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<https://doi.org/10.5194/egusphere-egu2020-21079>

PUBLISHER

EGU General Assembly 2020

VERSION

VoR (Version of Record)

PUBLISHER STATEMENT

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LICENCE

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REPOSITORY RECORD

Khouakhi, Abdou, Ian Pattison, Jesús López-de la Cruz, Oliver Mendoza-Cano, Robert Edwards, Raul Aquino, Paul Lepper, et al.. 2020. "An Internet of Things System for Urban Flood Monitoring and Short-term Flood Forecasting in Colima, Mexico". Loughborough University. <https://hdl.handle.net/2134/12685403.v1>.

An internet of things system for urban flood monitoring and short-term flood forecasting in Colima, Mexico

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Urban flooding is one of the major issues in many parts of the world and its management is often challenging. Here we present an Internet of Things (IoT) approach for monitoring urban flooding in the City of Colima, Mexico. A network of water level and weather sensors have been developed along with a web-based data platform integrated with IoT techniques to retrieve data using 3G/4G and Wi-Fi networks. The developed architecture uses the Message Queuing Telemetry Transport protocol to send real-time data packages from fixed nodes to a server that stores retrieved data in a non-relational database. Data can be accessed and displayed through different queries and graphical representations, allowing future use in flood analysis and prediction. Additionally, machine learning algorithms are integrated into the system for short-range water level predictions at different nodes of the network.

Network design

Field survey

Multiple Processes considered: e.g. tributary interactions, nested network, network density)

Several field campaigns were conducted across the catchments to:

- Define suitable sites
- Determine the optimal sites for flood monitoring and prediction
- Reliably collect and use water data before, during and after floods
- Assess the security of the data loggers/base stations
- Measure the strength of the 3G/4G signal at each site.

Working with local/water authorities

Weather stations and water level nodes

14 locations/nodes have been defined with 8 water level and soil moisture sites and 6 weather stations). Locations of weather stations are placed at different campuses of the University, public buildings and private houses (where rain sensor will be exposed, safe, and easy to maintain).

Network components

Weather station node

The WS node retrieves information from the the Atmos 41 which includes 12 weather sensors. It is a 3-wire interface following the SDI-12 protocol for communicating sensor measurements

Architecture

Water level node (RiverCore)

Uses the non-contact ultrasonic sensor. The RiverCore node composed of:

- 32 bits microcontroller unit
- 3G cellular modem electronic board
- Xbee (802.15.4) or LoRa radio
- Shield/daughter board
- RS-485 transceiver
- Regulated power supply
- Solar charge controller
- 12v 80Ah battery

RiverCore components

Drifters

In addition to the static nodes, we have developed drifters equipped with a set of sensors and a GPS unit able to collect information as it floats down the river system (i.e. water velocity and water temperature). Collected information can be passed to the static node or to a remote server via a mobile network

RiverDrone

Drone technology is also used to help localize drifters as they float down the river. RiverDrone is composed of:

- Microcontroller unit
- 3G cellular modem
- Xbee 802.15.4 or LoRa
- LiPo battery

Visualization

A web platform is developed to display the water level, soil moisture and weather conditions in real time.

3G

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3G

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NodeJS modules

socket.io

Machine learning pipeline

A set of machine learning algorithms are being implemented for short range water level prediction at specific locations using real time data collected, historical and other secondary data.