VTRC
Virginia Transportation Research Council

# Internet of Things-based Pavement Monitoring System

Korkut Bekiroglu (Korkut.Bekiroglu@sunypoly.edu), Jiayue (Joyce) Shen (shenj@sunypoly.edu),
SUNY Polytechnic Institute
Ali Tekeoglu (ali.tekeoglu@jhuapl.edu)
The Johns Hopkins University Applied Physics Laboratory
Ilker Boz (ilker.boz@vdot.virginia.gov)
The Virginia Transportation Research Council

POLYTECHNIC INSTITUTE • STATE UNIVERSITY OF NEW YORK •

# Schematic of IoT-based pavement monitoring system (5 modules)

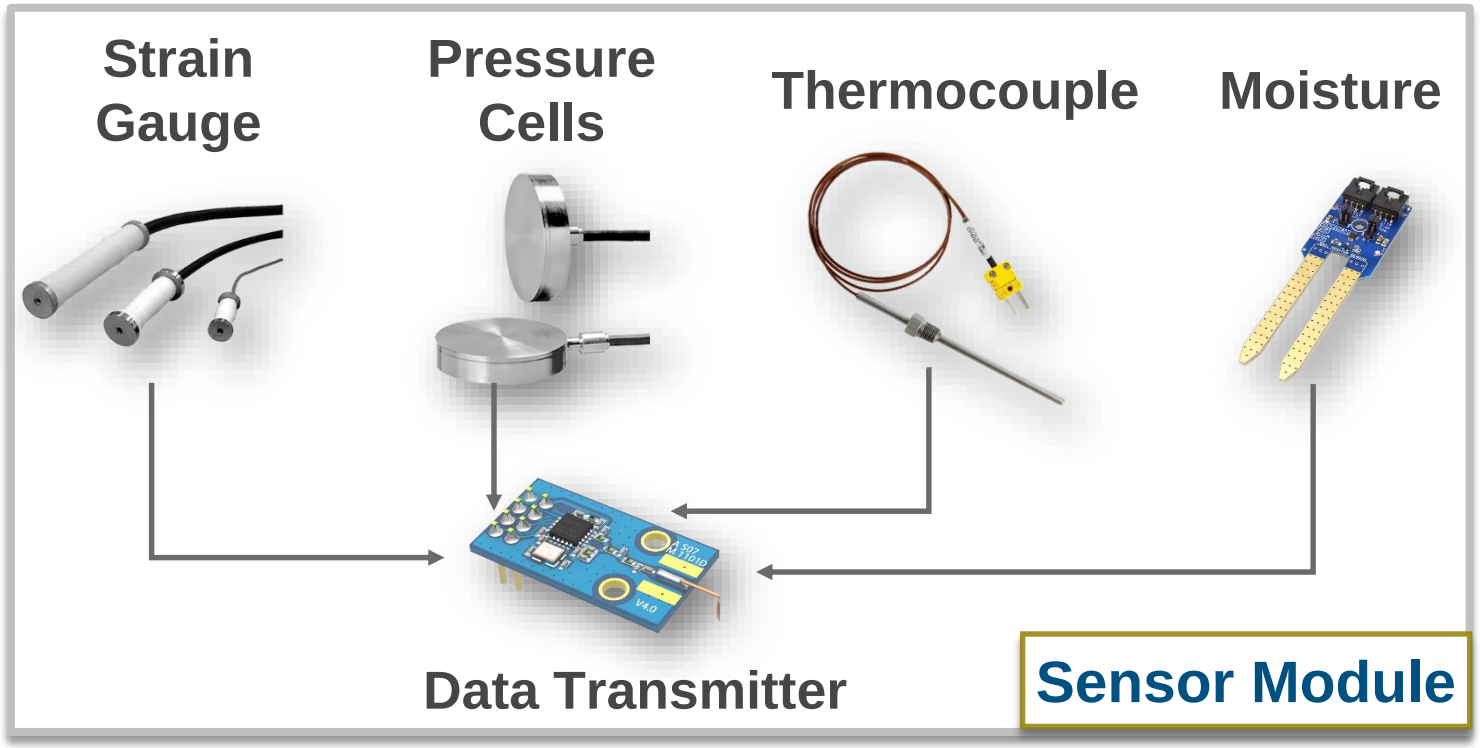
***Motivation***

- Full-scale pavement studies compared to laboratory-scale studies, provide a greater level of information.
- Can we collect real-time dense asphalt response data?
- Is it possible to accomplish this task with a low-cost devices?

***Low-Cost Internet of Things Based Real-Time Pavement Monitoring System (5 Modules)***

- Three considerations:
  - Ease of prototyping and development,
  - Cost,
  - Performance.

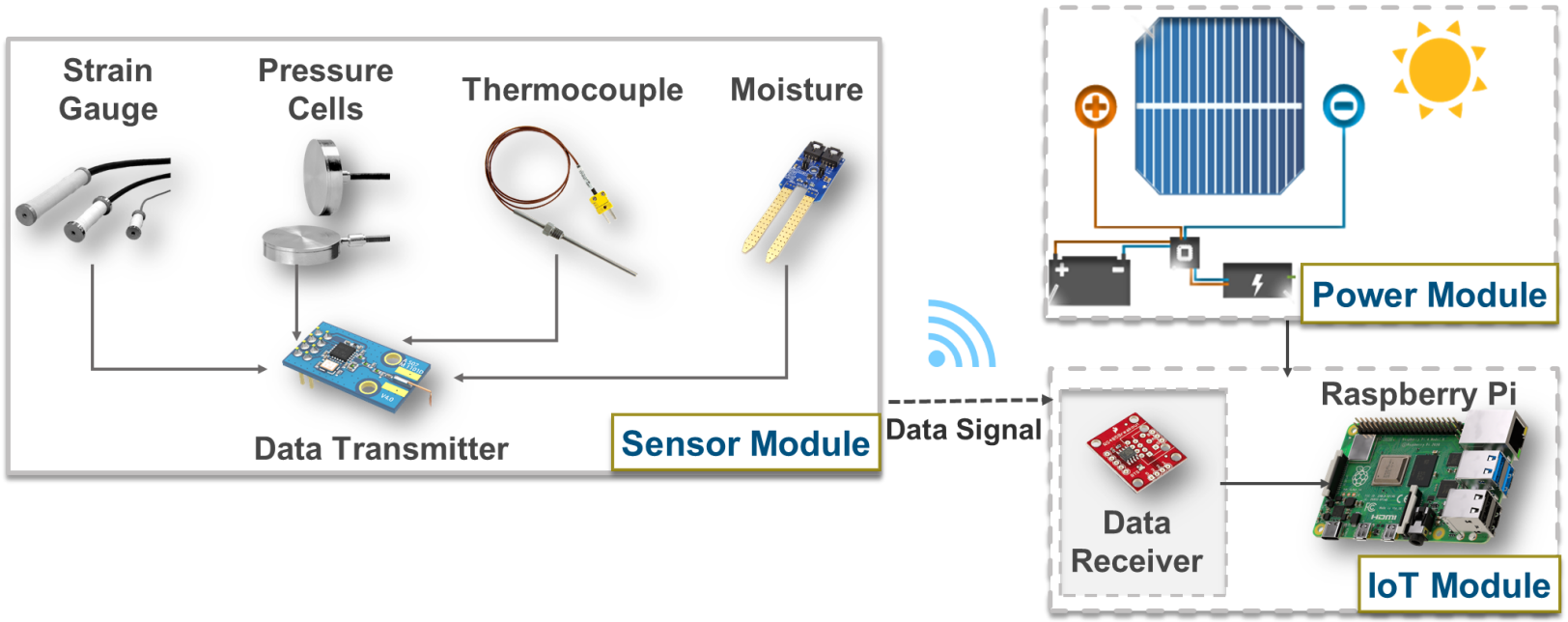
# Schematic of IoT-based pavement monitoring system (Sensor Module)




- ***Sensor modules***
  - Eliminate data acquisition box
  - Amplifying current sensor signals
  - Wired connection circuits with additional power supply
  - Filtering and sensor calibration
  - Various sensor can be connected
- ***Wireless Strain Sensor Research***
  - How to address energy consumption?
  - Does wireless signal strength enough?
  - Receiver/transmitter circuits designs
  - Simulation and initial sensors are fabricated and will be tested in lab environment.

- The pavement response is collected and transferred to an IoT interface, Raspberry Pi Module
- Other type of implementations are possible

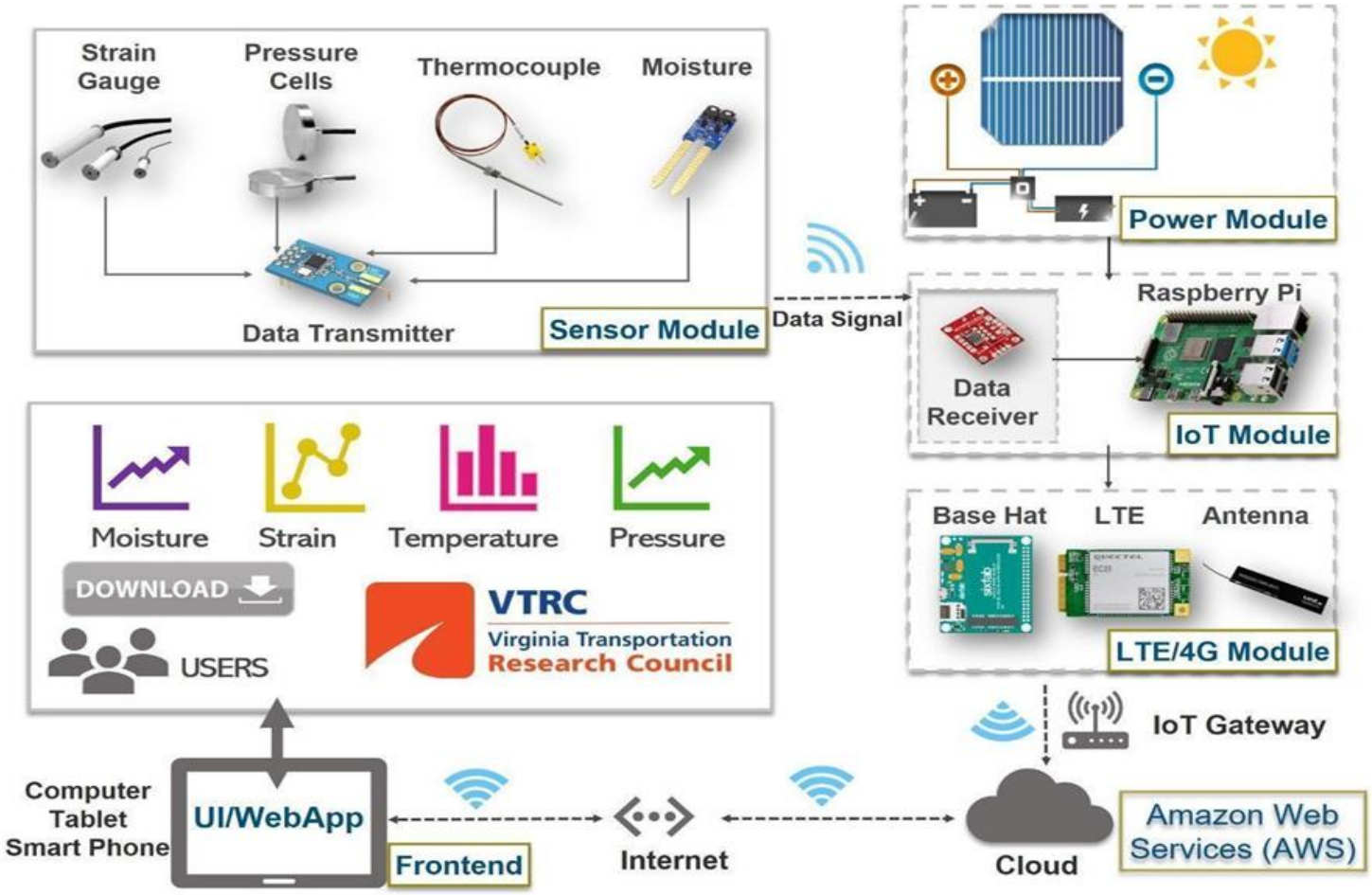
# Schematic of IoT-based pavement monitoring system (Power and IoT Module)




- ***Power modules***
  - PV panel can be used in rural areas.
  - Most expensive part of the PMS
  - How much power needed?
  - Design specification?
  - Installation Cost and maintenance cost?
- ***IoT Module***
  - Picked R-Pi 4 (microcomputer), fair enough
  - Raspbian Operating System
  - Need Data receiver
  - Can handle many sensors (more than 20).
  - Store data locally or push it to the cloud.

- R-pi 4 ($65-$100)

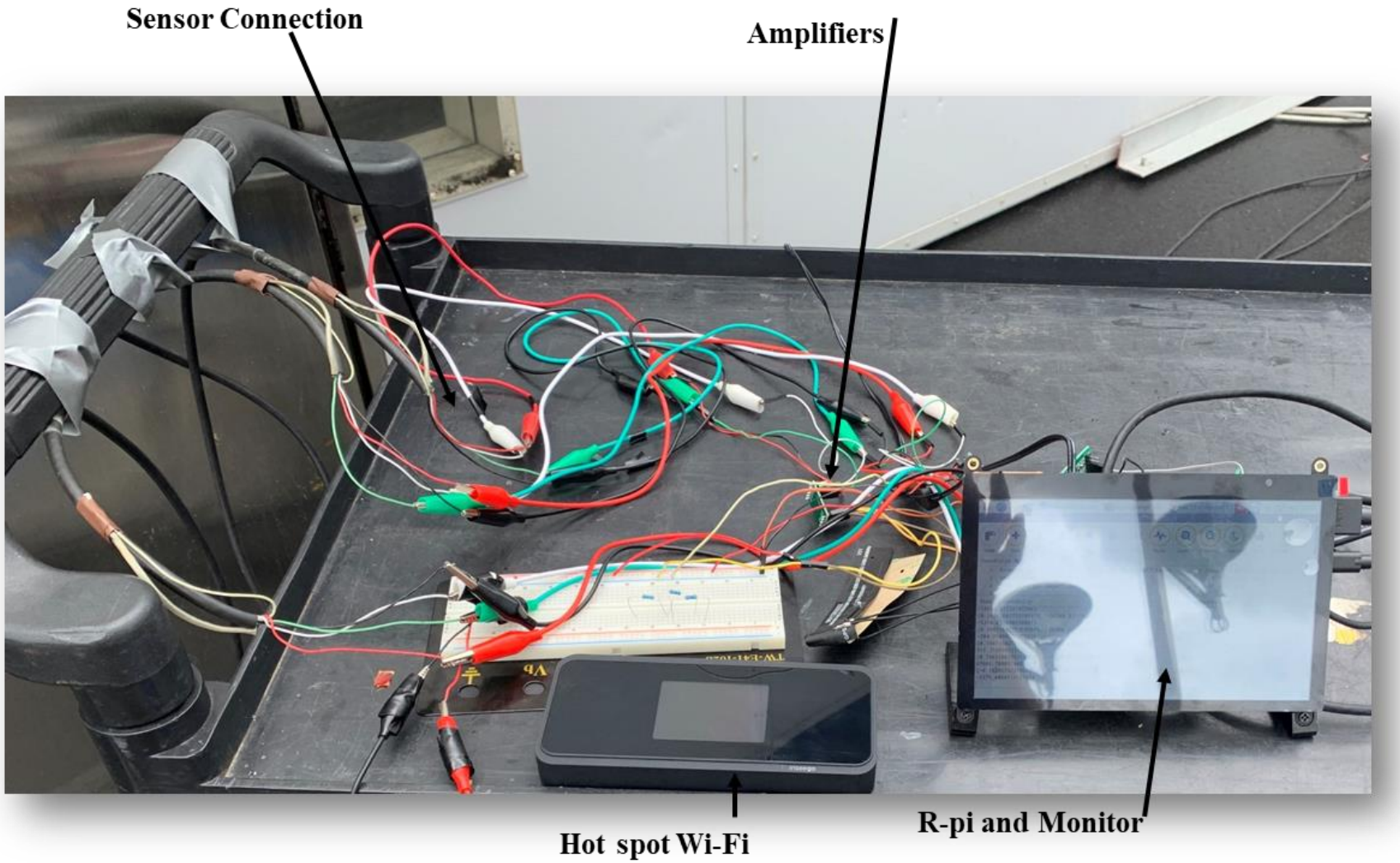
# Schematic of IoT-based pavement monitoring system (LTE and Cloud Module)




- Cellular Hardware ($109)
- Cloud – AWS (we used free version but it depends on how much you use it)

- ***Internet Connection – LTE Module***
  - If residential internet is available, not required
  - Cellular IoT Hat- LTE module.
  - Work with Twilio for testing, roaming for IoT devices
- ***Cloud Data Storage***
  - Do you have server?
  - Paid cloud services, such as AWS, AZURE etc.
  - Free version was enough for testing.
- ***Web Interface***
  - https://aliteke.github.io/research/vtrc/dashboard.html
  - Hosted on Github
  - Pull Data and plot in real time
  - Pay for every request from the cloud
  - **Data security!!!**

# PMS Testing

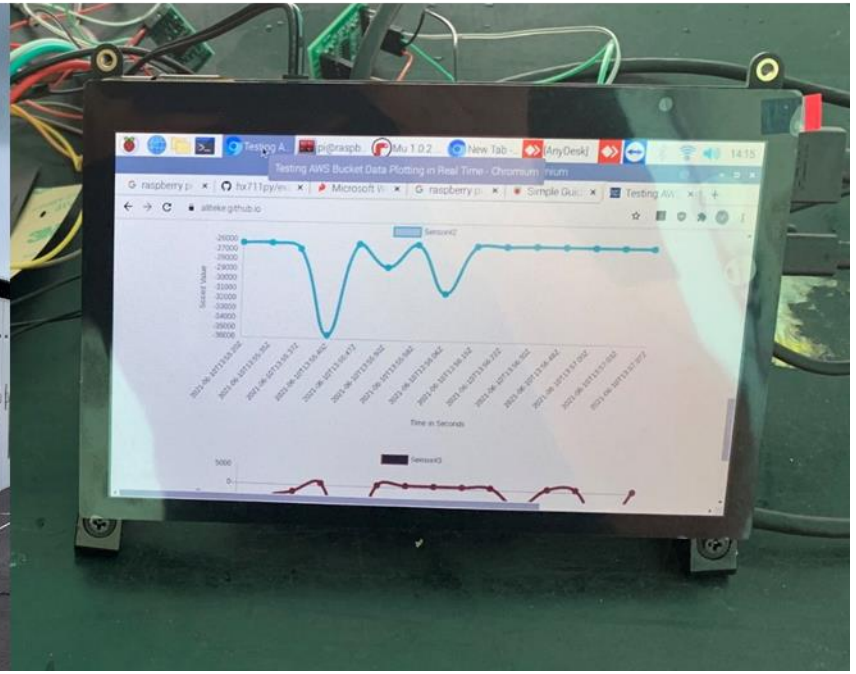

Sensor Connection
Amplifiers
Hot spot Wi-Fi
R-pi and Monitor

# PMS Testing

**HVS**


**Sensor Connection**

**Data Transfer and Visualization**



# PMS Testing (Any Question?)