Real-Time IoT-Enabled Water Management for Rooftop Urban Agriculture

Using Commercial Off-the-Shelf Products

By:
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Outline

• Introduction: Urban Agriculture (UA) and Internet of Things (IoT)

• Learning objectives

• Study site: Urban Farm Living Lab (UFLL)

• Hands-on guide to low-cost wireless monitoring of rooftop runoff

• Lessons learned and key takeaways
Introduction

• Increased interest in urban agriculture and rooftop farming

• The need to:
  ➢ Improve the stormwater management on rooftops farms at a lower cost
  ➢ Inform urban planning and policy
  ➢ Develop design guidance

• Internet of Things (IoT) provides us with new opportunities: Wi-Fi, Bluetooth and LPWAN

• LoRaWAN: long-range transmission and low-power requirement
Learning Objectives

The objectives of this presentation are to:

- Understand how the Internet of Things (IoT) can transform the stormwater management of a rooftop farm into a more efficient and innovative process
- Develop a low-cost sensor node that can send data wirelessly through the internet
- Integrate the node into a cloud-based platform and dashboard where data can be accessed in real-time and downloaded remotely
Study Site: Urban Farm Living Lab (UFLL)

- Rooftop of George Vari Engineering and Computing Centre at the campus
- Intensive green roof in 2004 and converted into a rooftop farm in 2014
- Grows around 3,500 to 4,500 kilograms of produce annually
- Split into zones (A, B, C and D) with three roof drains equipped with V-notch weirs
- Weirs were designed to allow flow monitoring
4-Step Hands-On Approach

1. Sensor node design
2. Programming and calibration
3. Field deployment
4. Data smoothing
5. Cloud integration and visualization
STEP 1: Sensor node design

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<td>1</td>
<td>Dragino LSN50 Generic LoRaWAN node</td>
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<td>2</td>
<td>eTape liquid level sensor – 5”</td>
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<td>3</td>
<td>Polycarbonate tube and housing cap</td>
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<tr>
<td>4</td>
<td>Resistor and wire tube</td>
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<td><strong>TOTAL</strong></td>
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[milonetech.com](milonetech.com) / [dragino.com](dragino.com) / [etape.com](etape.com)
STEP 1: Sensor Node Design

• Voltage/resistance divider

• Utilizing two pins of the eTape (P2, P3) and a resistor connected between P3 of the eTape and the GND of the LSN50

• P3 of the eTape delivers the analog input in volts

• The resistor can be in the range of 0 to 2000 ohm

• Corrected resistance output can be measured and used for calibration and into the code
STEP 2: Programming and calibration

Registration on TTN

Developing a payload

Calibration

Using:
- Device EUI
- APP Key
- Application EUI

- Working with Bytes
- Commercially-available nodes usually come with their own payloads
- Slight modification may be necessary

- Varying water level to get the corresponding voltage reading
STEP 2: Programming and calibration

Varying water level to get the corresponding voltage reading

\[ y = 21.059x - 19.545 \]

\[ R^2 = 0.9926 \]
STEP 3: Field deployment
STEP 4: Data Smoothing

• The developed sensor node provided consistency and high-quality data over the season.

• To address the sensor noise, water level data were smoothed to reduce dispersion and remove outliers using the exponential smoothing (ES) method.
STEP 5: Cloud integration and visualization

- A variety of IoT platform integrations to receive messages from sensors through TTN
- Ubidots has been used for this study
- Store and visualize data

All water level measurements are in cm

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: Roof drain
STEP 5: Cloud integration and visualization

- Create conditional events and alerts
- Reducing site visits and possibility of losing data!
Lessons learned and key takeaways

• Careful water use and managed stormwater have become imperative in achieving sustainability goals through urban farming

• The reduced cost of sensors and communication nodes and the availability of open-source projects encourage the runoff monitoring of rooftop farms

• Wireless sensor nodes allow easier deployment of various sensors and increase flexibility for monitoring

• Future research will have to analyze energy usage and optimization further
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End of Presentation – Thank You

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