CSE 120 Project Summaries
Spring 2021

1. Cardboard Box to Cloud

Background

Cisco sells equipment to customers, often large customers with many sites. However, the equipment arrives in their central goods depot in boxes. There's a whole process of turning a pile of cardboard boxes into a working setup, beginning with wiring it up in exactly the right way in a rack. Once it's wired up, then the remaining process can begin and we can get it configured and doing useful work; but until all of that is done it's serving no purpose. As we move to a world of edge computing, where we're trying to set up servers and switches in many unmanned locations, this process becomes increasingly difficult.

Problem(s)

The process of getting from a sealed box to a functioning datacenter is fraught with errors. One particular problem is that of getting the datacenter set up the way we want it. To take one customer we're working with, they use more than 4,000 small datacenters on the edge of their network. To rack that up involves sending out a technician to the site to do the assembling and the wiring. If the technician makes one mistake in what they're doing, we can't set up the system, and we need to wait days or weeks until there's another technician available to fix the problem. We want to build a system that sorts out this process so there are fewer mistakes, everything works faster, and it all costs less.

Objectives

Cisco interested in a process where:

- When the server is first received in the central receiving site, we create a record of it, and it is labelled with a label we can use to identify it.
- We will design the networking for a rack describing how they're going to be wired up. For our purposes, we're going to use a simple, fixed network topology that is easy to apply to the switches and servers that we're going to use. Bonus points if we can create more complex network setups with an editor, but we mainly want the basic setup that's used in most places - it's most useful to Cisco.
- We will help the technician understand which components go into which places in a datacenter rack; and explain how to add the network cabling. They'll use the labels we added earlier to work out which component is which.
- We will help them check that everything is correct before they leave the site, so that we don't have to send someone else out to fix the errors in the future.

We will provide you with a service you can run providing a REST call; it will (pretend to) report the state of the network wiring in a freshly installed rack. With that, you should be able to work through the rest of the process requiring lots of datacenter hardware.

2. Pest Control Reporting

Background

Agrecom, Inc. is transforming the agricultural and commercial pest control service through technology and great customer service. Agrecom was built with the understanding that Agricultural, Residential, and Commercial clients have unique needs. We offer the expertise to provide superior tools, products, and services for each of these situations, while excelling due to the flexibility that a small, local business can provide.

Problem(s)

Technicians servicing pest control stations are required to document activity and service at a many individual service stations at a single premise. This activity has to summed up and be documented in a report as left on premise. The information and summary about individual service stations is then collated into an electronic report and a map that is then sent to the customer electronically a few days later. Monthly this information is also used to create pesticide use reports for the governing agencies regulating chemical usage.

The current methods used to follow this procedure are manual and time consuming – generating a lot of paperwork and the potential for an abundance of errors. Whilst barcode scanners are currently deployed, the reconciliation of the data from the scanners is then manually reviewed and entered into a spreadsheet and cross referenced with a manually created map. This is a bout 3-4 person hours per customer site, amounting to a lot of labor costs just for the customer reports.

Objectives

The team is asked to research, develop, and test a new system that allows the technicians to quickly document and perform their services at the customer facilities using some form of barcode, RFID or other measure combined with their company tablets phones, and then that information be quickly and automatically collated into a service report that can be emailed or uploaded to a customer portal automatically.

Required results:

- The ability for the technician to scan or otherwise document electronically (RFID, Bluetooth, QCode etc) the activity at each individual service station.
- The ability for the technician to document chemical usage at the facility.
- The ability for the technician to add notes to the report electronically.
- All activity and reports to be stored in a centralized database.
- At the end of the service:
    - The service report should be generated and available to the technician to review.
    - The service report and map uploaded to cloud storage automatically.

Some key bonus features

- An updated map of the activities should be created.
- The ability to create and edit maps of facilities in a centralized manner before the technicians service the property.
- The service report to be automatically emailed to the customer once the technician has reviewed.
- Generate a monthly report of chemical usage by county based on service address.
- At the end of service print out to a portable printer in the technician's truck.
- Link into online billing system to automate delivery of invoices.
- Automatic notification of the technician if they missed any expected service stations at the facility before they depart.
- Visualization of activity and reports over time.
- The ability for the technicians to update maps with service station locations, or change property features.

3. Water Treatment Monitoring

Background

Agrecom, Inc. is transforming the agricultural and commercial pest control service through technology and great customer service. Agrecom was built with the understanding that Agricultural, Residential, and Commercial clients have unique needs. We offer the expertise to provide superior tools, products, and services for each of these situations, while excelling due to the flexibility that a small, local business can provide.

Problem(s)

Agrecom uses a remote monitoring technology to identify water flow and water quality. However, we also want to add a method to measure chemical usage and levels remotely.

We can roughly estimate the usage of chemicals via a formula, but it would be more ideal to have a physical sensor to show the level of the chemical tote. However, both the calculation AND the physical sensor would not be a part of the web interface of the device we use to measure water quality. So 2 and possibly more different user interfaces would be needed to monitor one location.

As well as Agrecom wanting to monitor its customer sites, the customers themselves would also want to see status to ensure that the system is operational, as well as a history.

Objectives

The team is asked to research, develop and test a new method to aggregate data from the existing systems, as well as provide an easy input for new systems such as a simulated sensor (to be provided) and some calculated estimations into a single user interface, monitor chemical levels in a tote or barrel, OR the estimated usage of the chemical – either resulting in an alert or notification when chemical needs replenishing.

Required results:

- An administrator portal to show individual sites and their readings.
- A customer portal that shows only select (configurable) sites and readings.
- The aggregation of information from the existing remote stations (JSON API).
- The calculation of chemical usage using information provided by the remote stations.
- The aggregation of chemical usage from a simulated sensor (to be provided).

Some key bonus features:

- User management capabilities.
- Rich visualizations of data within the portal.
- Notification of system events and alarms via email, SMS, or other methods.

4. Service Reminder Application for Industrial and Mobile Robots

Background

Omron Robotics and Safety Technologies, Inc. (ORT) is a technology company located in Pleasanton, CA, with offices in Amherst, NH. As the name indicates, ORT develops cutting edge robotic and safety technology and products. ORT has a full suite of Fixed (Industrial), Mobile and Collaborative robots for Industrial Automation applications. In addition to technology development, ORT also manufactures robots in the Pleasanton facility. The proposed project involves Engineering and Service functions.

Problem(s)

The main objective of this project is to develop a SW application field support services, which tracks relevant data from deployed robots, and facilitates scheduling of predictive maintenance activities. Much like cars, robots require regular maintenance over time to ensure they perform to specifications. A single robot that has subpar performance or breaks down may significantly impact productivity and even cause an entire manufacturing line to be stopped. It is therefore crucial to accurately track usage statistics of each robot and create notifications for service teams about upcoming maintenance requirements. Since a single site may have numerous robots of different types with varying first deployment dates, it is exceedingly difficult to achieve this task without automated tools.

Objectives

The Omron Robot Service Tracker application is an app that runs on a mobile phone or tablet (OS/platform TBD). It connects periodically to download latest usage about robots deployed at a particular site. The app then analyzes the data, compares against the maintenance requirements defined for each robot type, and provides a status update on the next recommended maintenance milestone. It presents the user a dashboard view that allows her to assess the overall situation at the site at a glance. The application issues alerts as required maintenance dates approach or are missed. The application should provide a configurable user interface that allows to user to filter the data based on various criteria (e.g., robot type) or adjust the frequency of reminders/alerts.

Other convenience features, such as calendar integration for service call scheduling and report generation, are highly desired. Collection of the data from robots and analysis of said data are beyond the scope of the project. The data and associated rules for determining service schedules for different robot types will be provided by Omron.

5. Customizable Views of Ag-gregated Data

Background

Veracruz.Ventures is a company based in Portugal created to Smart Farm, applying and developing cutting-edge agricultural technology and know-how in company management and farming. AgTech is the application of technology- especially software-hardware-data to the field of farming and encompasses diverse solutions to almost every step in the food production process. There are a plethora of web services and applications available in the AgTech community including services for farm management and irrigation information for different stations. These services in the AgTech community help growers to gain insight to understand the variables to find optimal agricultural practices. A grower has the opportunity to access over 1600+ AgTech services; however, they are using about 12-15 of these AgTech platforms for their agricultural practices. Veracruz Ventures desires a platform that integrates the data from disparate AgTech web services into customizable views and then enable to share best practices encompassing a growers-to-growers community forum in a crowdsourcing manner.

Problem(s)

The farming industry currently has several separate chains not yet integrable (i.e., the digital agronomy and production sector, planning and farming management sector, and market access and financing sector). For example, Wiseconn provides services on irrigation, while Agworld focuses on higher-level farm management. As multiple growers depend on these services often, they currently have to work with individual platforms to compile a holistic idea in their economic crop growth.

Currently, there is no such platform available in the AgTech industry that best integrates these branches both for and from the grower in a single platform. Moreover, there is no AgTech platform or services that provides insight on economic outcomes of agricultural practices. Hence, Veracruz Ventures proposes to design an intuitive and effective User Interface to connect these sectors together, to capture the farmers' know-how, and to trade it among the farming community.

Objectives

In the previous phase, multiple proof-of-concepts for data aggregation functionality and best practices sharing were prototyped, and an Ag-gregation platform was developed that fetches data from multiple services into one database. In this phase, the objective is to present the heterogeneous data in Ag-gregation (from disparate AgTech web services) into customizable views that are dynamic and dependent on the relationships among such heterogeneous data and farmers scenarios. Given the data from related and unrelated datasets that pertain to

this project, the main objective for teams in this phase is to design and build a prototype that best fits the growers' data needs to filter disparate data, presenting and correlating relevant information from databases.

6. UWMC's Volunteer Here

Background

United Way of Merced County is more than just a fundraiser. We are the convener, the provider and the support structure for many nonprofit programs and community initiatives throughout Merced County. We impact our community by supporting both nonprofit service providers and Merced County residents. Each year, through our programs and fiscal sponsorships, we support over 125,000 residents in Merced County.

Problem(s)

Each year nonprofits struggle with finding appropriate volunteers for their services. Volunteers are the lifeblood of every nonprofit and a needed resource for nonprofits to continue and excel at their missions. COVID-19 has strained the capacities of nonprofits as the needs have risen and volunteer services have plummeted to low levels. Due to many nonprofits running on tight budgets, nonprofits usually do not have the manpower to find, train and select volunteers for their services. Finally, most nonprofits still look for volunteers as they have had since their inception though the world has constantly changed around them. In order to build back up the volunteer base in Merced County, as well as, reaching younger generations of volunteers, we are proposing the Volunteer Here app, designed to match potential volunteers with nonprofits.

Objectives

The Volunteer Here app is designed for two sets of users, the nonprofit and the potential volunteer. Nonprofits will sign up for the volunteer service, administered by the United Way, and create a profile, detailing their mission, their volunteer needs, and a brief checklist of criteria of those needs. Potential volunteers sign up, create their profiles, and receive notifications of potential matches. In essence, creating a dating app for volunteerism. We think a successful app will be able to provide a simple interface for the onloading of clients who will then be able to easily find nonprofits which follow their interests and desires when they look to volunteer.

Overall, a successful project will take these details and create something truly unique for our county. We can see the process being as simple as a database which the administrators (United Way) can then take on more of a role of volunteer coordinator for the county or something more complex such as an algorithm which will actually match volunteers to nonprofits and automate much of the volunteer coordination process. By working with community partners, schools, and a social media campaign, we hope to assist in how nonprofits find, cultivate, and train their volunteers.

7. Virtual Substation

Background

As an electrified heavy rail system, **BART** draws electricity directly from PG&E, then “steps down” the high-voltage signal before distributing power to the trackway. Integral to this process are BART’s 60+ high-voltage traction power substations, which are located throughout its rail network. These facilities, which contain transformers, circuit breakers, switchgears, and other equipment, serve as the intermediary between the power grid and the electrified third rail that propels BART trains. These substations can be divided into two categories based on their age; there is an older “legacy” type as well as a newer type, which has modern digital protection and control equipment.

As part of BART’s onboarding process, new engineers and electricians visit traction power substations to familiarize themselves with their equipment and functions. As such, the substations are vital for training and

building the knowledge base of technical personnel. BART is now looking to develop virtual substations—3D environments that could be explored and engaged with like real-life substations, but remotely.

Problem(s)

This project entails the design and implementation of virtual substations to be used for training, testing, and troubleshooting purposes. They will contain interactive models of the equipment found in BART substations and be capable of simulating responses to the full range of possible inputs and outputs. For example, the virtual module should be able to model/simulate power system events and configurations, assess how the system would respond under various "what-if" scenarios, and allow users to determine the sequence of operations, state of equipment, likely root cause of the problem, and other factors. Since there are two different categories of substation, this project could require two teams working separately to develop two final deliverables.

Objectives

The project could span two semesters, with the teams visiting substations, collecting information, and beginning development of their virtual environments in the first semester. The second semester could be spent completing software development, implementing the virtual substations, and testing them for use by BART staff. Deliverables should be aesthetically appealing, user-friendly, and technically sophisticated enough to remain in use well into the future. This opportunity will challenge participants' technical knowledge, creativity and teamwork skills and is geared towards those studying computer engineering.

***Note that this project has been scaled back to span a single semester with a similar, but more focused objective. The scope is now for teams to work on a component of the substation.

8. Automated Battery Monitoring for Life Safety Assets

Background

In addition to trains, the Bay Area Rapid Transit District (**BART**) comprises over 130 miles of track and 50 passenger stations, as well as numerous other facilities and assets. Electricity is necessary to power many components of the system, from fare gates and station lighting to the train control network that is BART's nerve center—not to mention the traction power that propels the trains themselves.

Since PG&E electrical power can be lost at any time due to an unforeseen outage or service interruption, a backup system is crucial. BART maintains a sophisticated network of batteries and uninterruptible power supplies (UPS) to ensure that power is not only provided during such an interruption, but that the transfer from normal to backup electricity is as seamless as possible. This backup power system must be regularly maintained and monitored, with the bulk of this work having to be performed manually. This method of battery monitoring represents an unfortunate inefficiency, as electricians must obtain readings from batteries in the field, one-by-one.

Problem(s)

This project will entail developing a method to automate the battery monitoring process. This will most likely take the form of a script or set of scripts to query battery monitoring devices on the BART intranet and pull data, including resistance, temperature, voltage, and other parameters. This data will then need to be easily exported, filtered, and represented visually so that any changes over time can be clearly seen and responded to, with automatic alerts sent when certain changes occur.

Objectives

Automated battery monitoring will contribute to BART's fulfillment of life safety requirements while reducing the workload of maintenance personnel by perhaps dozens of work hours per week, freeing them up to prioritize other important tasks. This effort will provide project team members with valuable real-world experience that will prove marketable in areas such as facilities and asset management, as well as a variety of

other technical/industrial fields. Students of electrical, computer systems, and related engineering disciplines are encouraged to take part in this exciting project.

9. Patient logger environment

Background

Patients with chronic pain or other neurologic conditions frequently note that their symptoms vary with environmental conditions. This includes heat and light but also body position and level of activity. It would be useful for the patient and their physician to know how these factors influence their main symptoms such as pain, fatigue, or weakness. This might allow the patient and their physician to build a treatment plan that mitigates these environmental factors.

The **Fresno Institute of Neuroscience** is a local company that is mainly involved in providing care to patients with neurologic problems but also is involved in research and education.

Problem(s)

In order to solve this problem. it is necessary to have a platform that can log a few variables in addition to a patient input about how they are feeling. All of the parameters can be logged at a low data rate (<1/sec). For each patient depending on the clinical condition a different set of sensors may be chosen based on the clinical consideration. The most common might be the orientation of the back, pelvis and maybe upper legs in patients with back pain. In patients this might be an averaged surface EMG and in others might be skin surface temperature and environmental temperature. The patient input should be very simple maybe just a dial or dial plus a button that is also recorded at the same time as the sensor data.

Once this data is collected there needs to be a system to download the data generate graphs of symptoms vs time and symptoms as a function of sensor readings.

Objectives

For Engineering Capstone, the goal is to find a small and cheap platform for recording these signals and to generate a way to log the data. Should the sensors be wired or Bluetooth or some other wireless technology. Recordings will be over 1-3 days so power needs to last that long. Must be simple to place on patient and not impair the patient's mobility or be easy to dislodge. The device would be designed for multiple use but should be of moderate price.

For Software Capstone the critical issue is to download the data quickly, create reports and store the data in some secure format. There must also be an interface that allows addition of demographic data at the time the device is set up.

10. Docker Based On-Premises Modbus/Bacnet Server

Background

Sweep Energy designs and manufactures industrial wireless meters and software for real-time equipment monitoring. We have recently launched the sweep api, a simple cloud-based data gathering platform for storing and analyzing time series data in a scalable fashion.

Problem(s)

Facilities are looking to modernize their data monitoring systems by using cloud-based monitoring solutions for storing time series data for later analysis by data scientist and engineers. A large barrier to entry is facilitating the link between a cloud-based service and in network devices. Being able to store time series data in a cloud-based solution allows companies to scale their data science operations more easily without having to purchase hardware to do so. Develop a way to collect time-series sensory data from modbus/bacnet devices in a secure network and push to the Sweep API for later analysis.

Objectives
Build a docker based web-server app that provides the client with the means to define, connect and collect sensor data from modbus/bacnet devices in a secure network and send over the time series data to the Sweep API through a secure websocket connection. The system must have a web ui that allows the user to define all modbus/bacnet devices that will be monitored in the system and tell the user where modbus/bacnet device data will be saved on the sweep platform. Client should be able to collect and push real time data from 10 to 100 devices in near real-time every second.

11. Secure Realtime DB Import Desktop App

Background
Sweep Energy designs and manufactures industrial wireless meters and software for real-time equipment monitoring. We have recently launched the Sweep API, a simple cloud-based data gathering platform for storing and analyzing time series data in a scalable fashion.

Problem(s)
When it comes to real-time data processing, it become imperative that tools exist to import data from other sources into a cloud based compatible system. Without the means of properly importing existing data in a standard fashion, it limits interest in cloud-based service like ours, if they find it too difficult to upload existing data. Utilizing the Sweep API and Realtime WebSocket API, create a desktop app that allows the user to import data from either a MYSQL/Postgres DB, excel file, or CSV and import the data to a format required by the Sweep API. Provide the user with a visual viewer of how data will be translated from a db/file-based format to an equivalent sweep stream/directory-based format.

Objectives
Develop an electron app that allows you to import DB/file data and save to the Sweep API platform. Must provide a visual means to preview the import and edit the format before initiating an import to a directory/stream equivalent on the cloud service. Must verify that all data was successfully uploaded to the system and note any import errors. Parallelism would be ideal to speed up upload time.

12. Database Front-end App

Background
ISSNAF, a non-for-profit Foundation based in California, is the largest network of Italian Scholars, Researchers and Technologists in North America, with the mission to connect, empower and celebrate its members. It promotes networking and cultural, scientific, academic, and technological cooperation within its community and with public and private organizations in North America and in Italy. The Foundation is volunteer-based.

Problem(s)
The ISSNAF membership database powers its operations. ISSNAF currently lacks a tool for end users and administrators to conveniently access its database. Access to data is therefore limited to only tech-savvy users with database knowledge. It would be very beneficial to the ISSNAF community to gain this access via a friendly user interface. ISSNAF would need to approve the development platform proposed by the team.

Objectives
ISSNAF proposes that the team designs and develops an end-user app to access its MySQL database to obtain general information, extract data according to user-specified parameters, and show query results on screen as

well as in a report. Administration features should also be provided to allow a user to modify the data using both manual input as well as data imported from a file. The user interface should be extensible to facilitate adding features at a later time. The tool should be cross-platform.