Electrical, Computer & Energy Engineering
UNIVERSITY OF COLORADO BOULDER

ECEN 5783 Embedded Interface Design (Fall-2019)

Topic: **Embedded Interface Design**
Submission Date: **October 11th 2019**
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Project Title: **Industrial Plant Monitoring and Control System**

Abstract:

The proposed super project for the ECEN 5783 Embedded Interface Class has been built around the simple notion and philosophy of integration of IoT (connected devices) with the cloud across a huge area (i.e. an Industrial Manufacturing Plant). The prime inspiration behind this project is the fact that the end-user has control over the workplace – where critical data (e.g. number of employees working inside the plant at a specified point in time) can be traced. That said, the second inspiration revolves around the very idea that the user has the freedom to monitor and control the plant activities – probably from anywhere across the globe – as long as the user is connected to the internet or has a cellular network. Moreover, the design and objectives of this project are proposed with the premises that the user or the workplace may not have a consistent supply of internet services (assuming that are intermittent service breakdowns). Given that, it is highly critical of the system ends to meet consistently with the persistent data that rests on the cloud and the same for the data image that exists locally. Synchronization primitives in coherent merger with the buildup of cloud networking will allow the user to monitor/control the workplace.

Please Note: *This proposed project spans across three different courses in the ESE program: ECEN 5013-002 Advanced Embedded Software Development and ECEN 5833 Low Power Embedded Design Techniques. Prior permission from the course instructors will be duly taken before moving forward into the integration phase of this project outside the scope of ECEN 5783 EID. A clear work breakdown will be established highlighting the unique contribution made specific to each class and each team member.*

Technical Details:

The project will consist of the following critical elements that will go into as the building blocks.

1. Industrial Plant Side Module
2. Remote Operator Side Module
3. Amazon Web Service Module

Industrial Plant Side Module:

This is the part of the project where major sensing and interaction with the environment is made. This side of the project is concerned with low-power Bluetooth Mesh based communication between the main piece of hardware that is built in ECEN 5833 to interact with

a fingerprint module and a grid eye sensor that accumulates and records the number of working individuals inside the plant. These hardware blocks will have the ability to talk to a host (a Raspberry Pi on the plant side) that will communicate with the user via a local web client with UI using Tornado based websocket service. The host will also record the data acquired from the Bluetooth Mesh device and store it as persistent data into its local copy of MySQL database. Furthermore, the host interacts with a GSM module to communicate with the remote operator when internet services are not available. The host offers its data to a valid and authenticated personnel in the plant upon authorization via the NFC/RFID tag. The host eventually communicates with the AWS IoT service for making a cloud copy of its state (i.e. a twin copy) and synchronizes persistent data with the cloud.

Remote Operator Side Module:

The remote operator side module essentially runs a custom Linux kernel on a Beaglebone with the associated and required Linux device drivers that are built in the ECEN 5013-002 class. This target device interacts with the operator side and validates the requesting operator using a fingerprint module and an RFID/NFC based verification. The target device also connects itself with a buzzer that alerts the operator whenever there is an emergency on the industrial plant side or if the target realizes multiple attempts from an intruder to break in to the system. Furthermore, the target device connects with a local host (a Raspberry Pi) that in return communicates with the target device and connects it to the Amazon webservices and the cloud. The host also stores a local copy of the authenticated operators in its own MySQL database which it synchronizes with the cloud and the plant side. The Pi also communicates with a GSM module in cases where there is an internet service breakdown on the plant side. All authenticated host information is transferred by the target device to the host and then to the cloud – after which an authenticated operator can directly use a smartphone to connect with the cloud app (i.e. AWS SNS).

Amazon Web Service Module:

This is the most essential piece of the project that guarantees that a smooth and reliable communication between the remote operator and the plant side. With added data and communication encryption and decryption features, the cloud will bridge the communication between the remote operator and the plant side in a secure way. The amazon webservice module will essentially consist of the cloud and its various features given as below:

- AWS IoT
- AWS Lambda with Python
- AWS Dynamo DB
- AWS SNS
- AWS SQS Queue

Conclusion:

In a nutshell, this project with consist of the key learnings taken from EID Projects 1 through 3 and will involve critical hardware implementations that are built in EID as well as the other classes previously noted.

LINK TO BLOCK DIAGRAM: Provided in the submission comments section on Canvas.