MIDDLE EAST TECHNICAL UNIVERSITY

ELECTRICAL-ELECTRONICS ENGINEERING

DEPARTMENT

EE300 SUMMER PRACTICE REPORT

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SP Company Name: FEV Turkey

Company Division: Infotainment and Connectivity Systems

SP Date: 10.07.2023 – 04.08.2023

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1. INTRODUCTION

I did my EE300 internship, where I observed professional life for the first time, at FEV Turkey, in the Infotainment and Connectivity team. FEV Turkey stands as a leading automotive engineering and innovation company, operating as a crucial element of the global FEV Group. In the domain of automotive engineering, Infotainment and Connectivity System Engineering specializes in developing in-car systems for entertainment, communication, and information.

My practice lasted between 10.07.2023 and 04.08.2023, for a total of 4 weeks and 20 working days. Since I am interested in the automotive industry, I chose to do an internship in this company and team to observe business life and gain my first experiences in this sector. Interning at one of our country's leading companies in the field of Automotive R&D made great contributions to me observing both the industry and business life.

I started by learning what system engineering is and its basic terms, in the Infotainment and Connectivity Systems team which consists of 4 Electrical and Electronics Engineers. I researched why and where terms such as V-model, ASPICE, ADAS, and FMEA were used, and learned from the engineer I worked with where they were used in their work. I was given a research topic as the main task and then I was asked to prepare and present a presentation on the subject. I researched the project, which is about producing scenarios that will make daily life easier with an automation system to be installed between smart homes and vehicles; and determining how to install this system. I prepared and presented my presentation with the help of the engineer that I worked with.

2. DESCRIPTION OF THE COMPANY

1.1. Company Name

FEV TR Automotive and Energy Research and Engineering Ltd.

1.2. Company Location

ITU Ayazağa Campus Arı Teknokent Arı-1 Building Maslak/İstanbul

Phone: 0212 276 06 86

1.3. General Description

FEV, an internationally recognized engineering and development company, is an important player in the automotive and transportation industries. Founded in Germany in 1978, FEV has evolved into a global leader in providing innovative solutions for vehicle development, powertrain systems, and advanced technologies.

With a strong commitment to sustainable mobility, FEV offers a comprehensive range of services, spanning from concept design to production implementation. They have gained reputation for pioneering advancements in powertrain development, emissions reduction, electrification, and autonomous driving.

FEV's expertise extends to internal combustion engines, hybrid and electric powertrains, as well as fuel cell systems, reflecting their dedication to promoting environmentally friendly transportation solutions. They also actively contribute to the development of connected and autonomous vehicles, playing a crucial role in shaping the future of mobility.

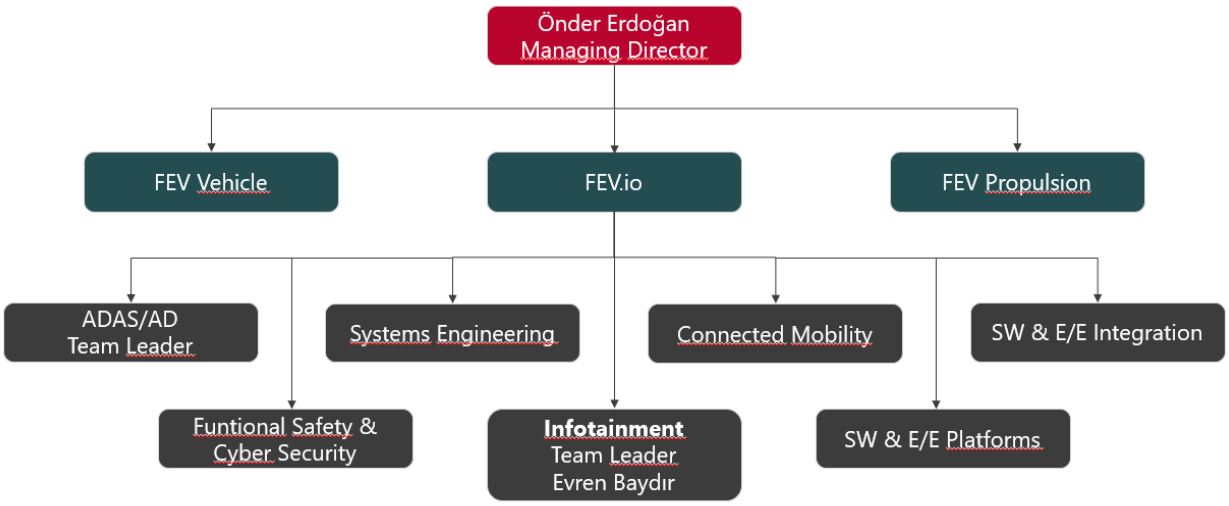
The company operates a network of state-of-the-art engineering facilities worldwide, fostering collaboration with global automotive manufacturers, suppliers, and research institutions. FEV's diverse team of experts continually strives to drive innovation and tackle industry challenges, making them an integral part of the ever-evolving automotive landscape. Their commitment to cutting-edge technology and sustainable practices solidifies FEV's position as a trusted partner for the automotive industry's most demanding projects and endeavors.

1.4. History of the Company

- FEV (Forschungsgesellschaft für Energietechnik und Verbrennungsmotoren) was established in 1978 by Prof. Franz Pischinger.
- In 1985, the company began operating in North America, California.
- In 1987, the company moved to Detroit, MI.
- In 1998, the company entered the Chinese market by opening its first office in Beijing.
- In 2000, the Asian Technical Center was established, in Dalian. Powertrain and vehicle development service is provided.
- In 2009, the India Technical Center was constructed in Pune.
- In the same year, a world-class durability testing center was opened in Brehna, Germany.
- In 2011, FEV Turkey was established.
- In 2013, FEV purchased the electronics company DGE Inc. and started to work in telematics and infotainment systems.
- In March 2015, FEV purchased D2T Powertrain Engineering S.A., a French company specializing in test systems and engineering services.
- In 2016, the company directed its attention toward areas such as connected and automated driving, cybersecurity, and alternative powertrains.

- In June 2016, the FEV Beijing Vehicle and Powertrain Development Center was established.
- In 2020, FEV opened the largest development and testing facility globally for high-voltage batteries used in both passenger and commercial vehicles.

1.5. Organization



3. SYSTEM ENGINEERING

In the intricate landscape of technological advancements and complex systems, system engineering stands as the cornerstone for achieving optimized functionality, performance, and reliability. This interdisciplinary field provides a structured and holistic approach, aiming to integrate diverse components and subsystems into a cohesive and efficient whole.

3.1. Infotainment

Infotainment is a term that combines "information" and "entertainment" and refers to the technology and systems integrated into vehicles to provide a range of features. These features typically include audio and video entertainment, navigation, smartphone connectivity, and information services, all designed to enhance the in-car experience for both drivers and passengers. Infotainment systems aim to deliver convenience, connectivity, and entertainment while ensuring safety and usability.

3.2. Connectivity

A Connectivity System Engineer is a specialized expert with the responsibility of creating, developing, implementing, and maintaining systems that facilitate the seamless exchange of data and communication between different devices, networks, or platforms. These professionals are instrumental in designing and optimizing systems that enhance connectivity across a wide array of applications, encompassing domains such as the automotive sector, telecommunications, the Internet of Things (IoT), and other industries.

3.3. V-Model

The V-Model, also known as the Verification and Validation Model, is a system engineering and software development approach that emphasizes the relationship between different development and testing phases. It is a variation of the traditional waterfall model and is particularly relevant in critical systems engineering and software development where testing and validation are essential. As the model is designed in a "V" shape, it is called V-Model. The steps and shape of the model are given in Figure 1. (Oppermann, 2023)

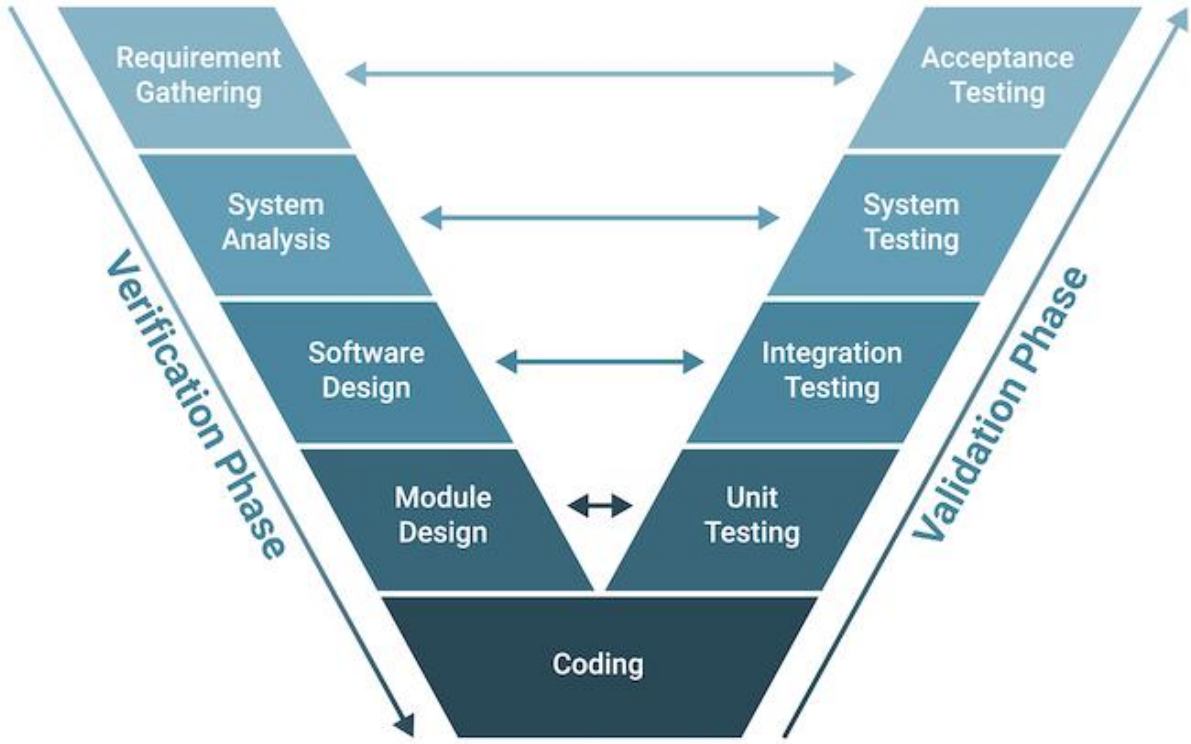


Figure 1 V-Model Steps

3.4. ASPICE

ASPICE, short for Automotive Software Process Improvement and Capability dEtermination, is a framework and standard applied in the automotive industry to evaluate and improve software development processes. It aims to elevate the quality, efficiency, and effectiveness of software development for automotive applications, ensuring that vehicle software aligns with safety, security, and performance requirements. ASPICE offers a structured approach to software development, with a particular focus on evaluating process capability and maturity levels, resembling other process improvement models like CMMI (Capability Maturity Model Integration). For automotive manufacturers and suppliers, ASPICE compliance is crucial to demonstrate their ability to produce top-tier software for vehicles while adhering to industry standards and regulations.

System engineers are using the System Engineering Process Group part of the ASPICE. This part consists of 5 items which are called SYS-1, SYS-2, SYS-3, SYS-4, SYS-5. The first 3 of them were using at my summer practice place, according to requests of OEMs.

a. SYS-1 (Requirement Elicitation)

In this step of the process, the needs and requirements of the service provider company are gathered, processed, and tracked during the production and usage process in order to determine the basic needs of the desired work products.

I. Collect stakeholder needs and demands.
II. Analyze stakeholder expectations.
III. Agree with stakeholders on needs.
IV. Determine stakeholder needs baseline.
V. Control stakeholder needs changes regularly.
VI. Set up customer-supplier connection mechanisms.

b. SYS-2 (System Requirements Analysis)

The purpose of this step is to generate a set of system requirements that will be used as a manual for the design of the system by using the defined stakeholder needs.

I. Determine system requirements.
II. Design system requirements.
III. Analyze system requirements.
IV. Analyze the effects on the working area.
V. Develop verification criteria.
VI. Generate bidirectional traceability
VII. Ensure consistency.
VIII. Inform about agreed system requirements.

c. SYS-3 (System Architectural Design)

In this step, the system architectural design is established, system requirements are matched with elements of the system, and system architectural design is evaluated according to defined criteria.

I. Build up system architectural design.
II. Allocate system requirements.
III. Identify interfaces of system elements.
IV. Determine variable elements.
V. Evaluate alternative system architectures.
VI. Generate bidirectional traceability
VII. Ensure consistency.
VIII. Inform about agreed system requirements.

3.5. FMEA

FMEA, or Failure Modes and Effects Analysis, is a systematic method used across industries to identify potential failures, assess their impacts, and prioritize them based on severity, occurrence, and detectability. It helps organizations proactively manage risks, enhance quality, and improve safety by developing action plans to address the most critical failure modes.

4. VEHICLE TO HOME AUTOMATION (V2H)

This topic is given to me as the summer practice project. Vehicle to Home Automation is an automation system that is used to provide an easier life for customers by enabling communication between smart homes and vehicles. Vehicle and home will share location, route, temperature, security, etc. information with each other and some automation scenarios will be triggered according to the information. The system gives options to the customer to activate automation scenarios, in other words, automation scenarios will be ready to trigger. These scenarios are created one by one. Aims of scenarios and flowcharts that guide how these scenarios work are generated and sketched.

Communication technologies to provide communication between the smart home and the vehicle are researched. Analysis of the communication technologies and facilities of each of them are listed in the presentation and are presented.

As the FEV is an automotive company, in order to set communication between home and vehicle, the project should be run with the collaboration in a smart home company. Therefore, the facilities of the smart home companies were also researched and presented to guide the project.

Automation applications and voice assistants such as Alexa, Siri, and Google Assistant could be used to set up the system easier than creating brand-new software. As communication technologies and smart home companies, the properties of these applications were researched and presented to the team.

4.1. Communication Technologies

Vehicles communicate with other devices or clouds via a Telemetic Control Unit (TCU) that could get information of battery, location, route, etc., and give commands to the vehicle according to the set software. Different communication devices and technologies could be attached to the TCU. As customers may go dozens of kilometers further than home with the vehicle, one of the long-range communication technologies should be used for this automation system. Possible technologies were researched and 3 of them were introduced.

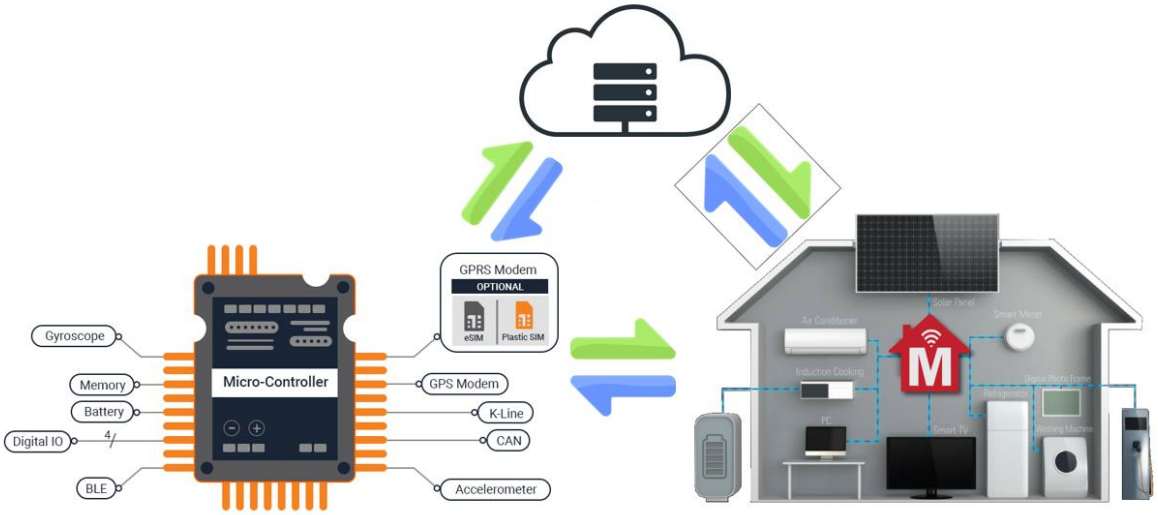


Figure 2 Communication Model of V2H

a. Sigfox Network

The Sigfox network is a global Internet of Things (IoT) network provided by Sigfox, a French company. It is designed for low-power, wide-area communication, allowing IoT devices to connect and transmit data over long distances while minimizing energy consumption. However, the data rate of the Sigfox is maximum 100 bps. Since Sigfox uses low power nearly 50 microwatts but has a very low data rate, using Sigfox as the main communication way is not the best choice, because of that it could be used as a complementary communication network. It uses the radio frequencies between 862 to 928 MHz. It is particularly suitable for applications where extended battery life and cost-efficient, long-range communication are essential, such as asset tracking, environmental monitoring, and industrial IoT. (Davitech, 2021)

b. Cellular Network

Cellular networks are wireless communication systems that divide regions into cells, each with its own base station. Key properties include broad coverage, mobility support, various frequency bands for different technology generations, compatibility with both voice and data services, security features, simultaneous support for multiple users, and ongoing technological advancements. Even if cellular networks provide high speed data rate and worldwide range, power consumption and cost of it is much higher than other technologies. Cellular networks are integral to modern communication, serving a wide range of applications and evolving through generations like 2G, 3G, 4G, and 5G to improve data speeds and efficiency.

c. LoRaWAN

LoRaWAN, or Long Range Wide Area Network, is a wireless communication protocol tailored for low-power, wide-area networks within the Internet of Things (IoT). It stands out for its long-range coverage, low power consumption, and cost-effectiveness. 433 MHz (Asia), 868 MHz (Europe), and 915 MHz (North America) frequencies are using. The data rate of LoRaWAN is acceptable for our project, between 0.3-50 kbps. Also, it provides protected bi-directional communication. LoRaWAN networks are well-suited for IoT applications, particularly in scenarios requiring extended battery life, wide coverage, and scalability for numerous connected devices. (Torres,2023)

4.2. Scenarios

I created 7 different automation scenarios, then I explained how they could be applied. A summary of each scenario is given in parts a, b, c, d, e, and flowcharts that I sketched of some of them are given in Figure 3, Figure 4, Figure 5, Figure 5, Figure 6, and Figure 7.

a. Vehicle and Home Temperature Optimization

When the customer starts route to home, the vehicle sends information about the location, route, and remaining time to arrive home via TCU. The smart home system checks whether the remaining time is less than necessary time to optimize temperature. If the answer is yes, the temperature optimization algorithm starts. It follows the given steps and when the customer arrives to the home, the temperature will be optimized with maximum efficiency. Therefore, the heating system does not have to work continuously, the home will not be cold or warm when the customer arrives or the customer does not have to turn on and turn off the heating system manually. Details and a draft of the scenario are shown in Figure 3.

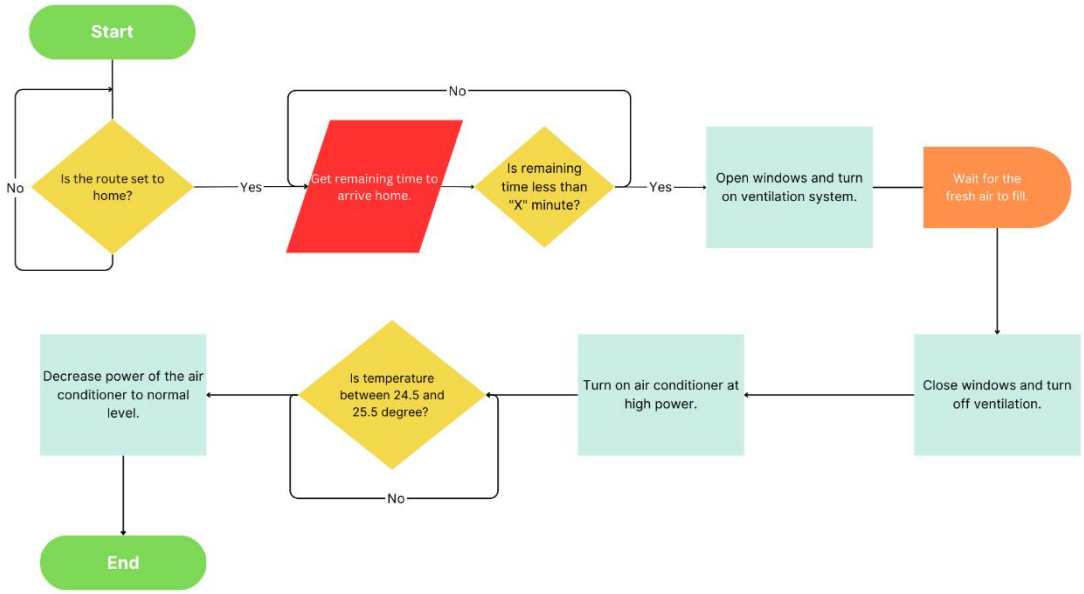


Figure 3 Flowchart of Home Temperature Optimization

In the opposite scenario, when the customer leaves home, the smart home sends information to the vehicle and it starts the vehicle temperature optimization algorithm.

b. Behaviors Relative to the Departure Point

When the customer starts route to home, TCU sends the location and route information of the vehicle to home. If the vehicle starts from near specific points or stops near specific points while coming home, different algorithms start according to departure and waiting points. Examples are given in the flowchart in Figure 4.

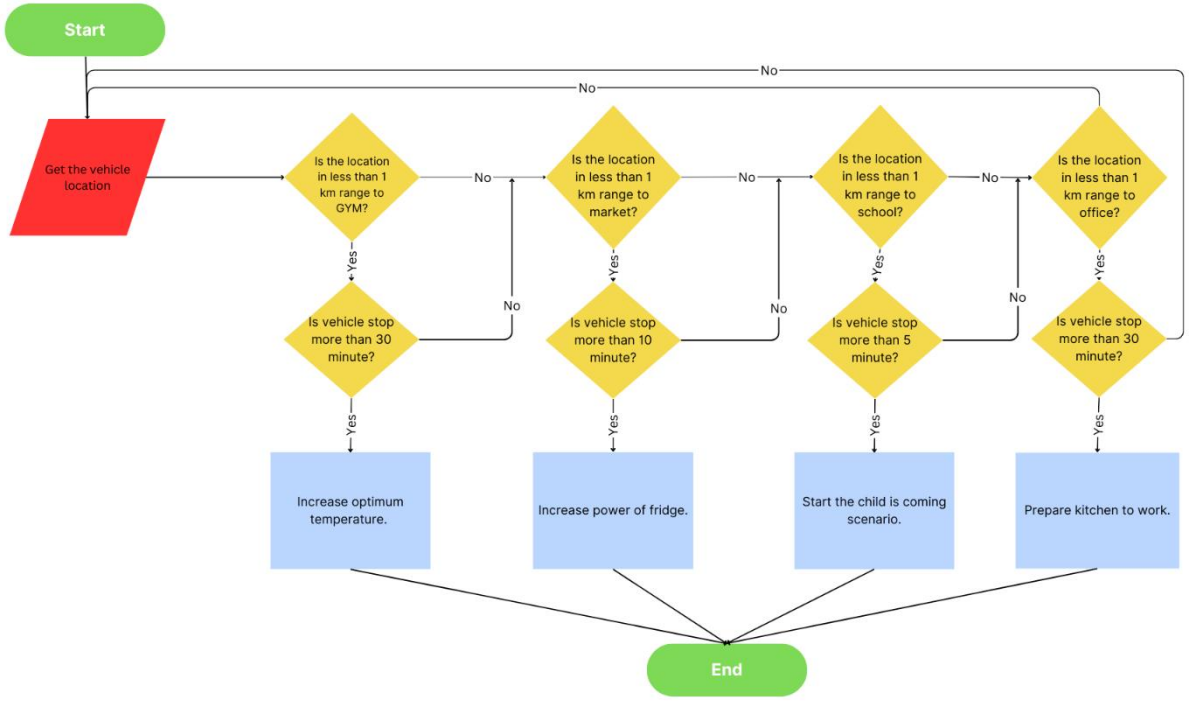


Figure 4 Flowchart of Departure Point Scenario

c. Notices Related to Calendar

The system checks events on the calendar, if the customer is not going to the correct event place or stays at home, the system notifies the user about upcoming events and travel information. How the scenario will work and how the system could be generated is shown in a general draft as a flowchart in Figure 5.

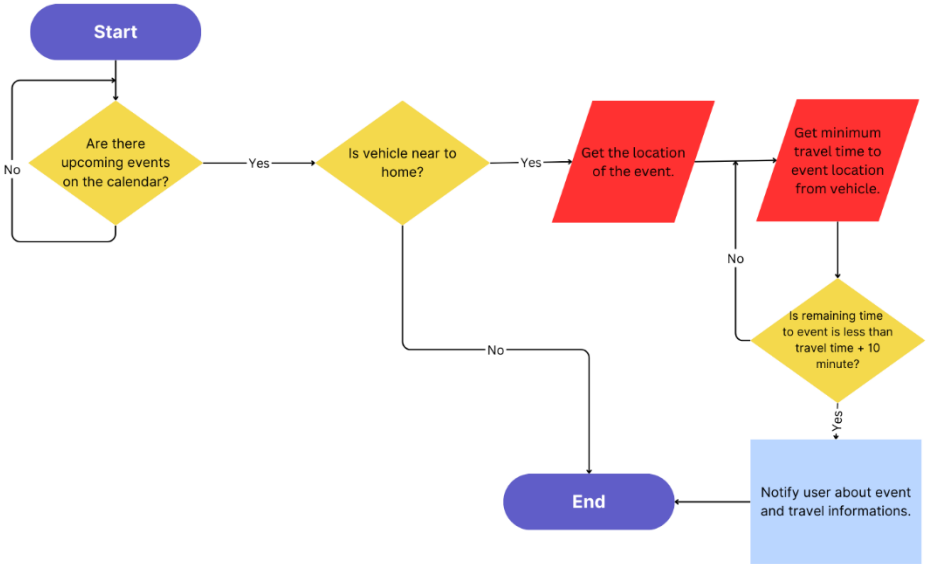


Figure 5 Flowchart of Notices Related to Calendar Scenario

d. Security Warnings

If an unsafe situation is detected around the vehicle, all cameras of the vehicle turns on and starts recording. The vehicle sends a notification to the smart home system and the user could send a notification to police via the smart home system. These properties and steps that the system should follow are given in Figure 6 as a flowchart.

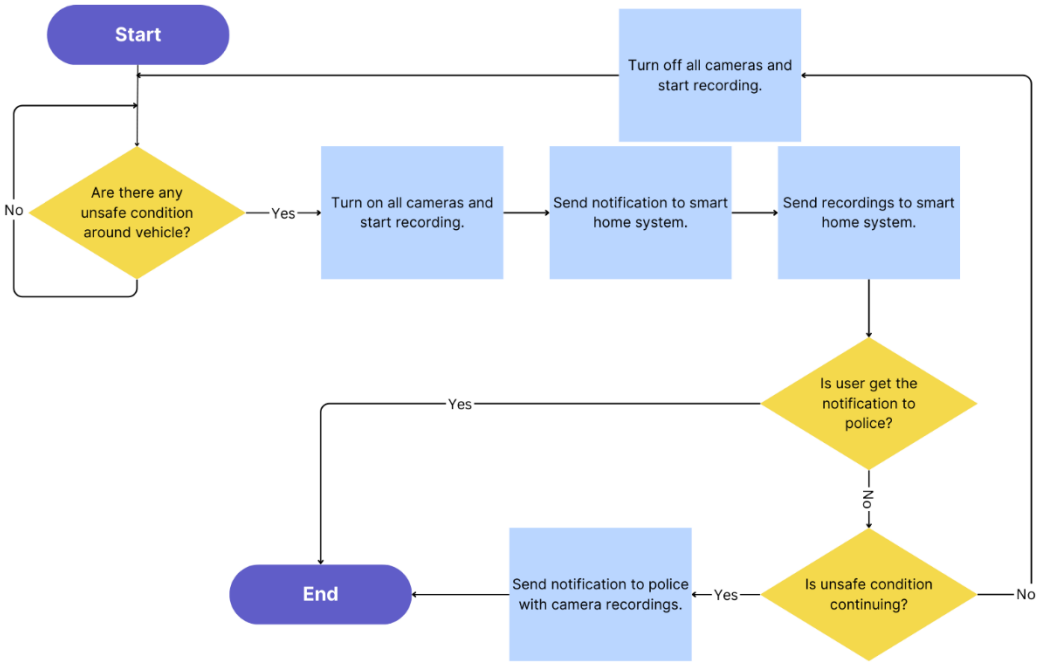


Figure 6 Flowchart of Security Warning Scenario

e. Music Continues

While driving a car, most people listen to music, radio, or podcasts. Most likely, what is being listened to is not finished, when the user arrives to home. The Vehicle to Home Automation system gets audio output information from the vehicle and sends it to the home if it is not finished. Then, when the user enters home audio will continue where it left off. The algorithm works as shown in Figure 7.

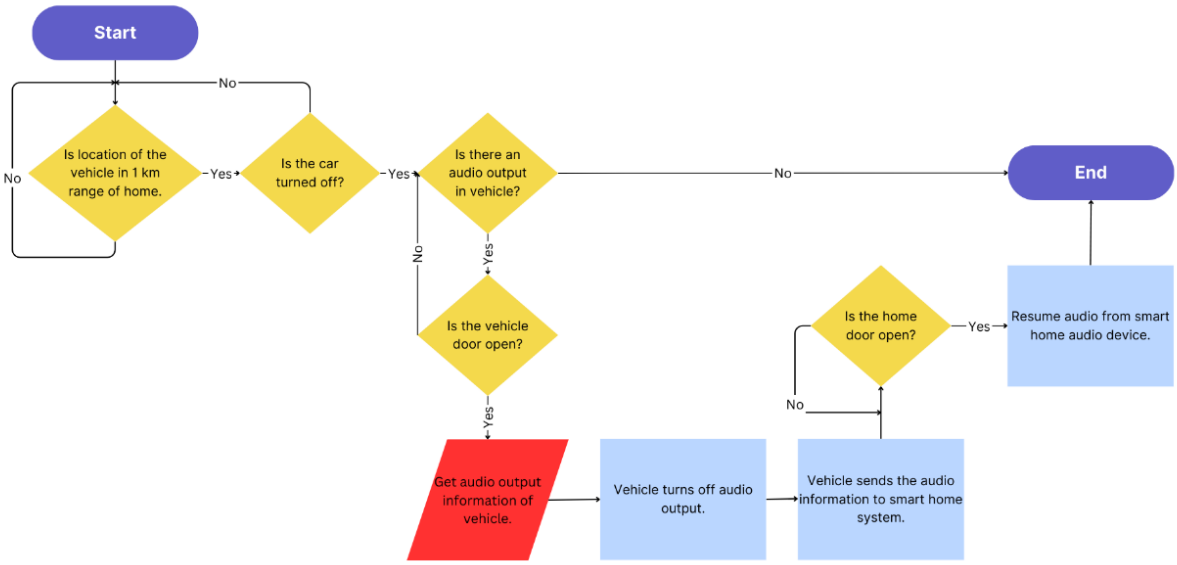


Figure 7 Flowchart of Music Continues Scenario

4.3. Automation Systems and Voice Assistants

Since it is very expensive and hard to create an automation system from scratch, combining ready-made softwares and components to set up the Vehicle to Home Automation system is easier and cheaper. There are some well-known home automation systems and voice assistants that could be used to set up our system.

a. IFTTT

IFTTT, or "If This, Then That," is a web-based service and mobile app that enables users to create customized automations and integrations between various online platforms, apps, and devices. It simplifies tasks by allowing users to set up triggers and actions, creating seamless connections between digital services and devices without the need for programming skills.

b. Amazon Alexa

Amazon Alexa is an artificial intelligence-powered virtual assistant developed by Amazon. It responds to voice commands, offering features like smart home control, information retrieval, entertainment, third-party app integrations, shopping capabilities, communication, and productivity tools. Alexa has been adapted to both smart homes and vehicles produced in recent years.

c. Google Assistant

Google Assistant, developed by Google, is a virtual assistant capable of performing tasks and answering questions using natural language voice commands. Its features encompass information retrieval, smart home control, entertainment, productivity tools, navigation, and wide-ranging app integrations. Available on various devices, Google Assistant enhances the user experience by facilitating voice-activated interactions and providing access to a broad array of services and functions.

d. Apple Siri

Siri, developed by Apple, is a virtual assistant integrated into Apple's various operating systems. It operates through voice commands and offers features like information retrieval, smart home control, entertainment, productivity tools, navigation, and multi-language support. Siri is deeply embedded in Apple's ecosystem, serving as a central part of the user experience across a range of Apple devices, including iPhones, iPads, Macs, Apple Watches, and Apple TVs.

5. CONCLUSION

Doing my first internship in one of the pioneering companies in its sector and being a part of it for a while was a very nice experience. One of my hesitations was making a summer practice where I only had to watch and observe what engineers do, but on the first day of my internship, all the components that I might need were given to me. After an orientation period of 3 days, my internship project is given to research and present. This project not only for learning something about work but also for creating innovative ideas was wanted. There are no strict rules or requirements for the project, I was given space to do my best and take initiative, in FEV.

The company trusts its employees, a hybrid working model is applied and there are not strict working times, employees only should finish their responsibilities on time, as I observed. This summer practice added a lot to me, such as self-confidence, working principles, teamwork, etc. I learned how system engineers work, and how projects progress. I experienced team meetings and international meetings that made by professionals. The project that I researched and presented to the team is going to be produced, I prepared a presentation and gave them to use when this project starts producing.

FEV is one of the best places to make summer practice and work for automotive industries, in Turkey. They see you not as an intern, sees you as a short-term professional employee. Engineers help you to improve yourself, give you responsibilities, and behave as colleagues. If you work in an office, there is an open office concept and in offices, there are a lot of engineers that work in different teams. You can meet with them and get information about many different areas of automotive.

6. REFERENCES

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