Designing a rainwater monitoring system to combat water scarcity in the slums of Mexico City

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Section 2

Majority of Mexico City populace lack access to clean water

Over 20 million residents of Mexico City have some form of trouble accessing clean drinking water. Mexico City has depleted underground aquifers which cannot be replenished at the same rate as consumption. The Mexican government has tried to alleviate the problem by trucking water into neighborhoods.This solution is not scalable and cost ineffective.

Figure 1: Mexico City's Initiative to Truck Water From Nearby Lakes Source: https://penniur.upenn.edu/uploads/media/02_Gutierrez.pdf.

Creating a Novel System to Measure Precipitation

Our goal is to create a rainwater monitoring system consisting of different nodes, where each node is responsible for measuring the precipitation data for a given area. We have developed 3 node prototypes, with one additional central gateway prototype where data is centralized and stored.

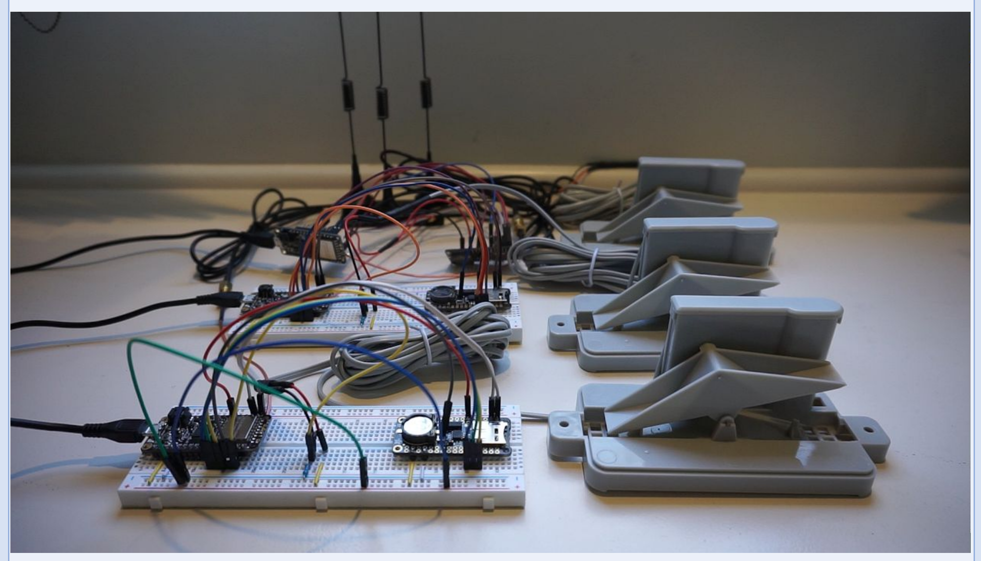

Figure 1: All 3 Assembled Data Collection Nodes

High accuracy, long range

Using the cottonCandy library and LoRa technology, we are able to transmit data across different nodes at a transmission radius up to 10 kilometres. In conjunction with an accurate tipping bucket rain gauge capable of measuring to the nearest 0.3mm, we have created a high accuracy, long range system.

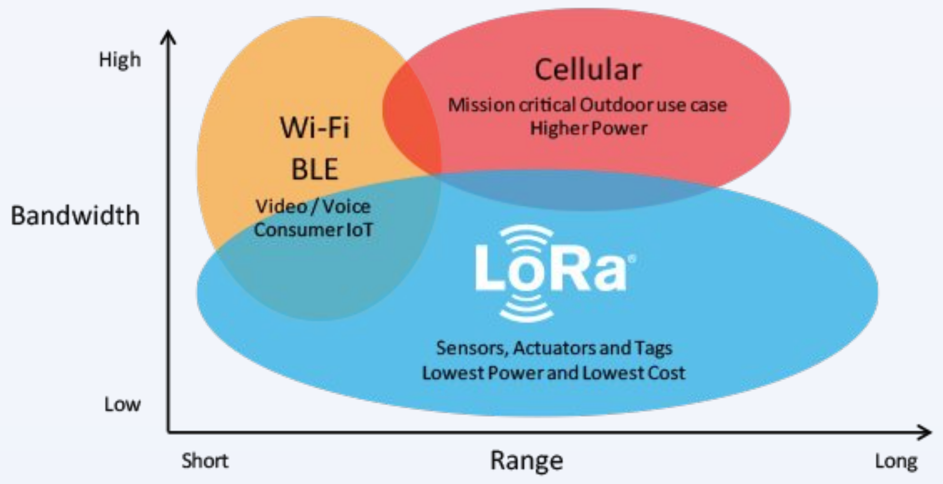

Figure 2: LoRa Performance versus other communication methods Source: https://www.semtech.com/lora

System design

Our current prototype system consists of 3 data collection nodes and 1 gateway node. The diagram below displays the architecture of our system.

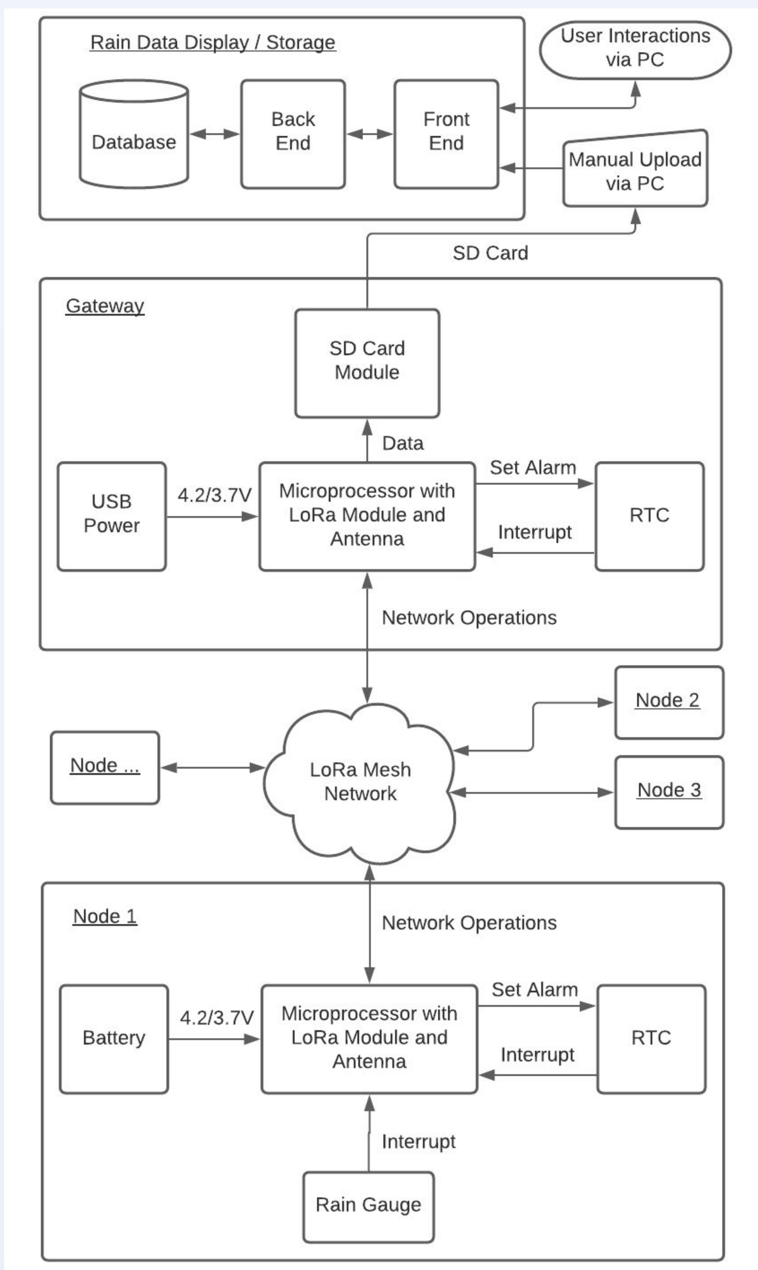

Figure 3 - System Block Diagram

System component: External attachments

The tipping bucket rain gauge measures rainfall to a 0.3mm accuracy.

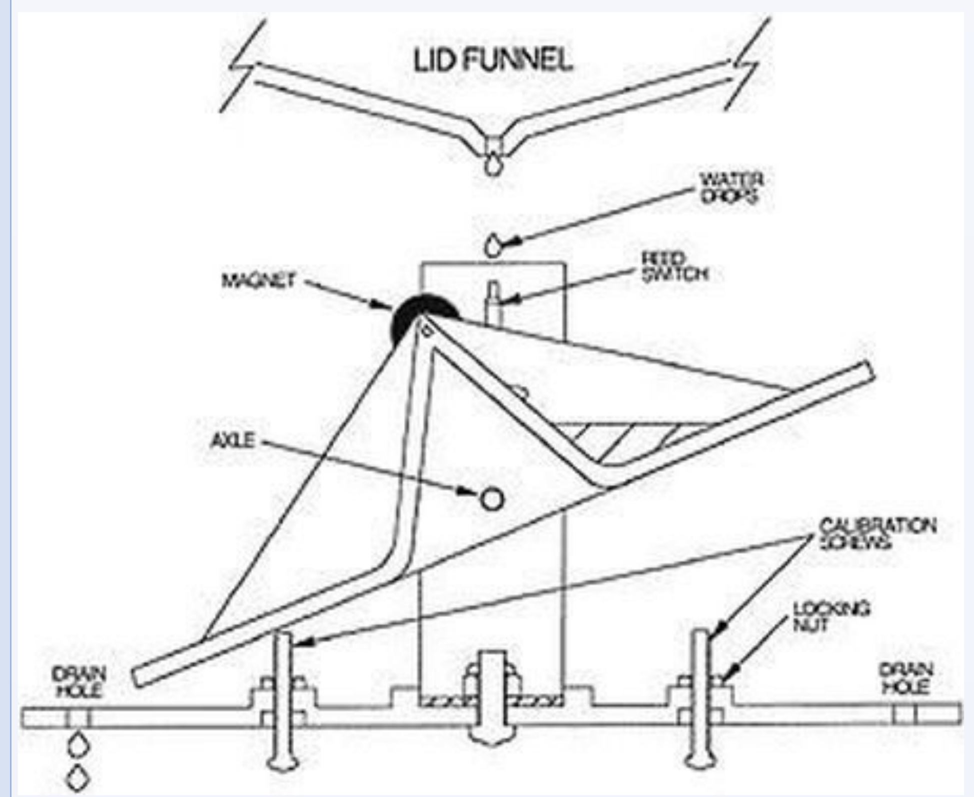

Figure 4: Tipping bucket rain gauge Source: https://duino4projects.com/arduino-weather-station-part3-rain/

The Adalogger Featherwing contains the RTC and microSD card required for deep sleep and data storage.

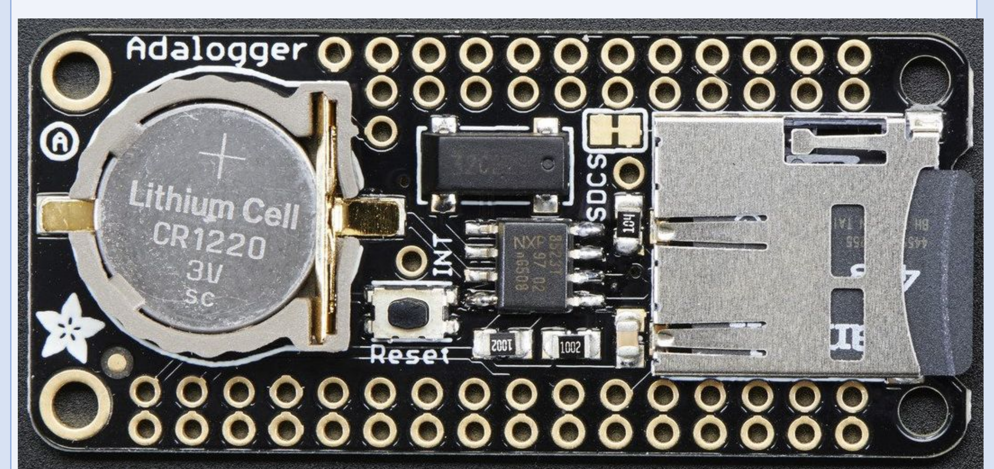

Figure 5: Adalogger FeatherWing RTC + SD Add-on

A 900 mAh Li-Poly battery is required to power the system for a 2 month period.

Figure 6: 900 mAh Li-Poly Battery

System Component: Node

The rain gauge, battery, and Adalogger Featherwing are attached to the node. The node will toggle between sleep and transmission states every 24 hours. During the 10 minute transmittance period, rainwater data measured by the rain gauge is sent to the gateway via LoRa radio.

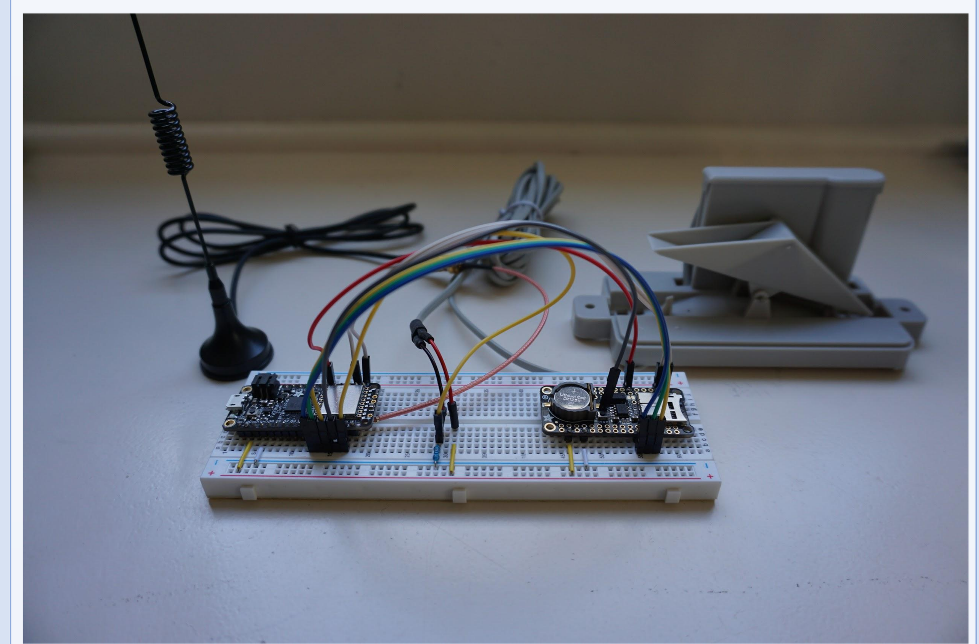

Figure 7: Rainwater Data Collection Node

The node is toggled between sleep and transmission states by the RTC through the use of interrupts. The rain data is also incremented through interrupts made by the rain gauge.

System Component: Gateway

The gateway initiates a request to every node in the spanning tree network to collect rainwater data. After each reply is received, the data is stored onto the gateway's microSD card. The gateway will also coordinate the next transmission time to each node.

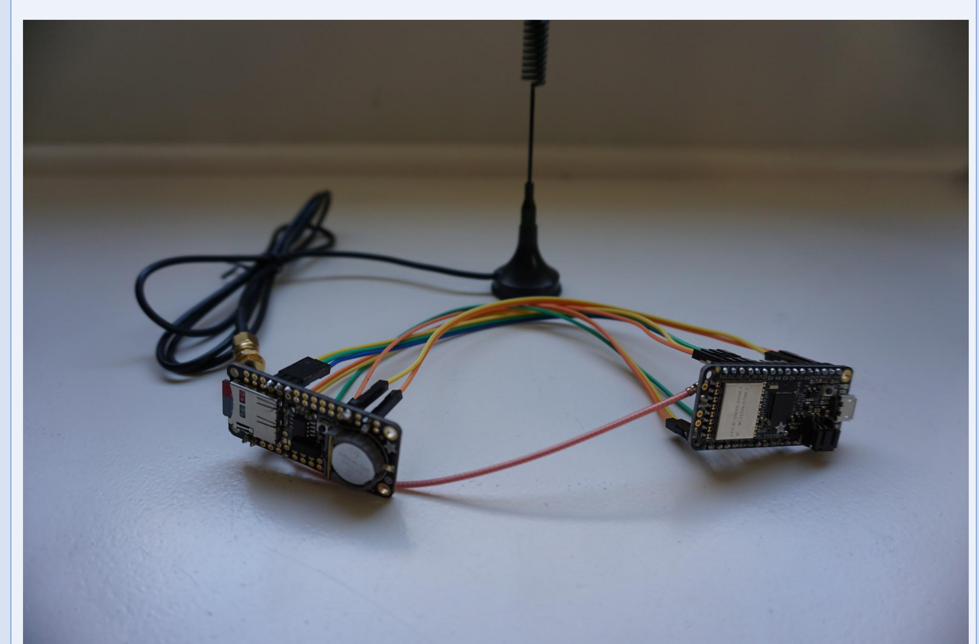

Figure 8: Rainwater Data Collection Gateway

System Component: Web Server

Rainwater data can be uploaded to our web application at https://rainwater.herokuapp.com/ where it contains both tabular and graphical view of rain data at each node.

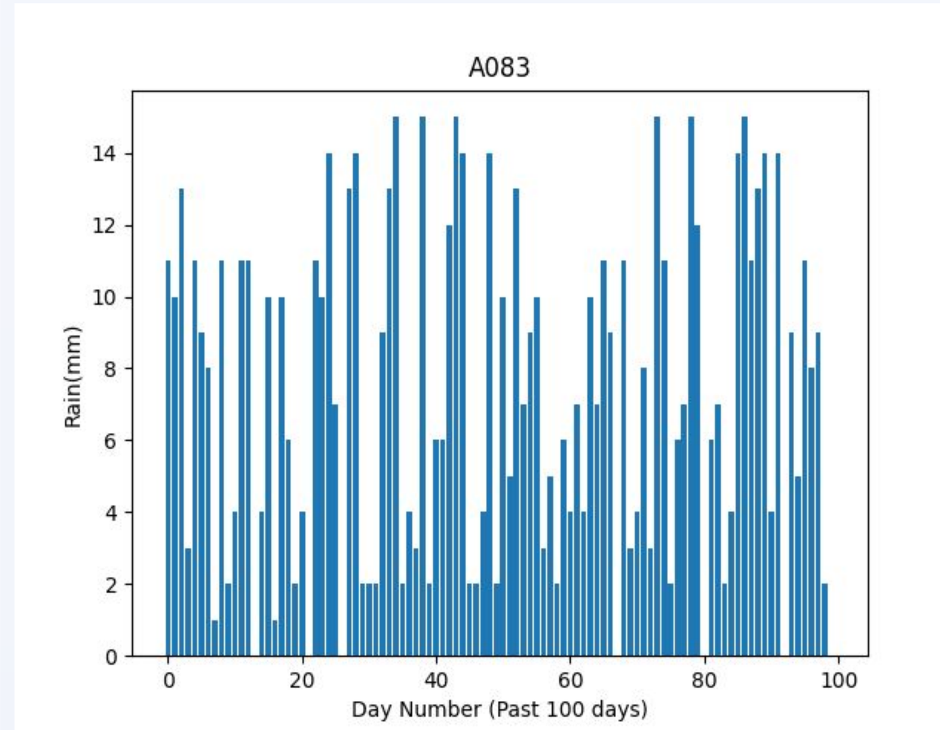

Figure 9: Rainwater Data For a Single Node

Rainwater Data

Browse... No file selected.

Submit

Plot 1 Plot 2 Plot 3

Display locations

NodeID	Rainfall(mm)	DateTime	Action
A082	2	2020-04-10	Delete
A081	5	2020-04-10	Delete
A083	11	2020-04-10	Delete
A082	1	2020-04-09	Delete
A081	15	2020-04-09	Delete
A083	10	2020-04-09	Delete
A082	3	2020-04-08	Delete
A081	0	2020-04-08	Delete
A083	13	2020-04-08	Delete
A082	15	2020-04-07	Delete
A081	0	2020-04-07	Delete
A083	3	2020-04-07	Delete
A082	0	2020-04-06	Delete
A081	8	2020-04-06	Delete
A083	11	2020-04-06	Delete
A082	0	2020-04-05	Delete
A081	14	2020-04-05	Delete
A083	9	2020-04-05	Delete
A082	15	2020-04-04	Delete

Figure 10: Tabular Rainwater Data

Conclusion

We have created a functional system that meets the expectations that were required by all stakeholders and can be deployed into the field with minimal modifications.

Acknowledgements

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