GR-127 IoT Clusters Platform for Data Collection, Analysis, and Visualization

Abstract

The Internet of Things (IoT) popularity leads more scientists and students to research this field. IoTs have an efficient way of monitoring complex infrastructure systems and the environment around them. Thus, they intervene in several areas such as health care, engineering, or monitoring the effects of climate change. IoT's primary function is to collect data and share them with a distant server through the internet or a private network. Research on IoTs is firstly about creating efficient light devices composed of sensors that follow rigorous security protocols to guarantee the integrity of the data from the collection to its destination. Secondly, the challenge is to store the data on a secure platform accessible by competent people for analysis and visualization. The next generations of IoT devices will have to pass through multiple tests to satisfy collection, transmission, and storing challenges. Our research implementation provides a physical system allowing users to set and configure sensors on Raspberry Pis or Arduinos for data collection, a secure data transfer using APIs, and a cloud base storing space for visualization and analysis. The objective is to make research on IoT devices easier by providing a ready-to-use platform that allows research teams to focus on developing and testing new devices. Also, it offers real-time visualization of collected data via a web bases application and an adequate database for future analysis. Our platform aims to help students conduct IoT research projects or provide a complete database to those interested in data science on various sensors or IoT devices.

Introduction & Motivation

- Internet of Things (IoT) offers unique technologies in improving human conditions and knowledge in many domains such as personal health care, environmental monitoring, home automation, smart mobility, and Industry [1].
- Research in the IoT field is critical for the future because of the benefits and flexibility it brings to our life.
- Many students in the computer science field express interest in research around small connected devices. Still, they face multiple challenges and do not have enough resources to research on this subject [2].
- IoT research requires advanced knowledge in electronics, operating systems, computer networks protocols, server configuration, and programming.
- Although they are simple devices that usually collect and transfer data, they need backbone infrastructure to process data and get instructions.
- We proposed a platform that combines pieces of hardware and a solid microservices infrastructure to support IoT research on campus.
- We provide RASPBERRY PIS 4 (RP4), sensors, a dedicated data collection and transfer network, a ready-to-use server and visualization, our expertise, and multiple other tools to help students in their tasks.

Materials and Methods

- Sensors are directly connected to RP4 build-in GPIO or using a GPIO extender. We use python scripts for data collection and implement different APIs and protocols to send data to servers securely.
- We have two primary transfer methods; depending on the use or the expectation of the platform user, data is sent to a local MariaDB server, or it can be sent to a remote cloud.
- MariaDB provides multiple databases for storing data or exporting. The platform has a website to do minimal visualization just for testing purposes.
- Our cloud infrastructure proposes more advanced tools using HTTPS protocols to stream data securely.

Proposed Architecture

- The proposed platform provides device monitoring, data collection, and transfer tools for any IoT research project. Its architecture, divided into hardware and software, makes it flexible so users can use each feature independently depending on their project.
- Hardware :
- The platform has an inventory of 20 RP4 mounted in clusters of 6 devices. Each RP4 is connected to a server and has a secure data transfer preconfigured.
- 20 Arduinos with Wi-Fi modules, micro-SD card, and GPIO allow computer engineers to implement small intelligent devices for their projects.
- We also propose about 150 sensors, from temperature sensors to cameras and motion sensors compatible with both devices offered with this platform.
- As shown in figure 2, all hardware devices and sensors are mounted on clusters to ensure an organized working environment for future users.
- Servers and Backend applications:
- We have Two RP4 servers responsible for the platform monitoring and soft configurations of devices.
- All RP4 runs on Raspberry Pi OS, with Python 3 using different APIs such as MariaDB Connector, WebSockets, or GPIO Libraries.
- The Platform network is configured with a TP-link Wi-Fi router and Each end-point device as a static IP address. RP4 servers have a wired connection for optimum data transfer. Every RP4 device is accessible from the network using SSH or VNC viewer
- We have different network protocols depending on the type of data transfer. Some of the protocols implemented are TPC/IP, HTTPS, or Sockets.
- We have an Apache server buddled with a MariaDB server and PHP server for the devices monitoring website, multiple databases on the MariaDB for data storing, and a code repository.
- The platform proposed open-source data analysis and visualization tools such as Grafana and Include configured with the clusters and host on a Campus server.
- The platform configuration and program are coded in Python, PHP, JavaScript, and Bootstrap is used for the website implementation.

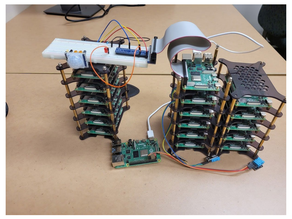

Figure 1 - actual picture

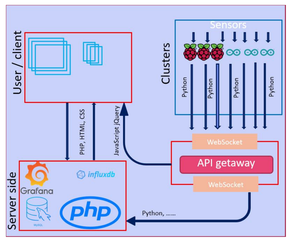

Figure 2 - Platform Architecture

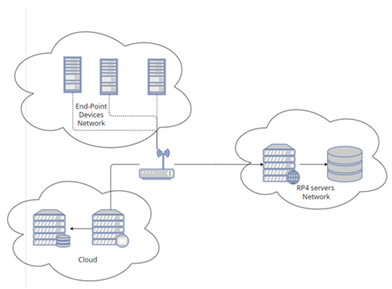

Figure 3 – Platform Devices Overview

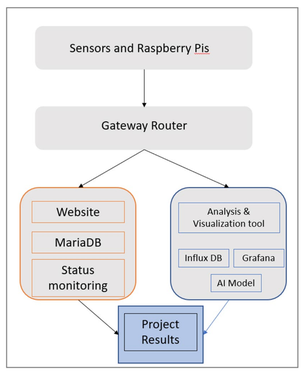

Figure 4 - Data Transfer Process

Results & Further Work

We have a functional platform prototype using a cluster composed of 6 RP4 running six different sensors.
We have a wireless data transfer system using our network for privacy and safety concerns. Also, we need a controlled environment for the platform development.
RP4 OS status is monitored locally using an RP4 Webserver. Also, data collection is effective on the cluster. We are collecting data continuously in different scenarios to test the platform limits.
On the cloud infrastructure side, we have two advanced data collection and visualization tools installed and running. After the test performances, we will test the cloud tools to ensure the safety of our data transfer protocols.
We are looking to open our platform to users by the end of this semester. We are confident of meeting our expectations by that time because we have reached all our previews milestones.
We are looking forward to working with students from different majors and backgrounds.

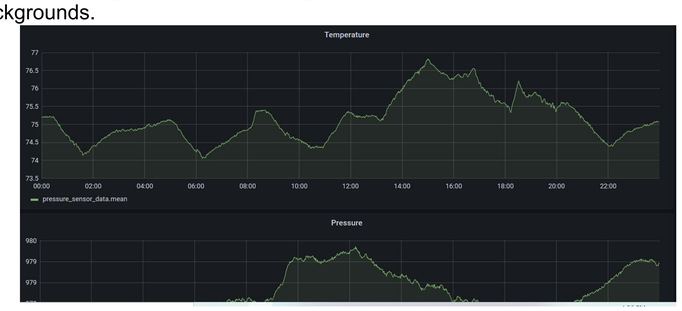

Figure 5 - Grafana visualizations

Conclusions

The platform is for Kennesaw State University students interested in research on IoT devices and students having class projects in the same field. This platform will help students with material advice and support during projects, saving time on system and server configurations. They can have more time to work on their model and their algorithms.
In the future, we are looking to develop a framework for data collection and visualization based on this project. We want to propose an efficient and relatively cheap model of data collection systems that can be used in countries to monitor environments and the Global Warming effect on the climate.

Acknowledgments & References

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