transitions to either Green or Red state.

3) Red State: This is the highest risk level. The algorithm can initiate a flood alarm only on this state.

For future use we can have two to three more main computer servers so that if one of main computer server fails to collect the information then other main computer server can collect the required information.

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AUTHORS

Saurabh Shukla , was born in Bulandshahr, India on 14 June 1985 . He has done his M.Tech from Indian Institute of Information Technology, Allahabad, India in 2010 and completed his B.Tech from U.P.T.U; Lucknow, India in 2008.He has an experience of 3 yrs working as an Instructor in Computer Science Department of Rajiv Gandhi Institute of Petroleum Technology, Rae Bareli, India. One of his paper entitled "Deployment of Wireless Sensor Actuator Network System to Monitor Off-Shore Deep Sea Oil Well" has published in International Journal of Computer Science Applications and Information Technologies (IJCSAIT) on September, 2013 under AR Publications. His second Paper entitled "To Design an Architectural Model for Deploying Wireless Sensor Network to Prevent Forest Fire" has been published in International Conference of Computer Science and Software Engineering(ICCSSE) organized by World Academy of Science Engineering and Technology(WASET) In MELBOURNE, Australia on 16-17December, 2013.

Prof.GN.Pandey has done his Ph.D. in 1966 from Banaras Hindu University, Varanasi, India   . He has done his Post –doctoral Research from University of Michigan, USA and completed his M.Tech in Chemical Engineering in 1963 from Indian Institute of Technology, kharagpur, India.He has done his B.Sc in Chemical Engineering in 1962 from Banaras Hindu University, Varanasi, India.
He has been awarded with "Distinguished Service Award", "Distinguished Alumnus Award" and with Rastriya Gaurav Award. He has supervised 27 research schemes, guided about 27 Ph.Ds written about 14 books, and published 225 research and technical papers. Currently he is working as a Vice-Chancellor of Arunachal University of Studies, Namsai, Arunachal Pradesh, India. He is also the Visiting Professor of Indian Institute of Information Technology, Allahabad, India.