Overview of My Technical Projects

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November 5, 2024

Contents

1 Introduction

This document provides an overview of the technical projects I have undertaken, summarizing their objectives, features, my contributions, and links to relevant repositories or media. They are listed in chronological order, starting with the oldest project.

2 Generally used technical skills

The following is a list of skills that I have learned from the projects I have worked on:

- Git(hub/kraken)
- Subversion
- Programming languages: C, C++, MySQL, Python
- Qt
- Zephyr RTOS
- STM32 microcontrollers
- ESP module
- Bluetooth Low Energy (BLE)
- Bluetooth mesh networking
- FPGA development
- DIS and C-DIS knowledge
- Gtest
- Valgrind
- Image processing with OpenCV
- Neural networks with Python

3 Robot Navigation System

3.1 Objective

The goal was to program a Pololu robot with a microcontroller capable of autonomous line following, maze navigation, and precise item retrieval from a storage grid. The robot also needed to handle low-battery scenarios by autonomously routing to a charging station.

3.2 Key Features

- Automatic sensor calibration for accurate line following
- Pathfinding algorithm for shortest route selection
- Programmable pick-up locations via a PC application

3.3 My Role

I focused on the robot's behavior within the storage grid, implementing an optimized pick-up algorithm. The robot systematically scanned rows along the x-axis, adjusting its y-axis position upon getting all items each row.

3.4 Outcome

We successfully programmed the robot to autonomously navigate black tape lines, retrieve items, and return to the starting point. The system also handled battery monitoring, routing the robot to a charging station when necessary.

3.5 Technical Skills

- C for robot programming

3.6 Links

The project repository on github is private.

Video Avans media students made about the project: https://www.youtube.com/watch?v=SRDnrjxwf_8&ab_channel=AvansTech

4 Weather Monitoring Station

4.1 Objective

This project aimed to create a weather station that collected and stored environmental data, presented through a custom GUI. It used an STM32 microcontroller, integrated sensors, and an ESP module for internet connectivity and data transmission.

4.2 Key Features

- ESP module for internet communication
- SQL database for data storage
- Qt-based GUI for data visualization
- STM32 microcontroller with integrated environmental sensors

4.3 My Role

I designed the PCB, configured the ESP module, and managed the SQL database. I ensured proper connections on the PCB based on sensor datasheets and programmed the ESP to relay data to the database.

4.4 Outcome

The system successfully collected sensor data, stored it in a SQL database, and presented it through the GUI. The STM32 handled local storage in case of network outages, preventing data loss.

4.5 Technical Skills

- STM32 microcontroller
- ESP module for internet connectivity
- SQL database
- PCB design

5 Home Automation System

5.1 Objective

The aim was to explore BLE technology by setting up a home automation system using BLE microcontroller dongles (Nordic dongles). The system included a custom GUI to control switches and lamps via Bluetooth, without requiring manual code changes.

5.2 Key Features

- Nordic dongles as switches and lamps
- BLE and Bluetooth mesh for communication
- Qt-based GUI for device configuration

5.3 My Role

I developed the Qt GUI and researched BLE mesh networking. I also contributed to a system that allowed easy configuration of devices using the mesh network.

5.4 Outcome

We faced numerous challenges with the Nordic SDK during this project. Despite these difficulties, we managed to get the dongles to communicate with each other using hardcoded connections. Although the GUI was developed, we did not have enough time to implement the actual connection between the GUI and the dongles.

5.5 Technical Skills

- Qt for GUI development
- Bluetooth Low Energy (BLE)
- Bluetooth mesh networking
- Nordic SDK

6 Robot with Vision System

6.1 Objective

The objective of this project was to program a pre-built robot equipped with a camera to navigate between black tape lines on the floor and recognize traffic signs. We implemented a neural network for traffic sign recognition to accomplish this.

6.2 Key Features

- Vision system for real-time traffic sign detection
- Neural network for sign classification

6.3 My Role

In collaboration with a teammate, I developed and trained a neural network model specifically for traffic sign recognition. We used images captured by the robot's camera, first extracting traffic signs from each image and then classifying them with our neural network.

6.4 Outcome

Our final robot could successfully navigate along the black tape on the floor and recognize traffic signs. Due to the camera's limited resolution, signs could only be accurately recognized at close range. Testing demonstrated that our neural network achieved an accuracy of approximately 90% in sign detection.

6.5 Technical Skills

- Python for neural network development
- OpenCV (cv2) for image processing
- NumPy for matrix operations

6.6 Links

Git repository for the project: https://github.com/heavydragon99/VisionProject

7 Retro Game on FPGA

7.1 Objective

The project focused on creating a retro-style video game implemented on an FPGA platform.

7.2 Key Features

- Custom game logic on FPGA
- State machine for managing game states and interactions
- Parallel processing for game logic and rendering

7.3 My Role

I developed the game's state machine and mechanics, ensuring smooth player control and accurate game logic. A big challenge was to implement everything parallel, as FPGA is not designed for sequential programming.

7.4 Outcome

The game was successfully deployed on the FPGA, providing a classic gaming experience with responsive controls and seamless state transitions.

7.5 Technical Skills

- FPGA development
- State machine design
- Game logic implementation

7.6 Links

Video about the final game we delivered: https://youtu.be/ffHNOK9DIWc?si=P1LWv95vnLnjlM2g

8 Internship: C-DIS Library

8.1 Objective

During my internship, I developed a library to compress DIS data into C-DIS format and decompress it back into DIS.

8.2 Key Features

- Compression of DIS data
- Decompression to DIS
- C++ library

8.3 My Role

I focused on handling Electromagnetic Emission PDUs and developed a dynamic bitwise datatype for efficient compression. By making the Electromagnetic Emission PDU I learned more about complex design with recursive structures.

8.4 Outcome

The project produced a functional library for compressing and decompressing DIS data. Although only a few DIS PDUs have been included, the library is designed to easily accommodate additional PDUs. Additionally, a test was provided to measure the time required for compression and decompression, as well as to compare the size of the original DIS message with the compressed CDIS message.

8.5 Technical Skills

- DIS and C-DIS knowledge
- Gtest for unit testing
- Valgrind for memory management
- Subversion for version control

8.6 Links

The project is hosted on Airbus's private Subversion repository.

9 Startweek Project

9.1 Objective

This project involved developing a handheld device for Avans' Startweek event, designed to guide students through the city and offer mini-games along the way.

9.2 Key Features

- Custom-built PCB
- Integration of multiple I/O components
- Self-contained handheld device

9.3 My Role

I developed part of the navigation system using Zephyr, integrating sensors like the LIS3MDL and LSM6DSO to determine device orientation.

9.4 Outcome

We produced a fully functional handheld device with a 16x16 LED matrix, a 4x4 button matrix, a 64 LED circle, multiple buttons, and a few switches, guiding students through specific locations and enabling mini-games.

9.5 Technical Skills

- Zephyr RTOS

9.6 Links

GitHub repository: https://github.com/JaroWMR/Startweek.git