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Integrated Weather & Flood Alerting System

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Abstract: Recent flooding of river Jhelum in Kashmir caused large scale devastation in the Kashmir valley. Also, cloud burst over Leh in Jammu &Kashmir two years ago, and at Kedarnath temple vicinity in Uttarkhand a year ago caused significant loss of life and property. In addition, a number of tourists were swept away due to opening of a dam's flood gates in Himachal Pradesh a few months ago. In this paper, we present an innovative solution to the frequent flooding problem faced in our country year after year. Named 'Integrated Weather and Flood Alerting System', the system is automated flood detection and early warning system designed using Internet of Things technologies. The system uses a novel approach and low-cost sensing devices to measure and analyze multiple weather and river parameters, namely, rainfall in the river basin / catchment area, water flow in the river, and water level at various locations along the river length to accurately predict flooding of the river in real-time. Timely flood alerts are then disseminated simultaneously and in real-time to nearby population, and the general public through multiple delivery mechanisms such as: 1) Audible alerts (using Hooters near human settlements on the river bank), Visual alerts (using flash lights deployed near the river banks), 3) text-based SMS alerts to all public in the vicinity of the river, 4) graphical, map based alerts on a Web-based dashboard for general public to view flood situation in the river, and 5) live alerts on online social media sites such as Facebook and Twitter for the public. The system consists of self-contained sensing and alerting units that can work autonomously when deployed at a river site, in addition to working in a networked environment. The system offers a low-cost alternative to traditional flood alerting mechanisms in use today.

Keywords: Raspberry Pi, IWFAS Field Unit, Twitter, Facebook, Short Message System, Database.

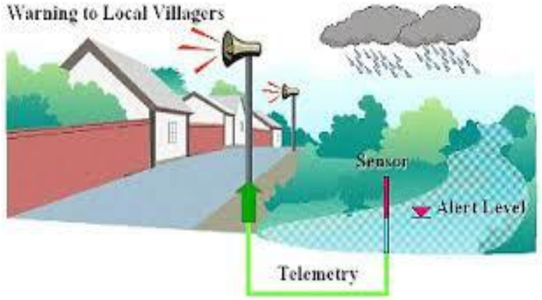
I. OVERVIEW / PROBLEM

Every year number of deaths due to flooding keeps increasing in different part of our country because of same reason i.e heavy rainfall, opening/failure of dam gate, and glacier melt/cloud burst. All the reasons for the flooding can be detected earlier and the corresponding action is possible for both the government and public. Unlike, other natural disaster flooding can be detected as well as predicted much earlier. Flash floods have impacted most of the states in our country. Whenever, flooding happens living area near the riverbank and downstream area are affected severely than others. They need to be alerted much earlier to have extra time to evacuate immediately. And the number of tourists swept away due to opening of dam gate. Hence, the tourists places and tourists should also be alerted regurlary. Government has huge revenue loss every year whenever the flooding occurs because they are not ready for the war.

India	Year	Death roll	Cause
[illegible]	[illegible]	[illegible]	[illegible]

In India, Recent flooding of river Jhelum in Kashmir caused large scale devastation in the Kashmir valley. Cloud burst over Leh in J&K two years ago, and at Kedarnath temple vicinity in Uttarkhand a year ago caused significant loss of life and property . A number of tourists were swept away due to opening of a Dam's crest gates in Himachal Pradesh a few months ago. We do not have a mechanism to detect flooding of rivers today. Our response to floods is reactive, not proactive. Even before the floods, the local weather condition gives early indications, but we fail to notice them and take action. Every time there are floods, we have large number of deaths and destruction of property. Flooding also results in huge financial burden on the state's exchequer in rescuing and providing relief to affected people.

II. SOLUTION



There is a need for an **Integrated Weather and Flood Alerting System** (IWFAS) that can be deployed at various points along a river's course. The system should provide early information about the following:

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1)Local weather condition around key stretches of a river on a frequent basis.
2)Warning / alert to people at various points along the river's stretch about impending flood threat.

Flood Detection Parameters

The IWFAS project uses three sensors to measure river related parameters.

1. Rainfall Level over the river
2. Water Flow (speed of water in the river)
3. Water Level in the river

Water Level sensor has 3 levels i.e Level1, Level2 and Level3. Rainfall is obtained by calculating the amount of rainfall for the last 24 hours. Water flow sensor is immersed on the water and based on the threshold values again three different water flow speed levels are determined.

Flood Detection Algorithm

The IWFAS software implements an algorithm that predicts flooding of river as follows:
Given a rain fall level, water flow level and water level, the software predicts the **Flood warning** to be issued at a given Field Unit in the river.
For e.g.,
If **RainFallLevel="High"** AND **WaterFlowLevel="High"** AND **WaterLevel="High"**, Then
FloodWarning="Critical"

RainFallLevel	WaterFlowLevel	WaterLevel	FloodWarning
High	High	High	Critical
High	High	Low	Low
High	High	Medium	High
High	Low	High	High
High	Low	Low	None
High	Low	Medium	Moderate
High	Medium	High	Critical
High	Medium	Low	Moderate
High	Medium	Medium	High
Low	High	High	Critical
Low	High	Low	Low
Low	High	Medium	Moderate
Low	Low	High	Low
Low	Low	Low	None
Low	Low	Medium	None
Low	Medium	High	Moderate
Low	Medium	Low	Low
Low	Medium	Medium	Low
Medium	High	High	Critical
Medium	High	Low	Low
Medium	High	Medium	High
Medium	Low	High	Moderate
Medium	Low	Low	None
Medium	Low	Medium	Low
Medium	Medium	High	High

As can be seen, three parameters, RainFallLevel, WaterFlowLevel and WaterLevel are used to determine the FloodWarning to be issued to people at a given FieldUnit.
As you can see, rainfall, water flow and water levels can have three values "low", "medium" or "high". Three parameters can result in 27 combinations, and giving rise to 5 flood warning levels.

Flood Dissemination Methods

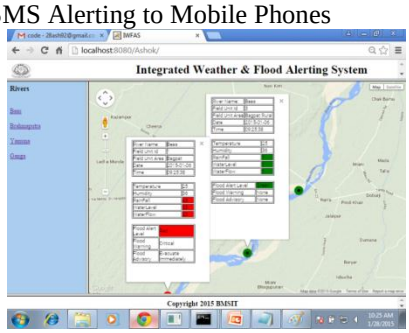
Alering people is done through various mechanism such as:

Local Alerting near the River:

- Audible Alerting (through Hooter)
- Visual Alerting (through Strobe Light)

Remote Alerting:

- Web based Alerting through Internet
- SMS Alerting to Mobile Phones



Alerting through Social Media Sites:

- Alerting through Facebook posts
- Alerting through Twitter tweets

Solution Features

IWFAS field unit has the following features:

- It has Raspberry Pi which has the processing speed of 700 Mhz.
- For the local people living along the river bank Hooter is deployed to indicate the flood.
- Strobe Light also deployed at the river bank for alerting local people locally.
- It has GSM modem to send sms to the mobile number once the flood is detected.
- It consists of temperature and humidity sensor which provides additional information with flood alert.
- Remote alerting such as facebook, twitter and web interface makes information to reach everyone in quick time.

Solution Benefits

- Local people, who live and work near the river bed can make use of the weather and flooding advisory to move to safer and higher places before it is too late.
- Tourists, can, for example use the weather and flooding advisory to plan their visit to the river suitably.
- Fishermen, for example can use the weather and flooding advisory to plan their fishing forays into the river suitably.
- People engaged in water sports such as river rafting, canoeing, etc. can use the information to get out of the water before the flood engulfs them.

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- In case of flooding, the state's disaster management teams can use real-time weather and flooding information from IWFAS to identify the affected areas quickly, evacuate people, minimizing casualties, and also to provide relief and supplies to displaced and evacuated people.

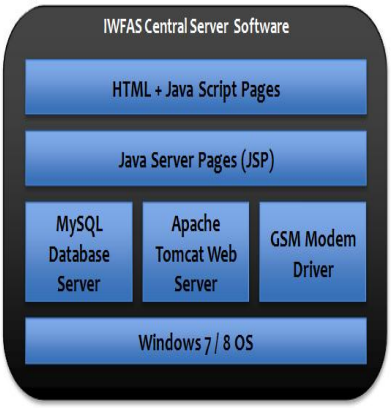
III. IMPLEMENTATION DETAILS

∗ The IWFAS field-units continually monitors temperature, humidity level, rain-fall, water level in the river near it's geography on real-time basis, and relays it to the IWFAS Central Server every 15 minutes. This information is also time-stamped and GPS-location stamped.

∗ The IWFAS Central Server gathers the real-time data from multiple field-units and publishes the same on a Google Map. It also stores the data for offline processing and reporting and analytics.

∗ A public user can visit the IWFAS web-site and check-out real-time weather and flooding information and advisories at different points along the river's course.

∗ Users in the vicinity of the river also receive flood warnings / alerts in real-time basis on their mobile phones.



The field-units also provides warnings / alerts in real-time through hooters, strobe lights and display units to people near to the river.

IV. DEPLOYMENT SCENARIO

IWFAS Field Units will be deployed near heavily populated areas and tourist centers near the river bank. Water level indicators connected to the IWFAS Field Units will be deployed at different altitudes from the river bank to measure increase in water levels and trigger flood alerts.

Weather sensors connected to the IWFAS Field Units will measure temperature, humidity and rain fall in the vicinity. The distance between river bank and IWFAS Field Unit will be based on the width of the river i.e if the river width is narrower then there is a high probability of water coming out of the river hence the Field Unit will be placed farther from the river.

The entire unit can be powered using solar. Other backup option for the powering the Field Unit is long storage battery.

Lessons Learnt

- For the Concept prototype system sophisticated modelling of the river terrain and basin is required to predict flood threats accurately.
- It requires multiple parameters to be taken into account. In the concept prototype system, a simplified approach using only 3 parameters, namely: water level, water flow and rain fall level near the river will be used for predicting flood threat.
- Further enhancements of the solution is required to improve the accuracy of flood prediction through use of sophisticated modelling tools, and additional parameters.

Future Extensions

Flood alerts can be delivered to the public through social networking sites such as Twitter and Facebook. Solar panels and batteries can be used to provide power to each IWFAS field-unit so that it can operate independently of the central power grid

Surveillance cameras can be integrated with the field-units deployed near the river bed to monitor:

1. Illegal sand mafia who make away with tonnes of sand from the river bed, causing erosion of the river bed and the river to flood the adjoining areas in monsoons
2. Illegal deforestation of the river bed by cutting down trees, which again causes erosion of the river bed

Pollution sensors can be integrated with the field-units deployed near the river bed to monitor pollution level of the water (especially in rivers such as Ganga). Upon received a flood threat, an unmanned aerial vehicle (UAV), or Drone can be made to fly over the river course. The UAV/Drone can capture live video footage of the water level in the river and relay it to the nearest IWFAS Field unit for onward transmission to the IWFAS Central Server. In addition, the UAV/Drone can also take local decisions and active the Field unit's Hooter, Strobe Light and LCD Display Unit if there is a flood threat.

V. CONCLUSION

Integrated Weather and Flood Alerting system predicts flood considering three parameters which increases the effieciency compared to the existing system. Also, provides various means of communication such as Audible alerting, Visual alerting for the local people near the river, Web based alerting through internet , SMS alert to mobile phones, Facebook alert, Twitter alert. The autonomous system that makes use of raspberry pi which process the data with the processing speed of 700 Mhz, enough for the computation of flood in realtime.

Flood alert system forecasts are extremely effective in reducing flood damage. Advanced warnings for floods can mean the difference between life and death and in reducing property losses. As little as one hour of lead-time can result in up to a 10-percent reduction on flood damages. Flood forecasting has proven to be a vital link in providing economic benefits to a Nation and must continue to improve[1].

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