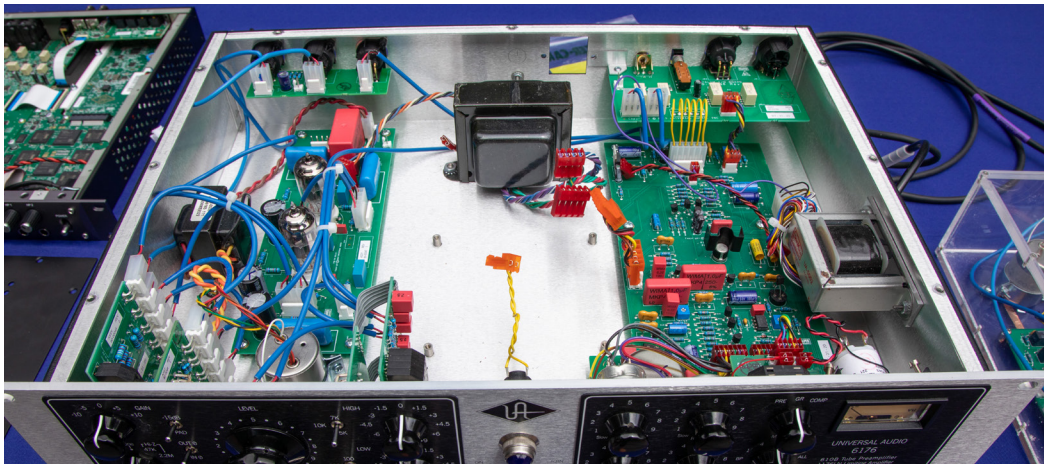
UC SANTA CRUZ | Baskin Engineering

PARTNERS' DAY

2023-2024

Corporate Sponsored Senior Projects Program and Senior Design Showcase



INTRODUCTION

This publication highlights the 13th year of the Corporate Sponsored Senior Projects Program (CSSPP) at the Baskin School of Engineering at UC Santa Cruz.

CSSPP provides a select group of students with a unique opportunity to work on real-world engineering projects as the culmination of their undergraduate education. Throughout the academic year, students interact with teammates and hold frequent meetings with their sponsors, getting feedback on the solutions they have developed and guidance on the work in progress. By working with mentors at corporate partner companies, students learn important skills, take on intriguing challenges, and begin to understand what it means to be a professional engineer.

We sincerely appreciate our corporate sponsors for their support of CSSPP at Baskin Engineering, trusting and mentoring our students, and providing them with challenging projects to work on. We also appreciate our students, who have worked hard and enriched our lives through their energy, intellect, and determination. This class of students is special in that they have had to rise above unique challenges throughout their time at UCSC, including working in a distributed environment over many quarters, dealing with disruptive weather patterns, and other significant distractions. I am enormously proud of our students for their perseverance, and grateful to our corporate partners for remaining dedicated to the program amidst many of these same challenges.

This publication also includes this year's Senior Design Showcase projects from student teams in the Computer Science and Computer Engineering programs, as well as our programs housed within the department of Electrical and Computer Engineering, all of whom worked on faculty/student initiated projects. As with our CSSPP projects, students working in our senior design program demonstrated a keen commitment to their projects and their teammates.

On behalf of my colleagues at the Baskin School of Engineering, I want to express the great pride we all take in the work of our students and their faculty mentors, and reiterate my gratitude to our corporate sponsors. A great deal of work goes into all of this programming, and I would like to close by thanking the staff and faculty who make it possible for our students to thrive in the Baskin School of Engineering and become prepared for successful careers as Baskin engineers.

Alexander L. Wolf
Dean, Baskin Engineering

ACKNOWLEDGMENTS

We would like to acknowledge and thank the faculty, teaching assistants, and staff who have been so instrumental in the Corporate Sponsored Senior Projects Program:

SENIOR DESIGN FACULTY
CORPORATE SPONSORED SENIOR PROJECTS PROGRAM 2023-24

Patrick Mantey
Director, Senior Design Capstone, Jack Baskin Endowed Professor, Computer Engineering, Emeritus, Baskin Engineering

Richard Jullig
Lecturer, Computer Science & Engineering

David Harrison
Lecturer, Computer Science & Engineering

Stephen Petersen
Teaching Professor, Electrical & Computer Engineering

Himadri Basu
Postdoc Researcher, Baskin Engineering

TEACHING ASSISTANTS & GRADUATE RESEARCH ASSISTANTS
CORPORATE SPONSORED SENIOR PROJECTS PROGRAM 2023-24

Prajas Kadepurkar

Golam Md Muktadir

Nahid Nasiri

Azzam Qureshi

Roy Shadmon

CORPORATE SPONSORED SENIOR PROJECTS PROGRAM STAFF

Alexander Wolf
Dean, Baskin Engineering

Frank Howley
Senior Director of Corporate Development, Baskin Engineering

Kelsey Evans Detwiler
Corporate Development Specialist, Baskin Engineering

Molly Sims
Executive Director of Development, Baskin Engineering

Peter Minogue
Director of Laboratories and Facilities, Baskin Engineering

Richard Sabala
Director of Laboratories & Facilities, Baskin Engineering

James Trent
Facilities Assistant, Baskin Engineering

Russell Evans
Baskin Engineering Lab Support Manager

Frankie Carsonie
BELS Teaching Lab Junior Engineer, Baskin Engineering Lab Support

Cesar Vargas
BELS Teaching Lab Junior Engineer, Baskin Engineering Lab Support

Andrea Pesce
Director of Industry Alliances, Innovation & Business Engagement Hub

Cary Coleman
Production Assistant, Copy Center

Carolyn Lagattuta
Communications & Marketing Executive Assistant and Photography

Molly McAleer Fine
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SPONSORS

Special thanks to our sponsors for their generous support of the Corporate Sponsored Senior Projects Program. Their time, experience, and financial support were immensely beneficial to our students' experience and success with their Senior Design Projects.

Capstone Project

Brinqa - Onboarding Guide

Valentin Casanova - Joseph Scheidt - Gea Loro
Satoki Ohashi - Santosh Shrestha

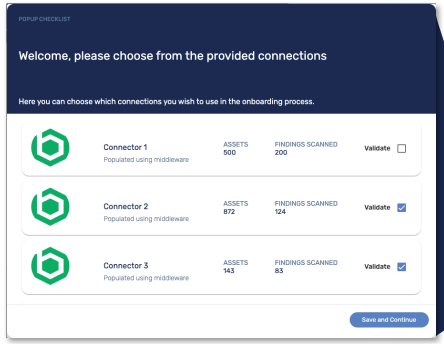
Try out our editor here! ->

Overview

Onboarding takes Months: Brinqa provides cybersecurity risk management solutions, involving a 6-9 month onboarding process for new clients to determine and implement necessary security measures through multiple meetings with the client's IT staff.

Brinqa needs a Guide: Brinqa customer success engineers need an onboarding guide that automates and streamlines this process, while being highly configurable and customized to each client. To effectively onboard multiple clients concurrently, Brinqa needs a system that generates custom onboarding guides to navigate each client's unique cybersecurity challenges.

We're here to help: Our project addresses this need with a no-code solution that enables engineers to intuitively generate dynamic and highly configurable onboarding guides tailored to each client's unique cybersecurity challenges.



Utilize Popups to monitor and document user inputs

Acknowledgements

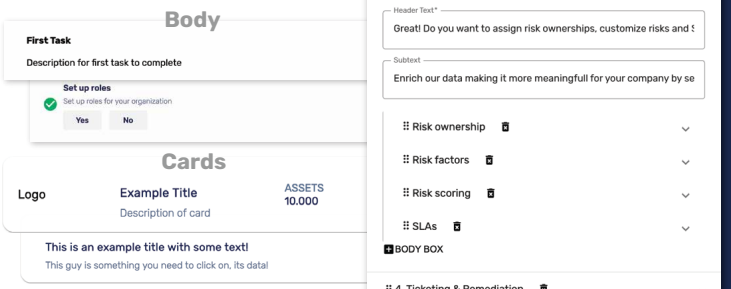
UCSC:
Richard Jullig
Roy Shadmon

Brinqa:
Paden Portillo

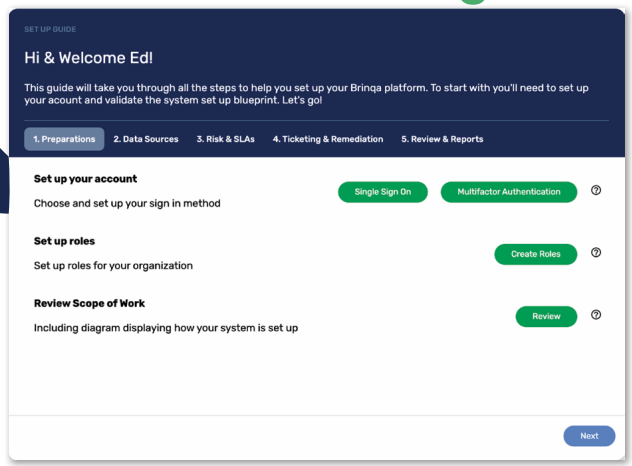
Result

Cascading Editor

Use the Cascading Editor to create, edit, and customize onboarding guides quickly and effiecently.



Custom Onboarding Guide



Approach

- Design onboarding guide and a website in Figma
- Create angular components which are configurable by JSON for each item in the Onboarding Guide
- Create Storybook Story for each component
- Individual component testing using Jest and Storybook visual testing
- Middleware for Brinqa server communication
- Create a website which allows users to customize the guide and save the JSON file

Key Features

Web App Editor: Customer success engineers can dynamically edit onboarding guides with a live preview. They can add modules, edit text, and rearrange content through an intuitive drag-and-drop interface.

Configuration Driven Guides: The onboarding guide is generated from a real-time updated JSON configuration file. Edits in the UI directly update the JSON, which can be saved, uploaded, and shared.

Editor Validation: Our editor enforces input and movement validation of tabs and content to reserve the integrity of the onboarding guide's format.

Middleware Data Population: The system has middleware infrastructure to allow portions of the onboarding guide to be populated using data from Brinqa databases, as the use user sees fit.

Conclusion

This project lays the foundation for the implementation of onboarding guides in Brinqa's client acquisition process. This software will cut down the onboarding process from 6 months to weeks per onboarding. Future additions to this software include deploying the onboarding guide to clients with a configured JSON file, complete with middleware-database integration.

Capstone Project

Brinqa - Customer Health Activity Dashboard

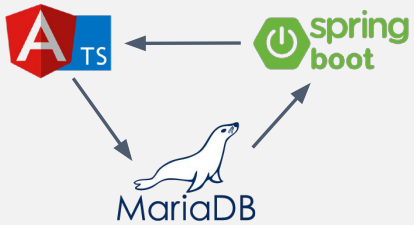
Carson Diehl, Rohit Nagabundi, Karen Korine, Ian Chong

Abstract

- Brinqa's project enhances the interface for Brinqa internal users with a comprehensive dashboard.
- Transitioning from manual JSON data analysis to an interactive, unified dashboard
- The application integrates key metrics such as login frequencies and user activity to aid in customer support and retention.
- Key challenges include adhering to Brinqa's existing tech stack for integration and maintaining minimal dependencies for security.
- Built with Angular TS, Spring Boot, and MariaDB to ensure seamless integration, scalability, and manageability.

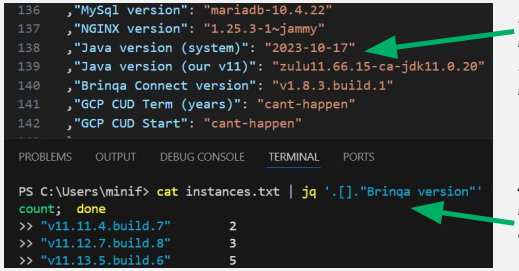
Approach

One of the main aspects of our approach was to add visualization through dynamic graphs, charts, and tables from data points to facilitate for easier inspection and understanding of a particular customer sentiment. Since we are in the cybersecurity sector, securing API endpoints and allowing it to integrate with Brinqa existing applications to pull data from their internal tools securely was a top priority.



Overview

Brinqa provides cybersecurity solutions for close to a thousand different clients. They currently interact with their customer data as raw text which makes quick assessment and group comparison difficult. To help manage the varying needs of each client, we were asked to make a dashboard that effortlessly displays customer data for internal analytics.

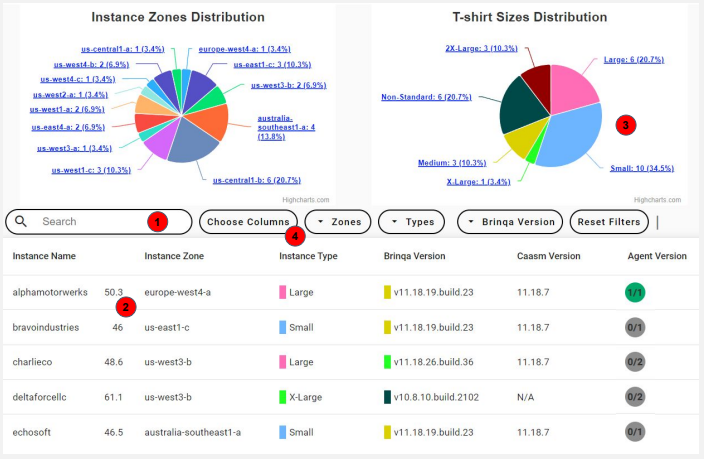


Most Brinqa employees currently interact with the customer list in an IDE for basic searching and JSON handling.

Any advanced queries are handwritten as Bash scripts to analyze the data.

With such a large customer base, it is important that Brinqa support staff is able to tell if a customer is having an issue at a glance.

UI features were color associated with priority table fields to give context and easy customer health assessment.



Acknowledgments

We, as a team, would like to acknowledge our sponsor, Brinqa, Ron Dovich and Paden Portillo. In addition, Lecturer Richard K. Jullig and Roy Shadmon for giving us this incredible opportunity to work on this capstone project.

Features

1. **Advanced Search** - query multiple fields at once and instantly update table.
2. **Customer Sentiment Score** - Composite score calculated based on recent usage statistics to legibly reflect customer health in a score out of 100.
3. **Dynamic Visualization** - Allow users to visualize data with interactive charts and graphs to easily observe patterns or trends in customers and their needs.
4. **Intuitive Customization** - Individual users can set preference for appearance and load them upon next login.

Results

- Decreased time needed for data analysis and comparison by 65%
- Led to a ~30% increase in efficiency and productivity when assisting customers
- Administrator privileges and modular code ensure updates to data sources or JSON are reflected without code refactor

Conclusion

Our Project has helped Brinqa in achieving an efficient and productive way to view and analyze data and better service customers. Our features were designed with expansion in mind so it can continue to provide customer health activity tracking for Brinqa.

Capstone Project

Dell LCBot

Avneesh Muralitharan, Brandon Llanes, Eunice Hong
Jodh Khubbar, Josue Martinez, Justin Lu

Abstract

Currently, when system upgrades fail or a system pre-check reports issues, sysadmins may have to manually sift through countless documents for a few days in effort to find a solution. Dell LCBot aims to greatly reduce the system downtime by leveraging a RAG based chatbot with open-source LLM models to semi-automate the troubleshooting process. In effort to further reduce system downtime, we chose to implement various optimization techniques such as markdown chunk splitting and prompt engineering.

Approach

Working Locally with Open-Source Models

Everything had to be run locally with open-source models as sending private information to an external LLM like GPT-4 would leak internal data. We decided to use Llama-3-8b, an LLM that can run locally with Ollama. Initially it was a challenge as LLMs are compute intensive, but improvements in LLMs (Llama2 -> Llama3) made it possible to run lightweight models with a higher degree of performance.

RAG and Markdown Chunking

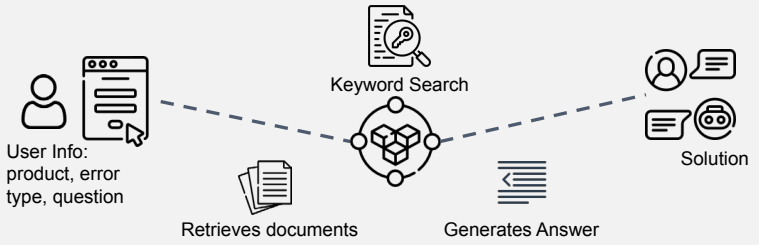
RAG helps us utilize external documents when generating answer. With the user input of product line, LCBot draws product specific documents from the knowledge base. To optimize the input flow of the document, we structured our own chunk splitting method based on markdown format.

Prompt Engineering with Few-Shot In-Context Learning to Prevent Hallucination

Before interacting with the chatbot, users fill out a form with their specific prompts, including system prompt, user prompt and assistant prompt, serving as guidance and for in-context learning examples, which help LLM generate answers based on users' specific need, and talior the answers in specific format without hallucination.

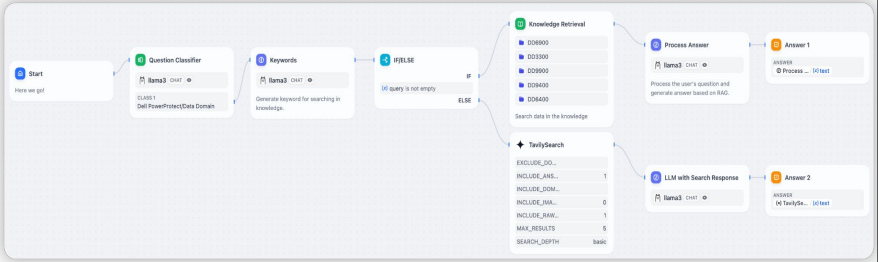
Overview

- Besides selling PCs and computer peripherals, Dell also has a line of servers called PowerProtect. PowerProtect is used internally for Dell Cloud and sold to other companies for their own internal use.
- Because of the complexity of these systems, fixing bugs and doing simple upgrades require searching for information across 1000+ documents. It takes sysadmins an average of three days to search for the correct upgrade workflow or Knowledge Base Articles (KBA), resulting in system downtime during this period.
- We built a chatbot for system admins to answer questions about upgrade workflows and bug fixes, reducing the time it takes to find the right documents from several days to seconds.



Workflow

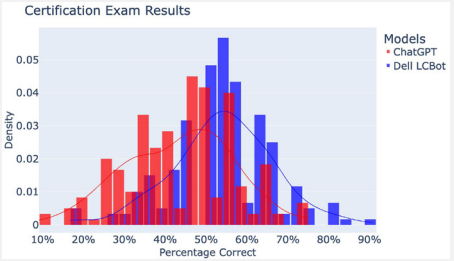
With the specified product line and error type, user's question is streamed to our model. Using this custom workflow, relevant documents are retrieved to the LLM with keyword search, and then the answers are generated based on the keyword search and knowledge retrieval results, then get delivered to user. Users can also enable the search feature to use Tavily search, a specific search engine for LLM to get relevant information about their questions and documents.



Analysis

Benchmark Testing

We tested the performance of LCBot on the Dell PowerProtect Certification exam. Sysadmins need to pass the exam with a score of 63% to operate Dell servers. Using chatGPT as a baseline, we plotted the spread of LCBot's scores as LLMs work non-deterministically and don't produce consistent output.



Bleu Score

To measure the accuracy of LCBot response, we compute the similarity score with use cases.

Multi-Path Retrieval Method

To retrieve relevant text from multi sources, and selects the best results matching the user query after reranking using rerank model.

Conclusion

In summary, LCBot is able to retrieve workflows and bug fixes from over 260+ Dell manuals. After this quarter, the chatbot will be deployed on Dell servers for internal use, streamlining information retrieval and significantly reducing system downtime. Looking ahead, our future goals include expanding the chatbot's knowledge base by incorporating internal KBAs and telemetry data. In conjunction, we plan to implement a user account system with defined levels of access to documents, ensuring that sensitive information remains secure while granting appropriate access to authorized personnel.

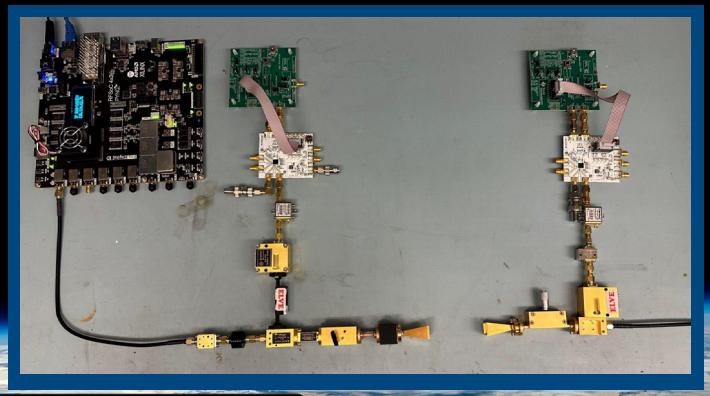
Acknowledgments

Sponsors: Colin Zou, Aruna Prabakar
Teaching Staff: Richard Jullig, Roy Shadmon

ELVE mmWave

What's Our Project's Purpose?

- Our team is dedicated to creating an RF link prototype that will establish a 5 [Gbps] one-way communication link that operates in the W-band, 76-81 [GHz]
- The prototype will utilize our company sponsor's, Elve Speed, TWTA (travelling-wave tube amplifier)
- This project is meant to be a proof of concept in application for a high-speed ground station link with LEO satellites



Team Member: Kristina Eliot

Link Budget/Antenna Propagation

- Calculates key parameters for the Receive and Transmitter sub-team, for signal performance and system reliability
  - Free Space Path Loss
  - Effective Aperture
  - Power Received

Team Members:
Seamus Kelly, Jessica Kaur

Radio Control

- Converts inputted 5 Gbps baseband signal into a suitable form for transmission using QPSK modulation
- Processes signal to remove noise and errors, ensuring clear and reliable communication

Team Members:
Derek Abarca, Rogelio Franco

Transmitter

- Tx takes the modulated baseband signal from RC and upconverts it to the W-band (78.5 GHz) to then transmit over the link in collaboration with Link Budget sub-team

Elve's TWTA

The TWT is a vacuum electronic device that amplifies signals over a wide frequency range, and when combined with a power supply, it forms a TWTA, capable of amplifying millimeter wave and sub-terahertz frequencies.

Receiver

- Receiver accepts the signal from Transmitter and prepares it for Radio Control to process
- The signal will be down converted from 78.5 GHz to 1.25 GHz and filtered for sources of distortion

Team Members:
Niki Mobtaker, Kevin Sandoval

Acknowledgements: The Elve mmWave team would like to thank the following individuals and groups for their support throughout this project: Professor Stephen Petersen, Elve Speed Inc., Sage Emerson, Harley Berman, Ian Chung, and Derek Huerta

Capstone Project
Eye Diagram Analyzer

Evan Metcalf, Thomas Pollicino, Alfonso Del Rosario
Lukas Teixeira Döpcke, Shreyas Vittal

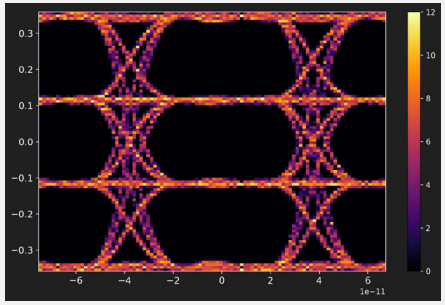
Problem

- Eye diagrams produced by network analyzers and oscilloscopes involve large amounts of data.
- Processing and analyzing the data to project and compare the resulting graphs is time-consuming.
- Comparing eye diagrams manually is inefficient and subjective.

Approach

- Downsample the data using various algorithms to speed up data processing.
- Perform comparisons using the plotted data in image form.
- Conduct comparisons on the data level of the eye diagrams.
- Rank the most similar eye diagrams to a given target eye diagram within a set.

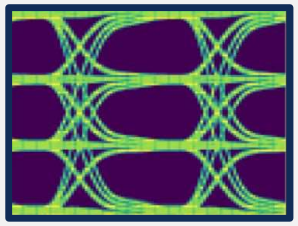
Downsampled Data



Project Overview

The project addresses the challenge of efficiently analyzing and comparing eye diagrams, which represent digital signal quality. By creating a system that incorporates data downsampling, image-based comparisons, and data-level comparisons, the project aims to streamline the process of finding similar eye diagrams within a large dataset. The approach balances precision and efficiency for faster and more accurate eye diagram analysis.

What is an Eye Diagram?



- An eye diagram is a graphical representation of a digital signal quality and characteristics.
- It is produced by overlapping many short segments of a digital signal to create a pattern resembling an eye.
- Eye diagrams are used to assess the quality of a digital transmission system and identify issues such as jitter, noise, etc.

Example

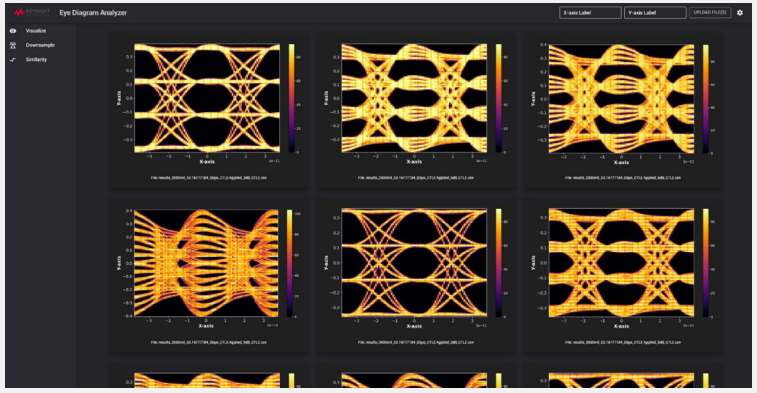
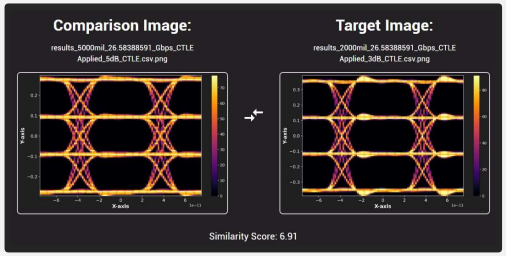


Image Analyzer

- Enables objective and precise comparison of eye diagram images for efficient analysis and evaluation.



Results

- Successfully downsampled datasets, producing similar eye diagrams.
- Implemented image processing and algorithmic comparison methods.
- Developed a web app for dataset input, downsampling, as well as eye diagram comparison.

Acknowledgements

UCSC

- Richard Jullig
- Prajas Kadepurkar

Keysight

- Jeff Drala
- Alan Copeland
- Ivan Diep
- Brennen DiRenzo
- Maxim Pletner
- Ailee Grumbine

Baskin Engineering

Capstone Project
Keysight: AI Forum Bot

Evan Metcalf, Thomas Pollicino, Alfonso Del Rosario
Lukas Teixeira Döpcke, Shreyas Vittal

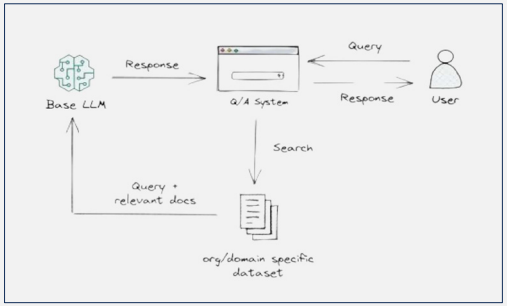
KEYSIGHT TECHNOLOGIES

Problem

- Users rely on the company forum for assistance with questions about the OpenTAP software.
- Limited number of engineers with the necessary expertise to provide comprehensive answers.
- Response time for questions is often too lengthy.

Approach

- Retrieval-Augmented-Generation



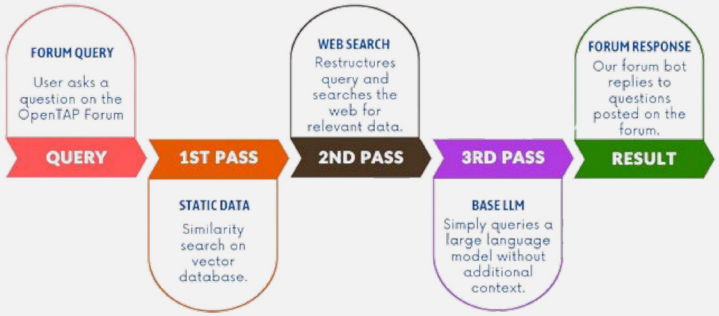
- Gather information relevant to the OpenTAP software from various sources (Github, Youtube, Documentation) and store into a vector database, a specialized database that efficiently stores and searches high-dimensional data for fast similarity-based retrieval.

OPENTAP YouTube GitHub

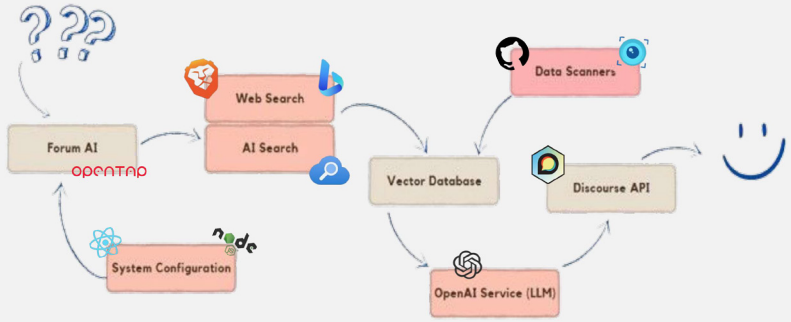
Project Overview

The AI forum bot addresses the problem statement by developing an AI system that can generate accurate and immediate responses to user queries on the OpenTAP forum, leveraging the capabilities of OpenTAP, an open-source test automation platform.

How does it work?



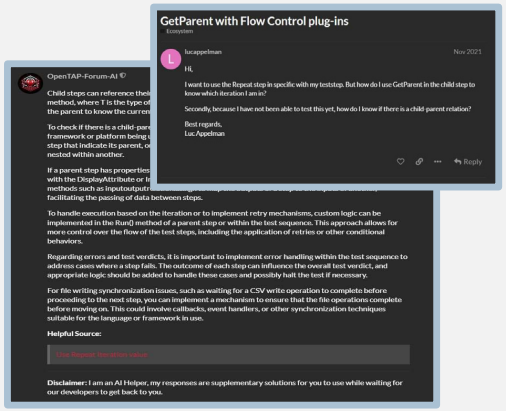
System Architecture



Results

- The AI forum bot answers **96.43%** of questions correctly.
- All public and relevant data is stored and updated in our vector database.
- Created a full-stack web application for system configuration and monitoring.

Example



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- Prajas Kadepurkar

Project Sponsors:
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- Alan Copeland
- Ivan Diep
- Brennen DiRenzo
- Maxim Pletner

Capstone Project

Keysight AI Plugin Generation Project

Madeline Miller, Ahmad Joseph, Philip Xie
Huy Nguyen, Shaunveer Gill

Terminology

Keysight - A company that provides tools that test and measure, such as developing a radio frequency analyzer for 5G / LTE field testing.

OpenTAP - Keysight's open source test automation project that automates standardized testing for devices, such as power supplies and batteries.

Plugin - Used to communicate between OpenTAP and the device being tested. Need a different plugin to connect to OpenTAP for every device.

LLM - Large Language Model is a type of AI program that can recognize and generate text; e.g. Chat GPT

RAG Approach - Uses external data sources, such as device documentation, to provide context that the LLM uses to base its answer on.

Abstract

Targeting test engineers involved in test automation, our AI-based solution offers an innovative approach to streamline plugin creation. We utilize LLMs to create a plugin for a user-specified device in Python or C#, decreasing software development time for test engineers. A common problem when AI is involved is AI hallucinations (incorrect or misleading results that AI models generate), which we reduced by implementing the RAG approach.

Acknowledgments

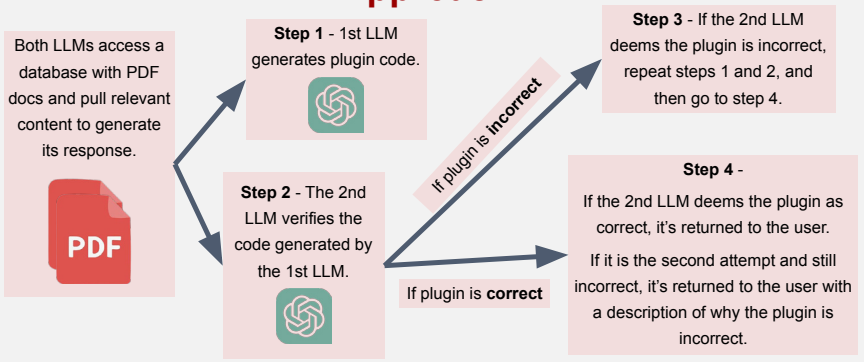
Keysight: Jeff Dralla, Maxim Pletner, Alan Copeland, Brennen Direnzo, Ivan Diep

UCSC: Richard Jullig, Prajas Kadepurkar

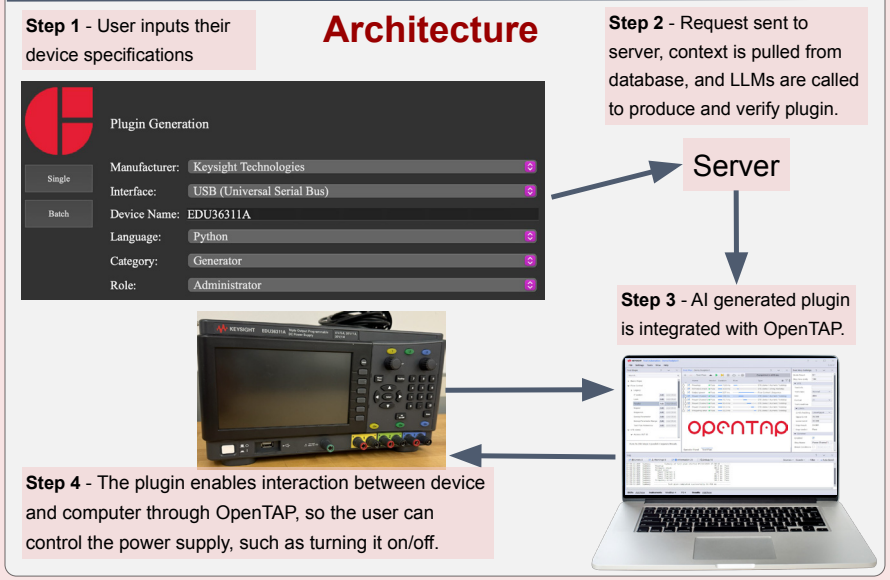
Overview

Test engineers, who do not necessarily have a software background, spend time learning how to create a new plugin for every device they want to test. We leverage LLMs to create and verify plugins for user-specified devices to minimize development time so that test engineers can focus on testing rather than initially developing software plugins.

Approach



Architecture



Analysis

When comparing the time it takes for a developer to code a plugin from scratch versus time spent waiting for a plugin to be generated, we found that we reduced the development time of OpenTap plugins by ~75%. In evaluating the accuracy of code generation, we examined whether the generated code meets syntactical requirements, adheres to the coding structure of plugins, and complies with errors.

Results

- **Plugin Generation**: Successfully generates plugins for a wide range of Keysight tools based on user's device specifications by leveraging LLM models and the RAG approach.
- **Streamlined Verification**: Plugins are verified before they are sent back to the use, ensuring that they compile and the necessary structural elements.
- **Compatibility Assurance**: Plugins produced can be used directly with various keysight softwares without any additional modifications.

Conclusion

We were able to decrease development time so that test engineers can focus on testing their device rather than software development. In the future, more time can be spent on fine tuning the prompt passed to the LLMs to produce the most accurate plugin. Additionally, the database that the LLMs have access to can be expanded with more extensive documentation to increase the quality of plugins that are produced.

Hardware Validation Dashboard

Ankur Ahir, Jonathan Michel, Matthew Polis
Mathew Raju, Rehan Ali

Overview

We have developed a user-friendly dashboard to visualize the results of daily regression tests at a glance. This was to solve an issue Nutanix had where they had to parse through hundreds of separate emails to identify trends in test failures.

Approach

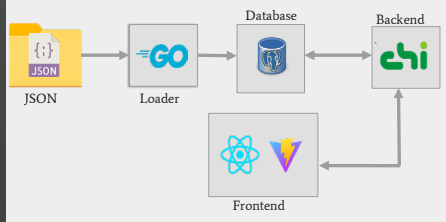
1. Parsing the data: One of the constraints we faced was that the input data was in a variable format. This required us to take an approach that involved writing a recursive JSON parsing algorithm that identified fields in both the input file and our database.

2. Uploading to the database: Once the data has been parsed by the loader, we then insert it into the database. We made the uploader generic enough to handle over two years' worth of semi-structured JSON data.

3. Backend formats data: Next, our backend makes queries to the database and formats the data, in such a way that our frontend can easily display it.

4. Displaying the data: Finally, our frontend displays the data in an interactive manner.

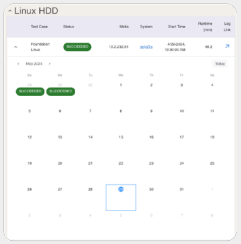
Architecture



Solution

What they had

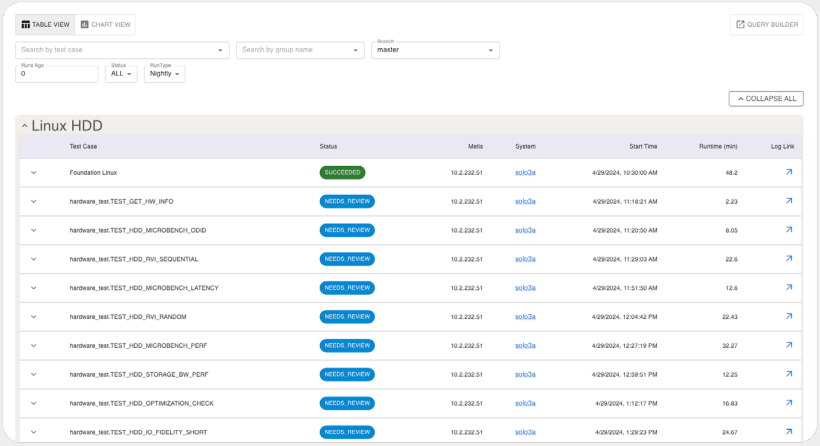
Testing was difficult for the Nutanix team because each test generated a huge amount of detailed hardware configuration data, about 2,000 lines per test. This data was written in JSON, a format that's easy for computers to read but can be hard for humans to sift through, especially when the structure of the data wasn't consistent.



What we gave them

We can now see the results of a test over a timespan enabling a quick comparison of results. If more data is required, the quick link shown will take you to pages with all the information available in a cleaner format. Data is now stored consistently under a new database. The Nutanix team plans to transition their JSON system into our new database loader.

Main Dashboard



Results

- Our app enables Nutanix employees to **quickly analyze** the status of tests and their history in one place.
- The parser's flexibility allows the team to change the logs in any way they'd like **without having to rewrite or reconfigure** the tool.
- The Nutanix team now has a tool that can **quickly notice trends** in test results and help pinpoint the cause.
- It also enables sharing of results between team members, only requiring sharing the link to the page.
- Finally, the centralization of hardware data will create the ability to **find long term associations** between hardware elements and test behavior.

Conclusion

- Our loader has successfully ingested the prior test result data.
- The dashboard has enabled Nutanix employees to quickly and easily analyze test results.
- The dashboard has been deployed with Nutanix, and we have satisfied our main objective to centralize and visualize test result data.

Acknowledgements

UCSC
Richard Jullig
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Rob Mills
Varinder Sogi
Spencer Kase Rohlfing
YJ Yang

Advanced Memory Utilization Analytics

Camden Beard, Daniel Hsieh, Teresa Wu
Apramay Singh, Jason Tanita, Dongjing Wang

Abstract

Users of large-scale systems with numerous virtual machines often face difficulty in identifying the specific process/component that is responsible for system slowdowns.

Our project aims to diagnose performance issues within a system by providing accessible and user-friendly visualization of bandwidth metrics in real time, allowing Nutanix admins to quickly identify the root causes of system slowdowns.

Impact

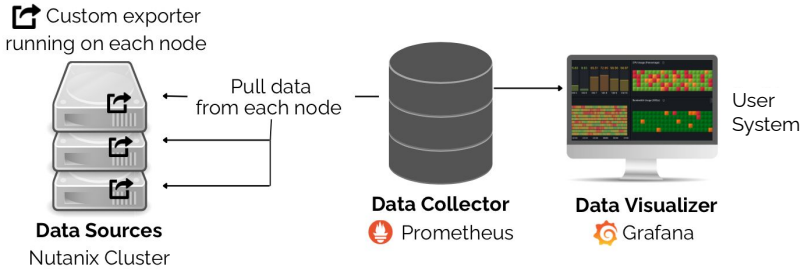
Prior to our project, system admins would have to cross-reference a variety of different command-line tools in order to verify system performance issues. Additionally, these tools only have the ability to monitor performance in the current moment.

Now, our project provides a single point of reference for visualizing both current and historical performance data, allowing admins to quickly pinpoint issues instead of having to spend time manually running diagnostics.

Overview

Nutanix provides cloud computing options to customers worldwide through hypervisor software for virtual machine management. With the rapid growth of data-intensive workloads on computer systems, there is an increasing need to efficiently monitor memory on each system to ensure the maximization of bandwidth capabilities.

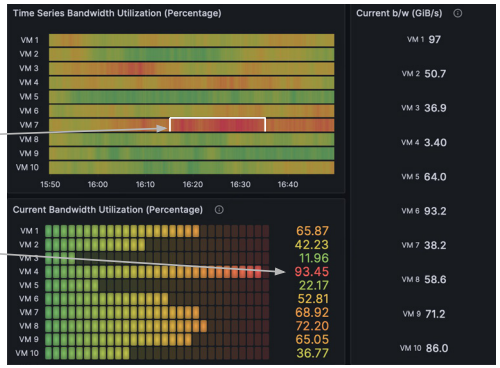
Architecture



Results

High memory bandwidth utilization

Current memory bandwidth utilization



Our finalized product is an end-to-end system that elevates low-level hardware metrics, offering enhanced insight into workloads.

Approach

Outline of our end-to-end system:

- **Gather performance data** from Nutanix nodes by running our custom exporter, which utilizes Linux tooling
- **Aggregate metrics** with data collector database
- **Chart metrics** by connecting data collector to our tailored dashboard visualization

Conclusion

We have implemented a dashboard that displays priority metrics in real time, allowing for quick and easy identification of bandwidth issues.

Possible future features include:

- Alerts for performance issues
- Analysis of bottleneck causes

Acknowledgments

Project Sponsors:
Rob Mills, Hiren Desai, Varinder Sogi

Teaching Staff:
Richard Jullig, Roy Shadmon

Oxford Instruments: X-Ray Technologies Artifact Detection Automation

Akash Balakrishnan, Andrew Yegiayan, Alec Navapanich, Colby Frey, Alan Tan

Abstract

The **Alpine Software** delivers an automated production system for the detection of radio-opaque **artifacts** within a **beryllium disk**. Through the incorporation of instrument control and image processing techniques into a skeuomorphic GUI, acquisition time can be cut by **up to 80%**. This application provides quality assurance operators a streamlined way to flag potential **artifacts** to replace or otherwise categorize samples that do not satisfy a customer's requirements.

Approach

The **Alpine Tower** is a lead-lined cabinet housing the **power supply, camera, and X-Ray sources** for testing samples. A manual test requires the operator to physically man the tower for the entire duration of the test in order to control the camera, power supply and X-Rays.

Alpine Tower

The **Alpine Software** is an application that **virtually controls** the testing features of the **Alpine Tower**. Using a series of **Data Acquisition Devices (DAQs)** we can send and receive info between the physical tower to the virtual software.

By using a file called a "**Recipe**", we can make presets that will fill all necessary values for each test step with just one click, **further reducing hands-on operator involvement**.

Overview

What are artifacts?

Artifacts are small defects on a **beryllium disk** which can appear as false positives in X-Ray images. **Figure 1** shows an X-Ray image of bone fragments labeled 1 - 6. The object marked "**a**" is actually an **artifact on the beryllium disk** used to take the X-Ray! In this case, the artifact's similarity to bone fragments could lead to misdiagnosis for the patient.

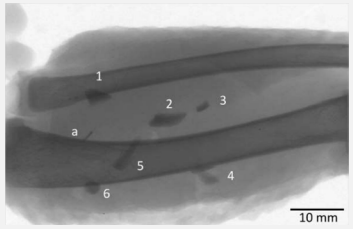


Figure 1

Figure 2

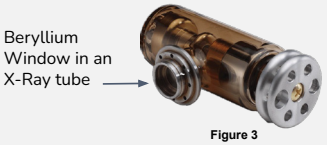
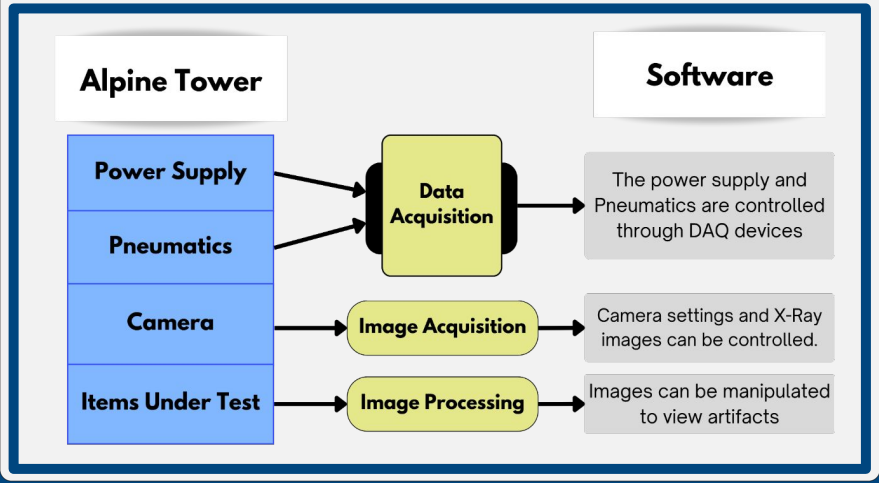


Figure 3

Enhanced Quality Assurance

Oxford Instruments develops X-Ray equipment for various industries. With tight tolerances comes the need for rigorous and detailed testing to ensure that each product meets the customer's standards. Our team developed the **Alpine Software** which streamlines, standardizes, and automates the window inspection process for X-Ray sources (previously done manually at Oxford Instruments).



Results

Image Processing:
Using the **Alpine Software**, quality assurance operators can cut the time per disk by up to 80%. We have automated the lengthy and error-prone image processing procedures which **highlight** and **quantify** artifacts on beryllium disks. This drastically accelerates the process while still providing granular control to experienced operators.

Virtual Control:
Control of the Alpine Tower has been moved to the software and now can be entirely managed from a skeuomorphic UI that mimics the original inputs on the display board.

Data Collection:
The results of all tests are documented and stored in a file architecture for future reference and analysis.

Conclusion

Alpine Software is a tool that automates the detection of artifacts in **beryllium disks**, reduces the manual operating time, and provides robust test documentation.

Acknowledgments

UCSC
Prof: Richard Jullig
TA: Roy Shadmon

OI:XT
Mark Patton
Chris McKenzie
Daisy Avila

UC SANTA CRUZ
BaskinEngineering

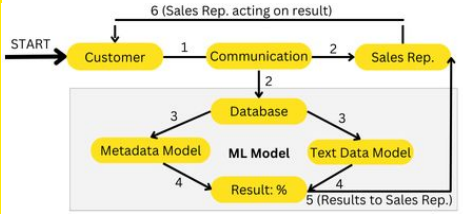
Capstone Project

B2B Sales Forecasting

Courtney Wei, Jonathan Vengosh, Michael Lee, Gaurav Sahasrabudhe, Joshua Angel, Tanuj Sood

Rimini Street®

Approach



Text Data Model

- We predict based on the summaries of past and future actions by the salesperson.
- We transform our data using a Vectorizer, which manipulates the text to represent the data as numbers and then pass the data into our text model to predict whether or not a sale goes through.

Ensemble

- The probability predictions from the text data and metadata models were obtained.
- The final prediction was determined by taking the maximum probability from either model for each instance with a threshold of 0.5 to convert them into final class predictions.
- This ensemble approach leverages the strengths of both models to improve overall prediction performance.

Metadata Model

- We narrowed down our features to Annual Revenue, IT budget, opportunity created date, etc.
- We processed the data: percentile limitations on numerical data, converting categorical data into numerical data (dates to number of days, one hot encoding etc).
- We normalized this data using our choice of scaler.
- Lastly, we ran this through a model to predict whether or not the sale went through.

Background

Rimini Street is a market leader in third-party enterprise software support services, specializing in ERP Services (business process), CRM Services (customer relationship management), and Databases (backend data storage).

The sales process for these support services is long and extremely complex as it involves business-critical infrastructure, many decision makers, and navigating existing support contracts with vendors.

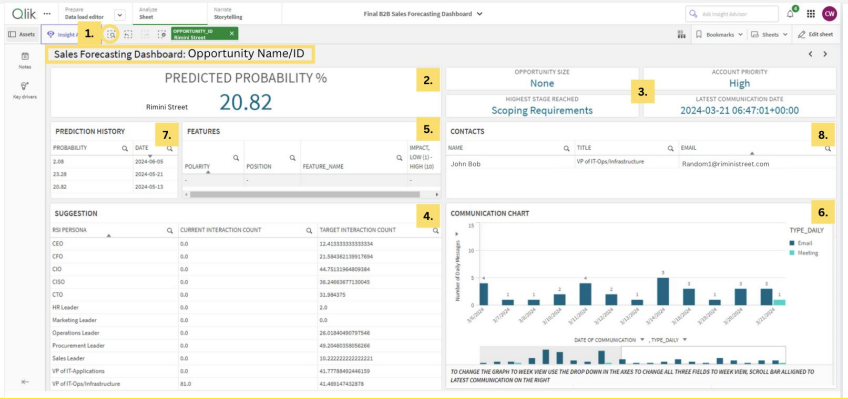
Overview

Every quarter, the sales team at Rimini Street must forecast which opportunities will close. Accuracy is critical as these forecasts drive decision-making around prioritization, resource allocation, and compensation.

Due to the complexity of the sales process, forecasting each sales opportunity requires considering an overwhelming number of factors. Typically, it takes over 9 months to close a sale, involving hundreds of data points, consisting of emails, phone conversations, technical documentation, and legal contracts.

Considering all this information and contextualizing it for forecasting is extremely time consuming for the sales team. Our project aims to support the sales team by developing a machine learning model that predicts the outcome of a sale, represented through a dashboard. This dashboard enables the sales team to gain deeper insights into all factors influencing each sale.

Sales Forecasting Dashboard



Analysis

Our ensemble model achieves an **84%** accuracy in forecasting opportunity outcomes for the quarter when tested on historical data.

```
Accuracy: 0.8441295546558705
Classification Report:
              precision    recall  f1-score

           0       0.92      0.87      0.89
           1       0.66      0.75      0.70

    accuracy                           0.84
   macro avg       0.79      0.81      0.80
weighted avg       0.85      0.84      0.85
```

Dashboard Features

The ensemble powers the Sales Forecasting dashboard.
It provides the following functions:

1. Ability to search for each opportunity
2. Forecasts the sales
3. Displays relevant basis information (Opportunity Size, Highest Reached Stage, Case Priority Ranking, Last Communication Date)
4. Advises communication suggestions
5. Lists positive and negative features
6. Shows the communication frequency timeline
7. Keeps track of the prediction history
8. Lists the top contacts with email links

Conclusion

We were able to finish all of our major goals, which includes the Sales Prediction Machine Learning Model and Sales Forecasting Dashboard. Future improvements can be made towards the sales prediction model accuracy, dashboard UI, and a fully built pipeline to allow users to experiment with inputting different feature values in the dashboard to change the sales prediction.

Acknowledgments

UCSC	Rimini Street
Richard Jullig	Tyler Munger
Roy Shadmon	Phil Cullen

We are very pleased to include faculty-selected posters for the Senior Design Projects that were done without industry sponsors. Some of these projects were instigated and/or sponsored by research at Baskin Engineering, while others were created by students with the assistance of faculty mentors and TAs.

Gorilla Vault

Jovan Jassal, Mirely Perez, Dominik Novello, Bradley Paoli, Jake Podraza, Xavier Thompson, Shams Shniian
University of California, Santa Cruz | Baskin School of Engineering

Project Overview

Problem: Packages delivered to houses get stolen too often

Solution: Reduce the number of delivered packages that are stolen from houses

Design Objectives

Reduction in Theft
Up to 70%

Highly Secure
24-Hour Operation

Stores Multiple Packages
Up to 3 Medium Sized Packages

Target Users

John - Busy Software Developer:
Needs a reliable system that secures packages delivered during his absence

Emma - Homeowner:
Needs an easy to use system to prevent package theft

Alex - Frequent Traveler:
Needs a way to manage and secure packages remotely

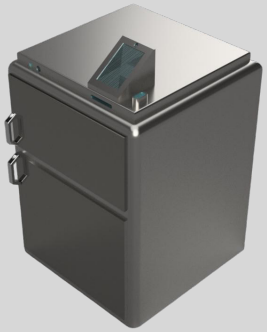
Design for Manufacture / Maintenance

- Minimize the number of parts by making the box as one full piece
- Standardize parts to reduce variety by having the same box material, door handles, hinges, and locks
- Design for easy assembly and access for service by leaving space between the bottom and top doors
- Implement software features to allow access to box internals for maintenance or repair without compromising security such as having a dedicated maintenance mode

Aesthetic Prototype

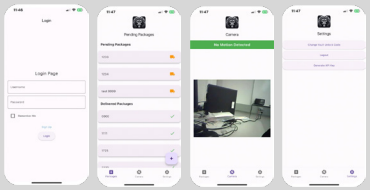
Mobile Application

Physical Vault



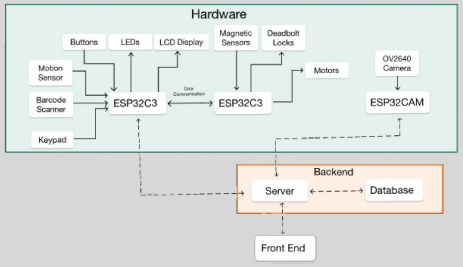
Functional Prototype

Mobile Application



Physical Vault

System Architecture



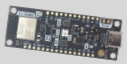
- Embedded Hardware communicates with the web server via HTTPS, requiring a valid and unique API key
- Mobile Application communicates with the web server via HTTPS, requiring a valid jwt token
- MongoDB database is accessed within the web server
- Communication Protocols:
  - I2C - LCD Display, Keypad, OV2640 Camera
  - ADC - Motion Sensor
  - Digital GPIOs - Buttons, LEDs, Door Communication, Magnetic Sensors, Deadbolt Locks, Motors
  - UART - Barcode Scanner
  - WiFi - HTTPS Requests

Mobile Application

Flutter

- Allows users to manage and track packages remotely
- Supported Features: Input new package identification numbers, track the delivery status of packages, and update the vault access code
- Security Features: View camera footage and motion status around the vault
- Supported on iOS and Android mobile operating systems

Hardware Components



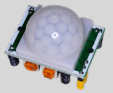
ESP32C3: Functions as the main controller, facilitating interactions between components and the server

Barcode Scanner: Quick , efficient, and secure access for delivery personnel

LCD Display: Prompts code entry and indicates the selected door's access status

Keypad: Users can securely unlock the top or bottom door with a code

Middle Door Mechanism: Uses motors to transfer packages securely to private storage



Motion Sensor: Detects motion around the vault and notifies user

ESP32CAM: Streams live footage to the app at 2 frames per second

Acknowledgments

Special thanks to Doctor Harrison for guiding us through this project

Contact Details

For more information, please contact Jovan Jassal at jjassal@ucsc.edu

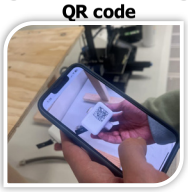
HydroConnect

Remote Water Consumption Measurement Device

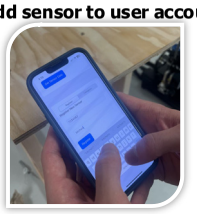
Gustavo Fonseca, Tim Kraemer, Gary Mejia-Martinez, Tirath Shah, Mitchell Tansey, Darren Yu, Kyven Wang

Installation Steps

1. Register sensor through QR code



2. Add sensor to user account



3. Unscrew sink inlet pipe

4. Attach female-to-female adapter

5. Attach sensor to adapter

6. Turn sensor on using switch

7. Attach inlet pipe to sensor

It's that easy!

General Overview

Need Statement

For the regular homeowner, we propose a device that attaches to faucets to track and store water usage statistics. The goal is to help users reduce utility costs and minimize their environmental impact by providing accurate and convenient monitoring of water consumption within their homes.

Design Objectives

- Design an effective installation for standard faucets and water inlets, with **minimal effort for the consumer**.
- Develop a robust, secure web server for data storage and retrieval, utilizing **standard encryption methods**.
- Ensure a seamless user experience on a mobile app with real-time sensor data.
- Achieve **less than 5% error** in water flow measuring and calculations.

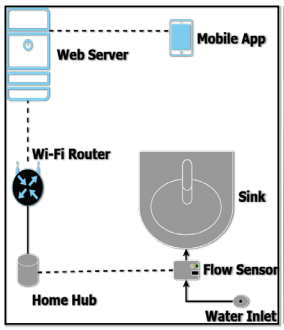


Fig. 1 Full Overview Diagram

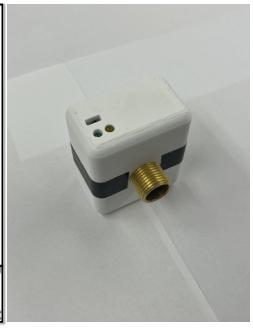


Fig. 2 Functional Prototype for Sink Attachment

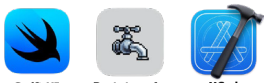
iOS App Design

Accompanying Swift App

Register/Deregister new sensors using QR code scanner on app.

Use of multiple sensors enables the ability to view live/historic data for specific sinks/water outlets.

Secure user login and registration through **JWT (JSON Web Token) Authorization**.



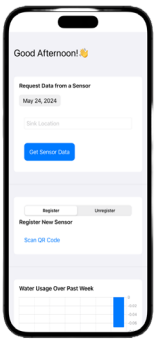


Fig. 3 Mobile App Home Page

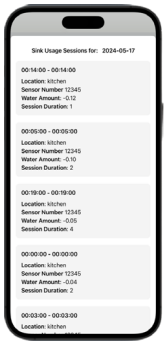


Fig. 4 Sensor Data View Page

Web Server Design

Web Server & Data Store on AWS Lightsail

Web Server used to store info such as user data, sessions, and registered sensors.

Back-end routing service written in **Flask**, rapid querying to a **PostgreSQL** database.

Reverse Proxy by Nginx handles incoming data packets from "Home Hub."

JWT Authorization is used to verify credentials by and provide correct data to the user app.

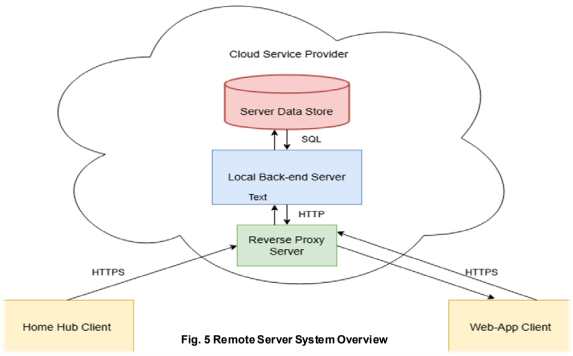


Fig. 5 Remote Server System Overview

Hardware Design

Sensing Attachment & Home Hub

Hardware is composed of two parts, **IoT Sensing Device** and **"Home Hub."**

Connection via **MQTT Broker** for seamless and secure connection.

Data from Home Hub sent to webserver w/ **API key** & **sensor ID via HTTPS request**.

Breakdown Animation

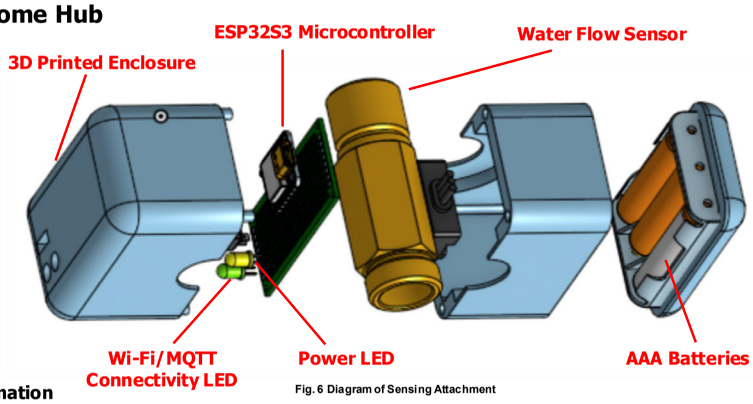


Fig. 6 Diagram of Sensing Attachment

Smart Dumbbell

Christopher Mathai, Bryce Cheng, Duo Yu, Brandon Lee
Jason Ho, Kevin Hsieh, Zhicong Zhang

Baskin Engineering

SMART DUMBBELL

Design Statement

Need Statement
Creating workout plans and tracking progress takes a lot of time

Goal Statement
Save time by providing an all-in-one virtual ecosystem to plan, track, and show user fitness data

Design Objectives

Accuracy
95%

Setup Time
<30 seconds

Monetary cost
<$20

Battery Life
40 hours

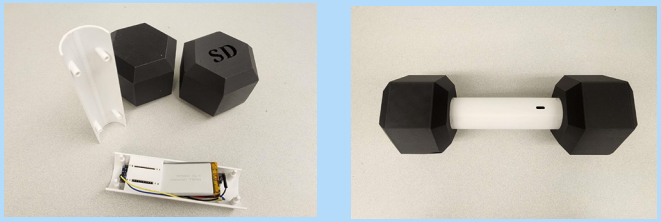
Personas

James | Gym Owner
Goals: Attract more customers
Lower maintenance cost

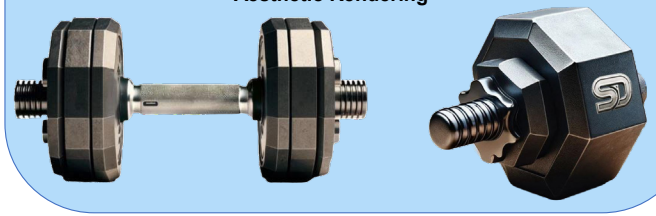
Jane | Student
Goals: Efficiently use their time in the gym
Ability to track progress

Jon | Personal Trainer
Goals: Accurately track client workouts
Provides client progress report

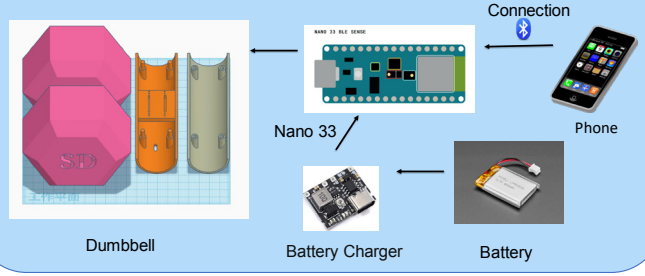
Functional Prototype



Aesthetic Rendering



Design Overview



Maintenance

- Connect to Bluetooth and enable app permissions
- Enter user data
- Set goal (optional)
- Recharge battery when low battery signal is displayed
- Keep ports clean of sweat

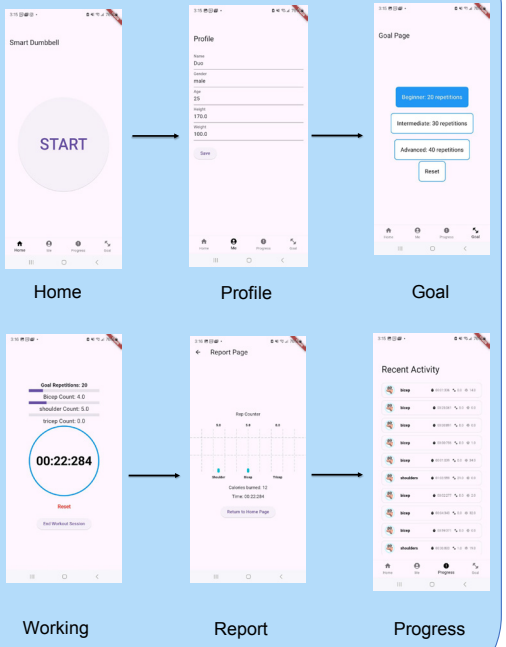
Components

- Arduino Nano 33 BLE
- Lipo Rechargeable Battery
- Teyleten Battery Charger
- Phone for BLE Connection

Manufacturing

- Flash chip and connect sensors
- Cast the steel handle
- Embed chip and sensor
- Stabilize and secure chip/sensor

App Layout



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We would like to thank Professor Harrison for his guidance and feedback throughout the duration of this project

Contact Information

cjmathai@ucsc.edu
zzhan375@ucsc.edu

SMARTFEEDR: Automatic Pet Feeder

Da Eun Lee, Sriharsha Maddala, Ginna Khang, Kristina Fout, Leon Feng, Mallika Gupte

Email: cse123ateam4@gmail.com

Need Statement

For busy pet owners, our automatic pet feeder ensures pets are well-fed and cared for remotely. Perfect for those away for long hours or days, it provides peace of mind. Ideal for both dog and cat owners, our feeder offers unmatched convenience and support.

Design Objectives

Our Automatic Pet Feeder:

- Live Camera Feed: Dual-angle live feed for monitoring food and pet.
- Mobile App Control: Full functionality via a user-friendly app.
- Hygiene Focused: Water bowl cover and automatic food covering.
- Waste Reduction: Discards uneaten food after 24 hours, minimizing waste by 75%.

Goals:

- Reduce the need for pet care during work travel to 15%.
- Decrease job changes for more pet time to 20%.
- Cut reliance on external pet monitoring to 13%.

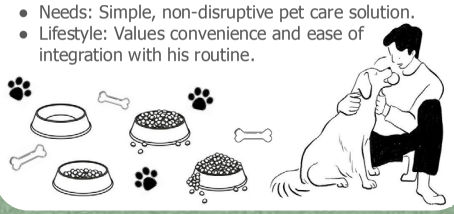
Personas

Grace

- Profile: Lives alone, cat owner, productive, and open-minded
- Routine: Leaves home by 7AM, commutes for an hour, occasionally does overtime.
- Needs: Easy way to check in on her cat, manage care remotely.
- Pet Care Preferences: Cat eats only dry food.

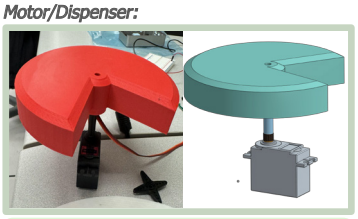
Bob

- Profile: 43-year old business owner, inherited a dog, minimal pet experience.
- Routine: Frequent short-distance travel, enjoys social activities after work.
- Needs: Simple, non-disruptive pet care solution.
- Lifestyle: Values convenience and ease of integration with his routine.



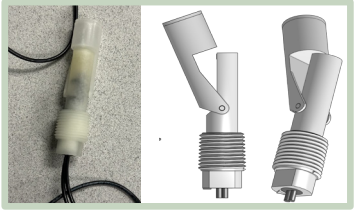
Hardware + Structure Design

Motor/Dispenser:



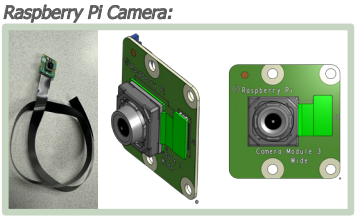
Features a motor-driven, Pac-Man shaped fan that dispenses pet food into the bowl as it rotates.

Liquid Level Switch Sensor:



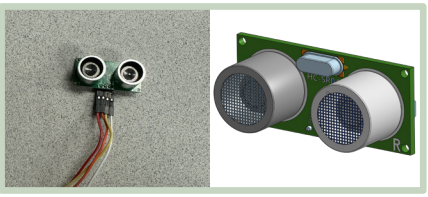
Signals low water level when the mouth is open and high water level when closed. Updates every 20 seconds or on-demand with a button click.

Raspberry Pi Camera:



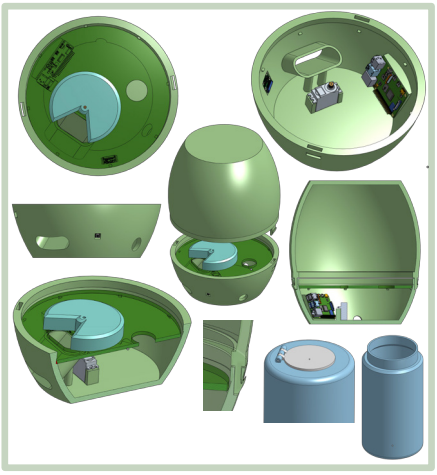
Provides real-time images of the feeder's vicinity. Press the capture button for instant updates.

Ultrasonic Sensor:



Measures the distance from the lid to the pet food, indicating when the container is nearly empty. Updates every 20 seconds or on-demand with a button click.

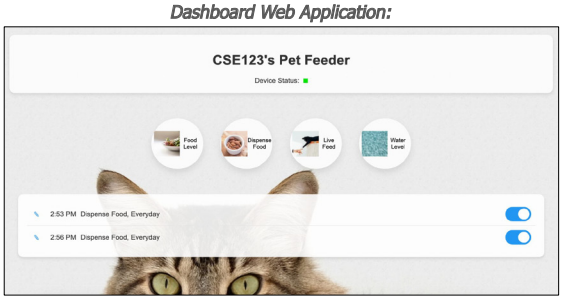
CAD Designs:



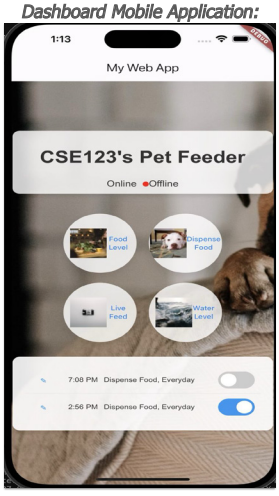
Final design consists of two parts — a top and bottom compartment. The top will hold the food and water containers. The bottom will hold all the hardware and holes for dispensing food and water.

Software Design

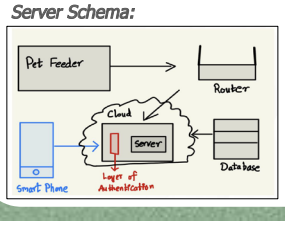
Dashboard Web Application:



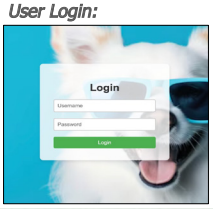
Dashboard Mobile Application:



Server Schema:



User Login:



CONTACT US

Patrick Mantey
Director, Senior Design Capstone Jack Baskin Endowed Professor, Computer Engineering, Emeritus
mantey@ucsc.edu

Frank Howley
Senior Director of Corporate Development
fhowley@ucsc.edu

Kelsey Evans Detwiler
Corporate Development Specialist
ked@ucsc.edu

Molly Sims
Executive Director of Development
molly.sims@ucsc.edu

Visit our website: **csspp.soe.ucsc.edu**
Email: **bsoedev@ucsc.edu**

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