

Amir Mohammad Yavari

D I G I T A L P O R T F O L I O

“I certify that the work included in this portfolio is my own original work. Work included which was conducted as part of a team or other group is indicated and attributed as such—the other team members are named and a true description of my role in the project is included.”

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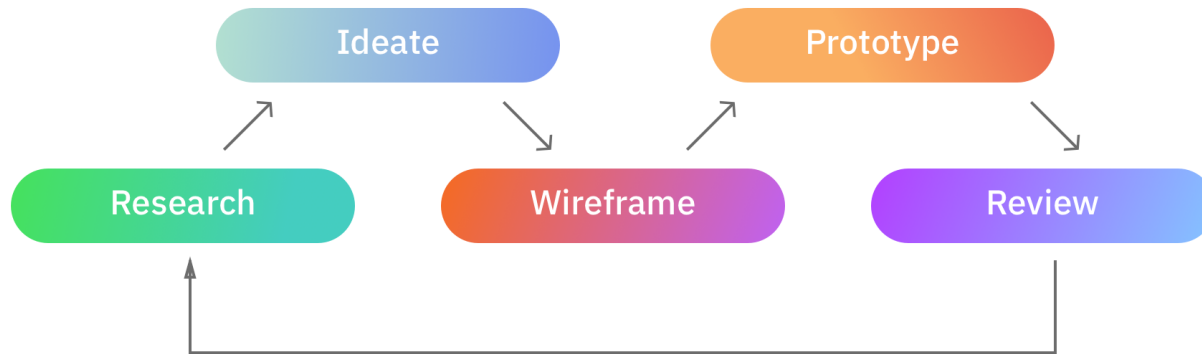
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Design Process



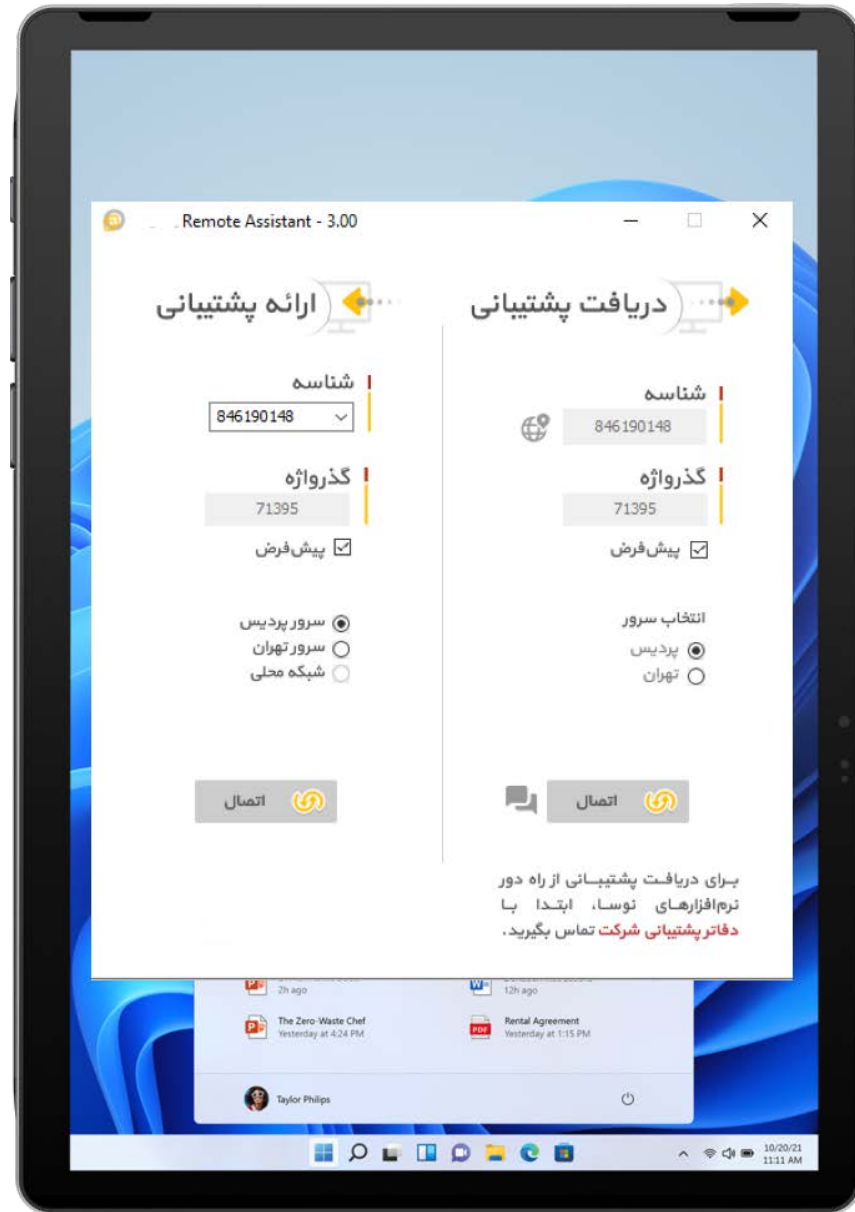
CASE STUDY 01

REMOTE DESKTOP

INTRODUCTION

Many companies have a support department to provide proper support and customer satisfaction. Companies whose services are computer-based need to be able to view the user's system for better guidance. So some companies started building remote desktop software.

Most applications are provided by developed countries, so the servers of these applications are located in these countries, which causes delays in communication and lag in distant countries. Some software also requires an in-app purchase for a monthly subscription, which can be costly for a company. Thus, some turn to free apps that have lower security or capabilities.



CASE STUDY 01

REMOTE DESKTOP

PROBLEM

Iran, as a country located in the Middle East, has been denied accessing to many applications for many years due to sanctions. One of the applications that had a great impact on the support of companies was Team Viewer, which decided to avoid providing services to Iran due to policies adopted several years ago.

Due to the low speed of the Internet in Iran, access to foreign services is very difficult and often impossible. In addition, due to widespread filtering in the country, sometimes the services can not be trusted for daily use. For example, anydesk software is often limited and also has a low speed.

During the discontinuation of remote desktop services, I noticed that companies were trying to introduce alternative applications to solve this problem. I want to point out that companies need such a tool. It can be said that the key to providing proper support is the existence of a monitoring system and step-by-step interaction with users, but the lack of access to remote desktops has caused weakness in this area. Inspired by this, the idea of creating NRa for a knowledge-based company came to my mind. -A remote desktop application to access and meet the needs of a particular company. My goal was to create an application that give opportunity to the support team to help users.

SOLUTION

My proposed solution was introducing a Windows program that allows users and the support team to connect to each other and also be able to use the company's internal server for connection.

To satisfy company's issue, sometimes instead of creating an application from ground up, I decided to use an open-source project and expand viral feature to address company's concern. Ultra VNC is an open-source remote desktop that its code and sources are available in their website and github.

Also, most programs do not differentiate between the end-user and the support team, but in this scenario we do not want users be able to connect to another computer. Therefore, it is necessary to prepare and design software based on the company's need.

The app divided users in two groups:

1. The first concept is the viewer. Viewer is the helper that must connect to the server and control and monitor it.
2. The second concept is server. Server is the recipient whose computer must be controlled and monitored.

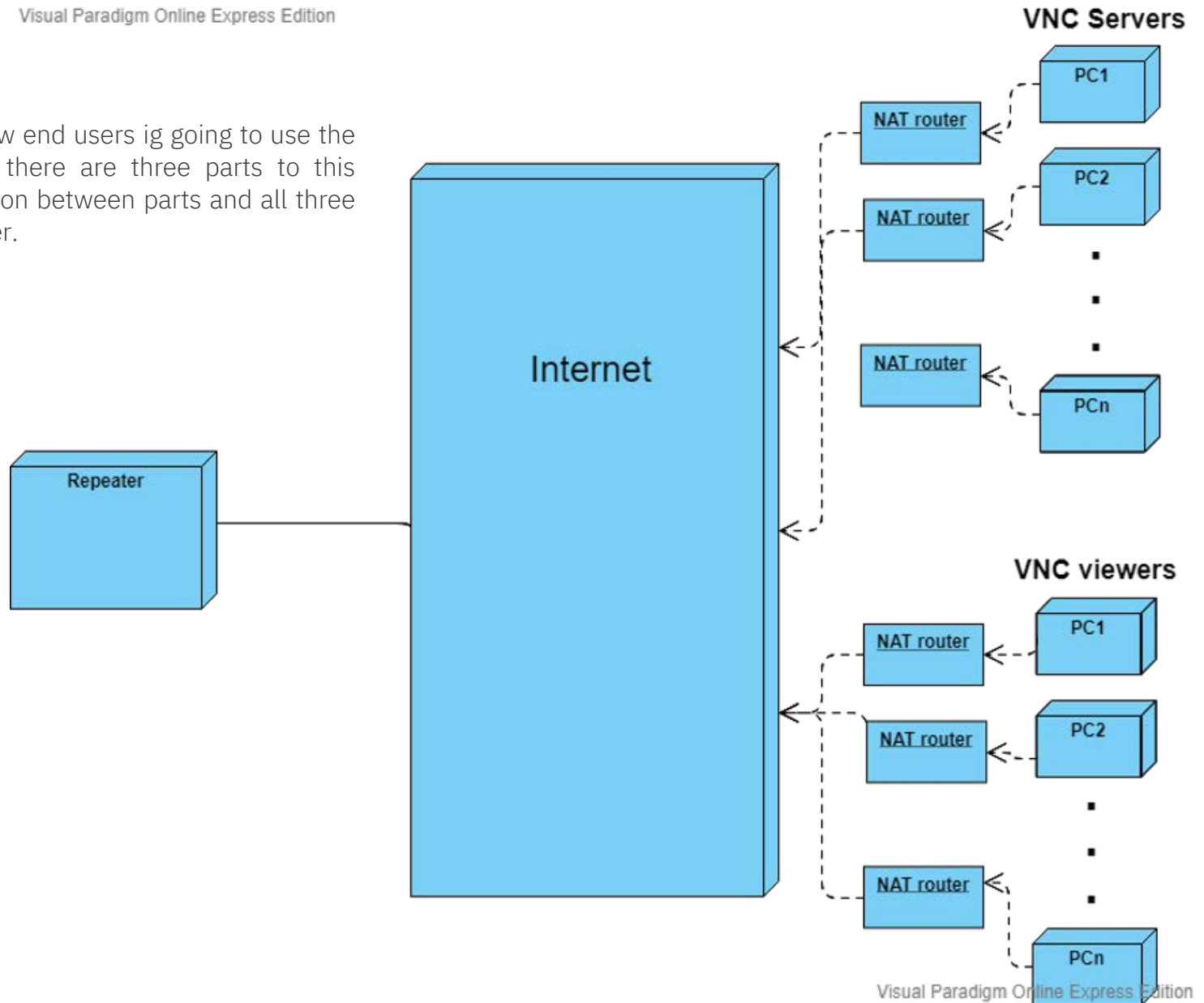
CASE STUDY 01

REMOTE DESKTOP

Visual Paradigm Online Express Edition

USER FLOW

User Flow Defines the process of how end users are going to use the application. As previously defined, there are three parts to this project and there is a close connection between parts and all three parts need to work flawlessly together.



CASE STUDY 01

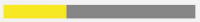
REMOTE DESKTOP

USER PERSONAS



Name: Ahmad Mohammadzadeh
Age: 57
Occupation: CEO
Education: Master of Business Administration

Technology Skill



Need:

- Reliable software for support team
- Use the company's server as a provider



Name: Divya Nair
Age: 26
Occupation: Data Analyst
Education: B.Engineering

Technology Skill



Need:

- Understanding application environment and ease of use
- simple menu design

In the first phase, we need to first run the repeater on the company's servers. To do this, we need to specify the port that the repeater needs. One of the main needs of the program is updating, so it is necessary that our module can control the version as well. We have left the version controller in the repeater because users do not have access to it and it is implemented inside the servers and has higher security.

The repeater acts like a proxy server. Both servers and viewers connect to it and can connect to each other through it. This is a way of circumventing the limitations that nat has placed on us. In fact, connections are managed and packets are sent through the repeater.

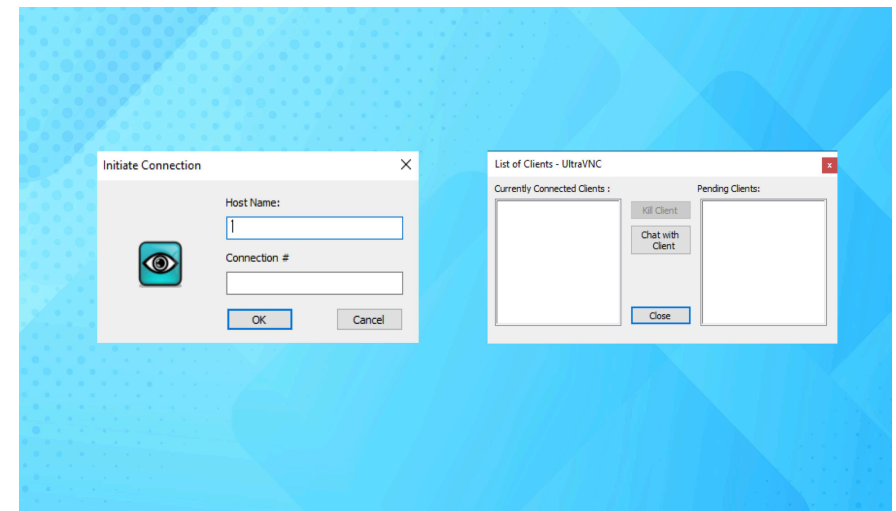
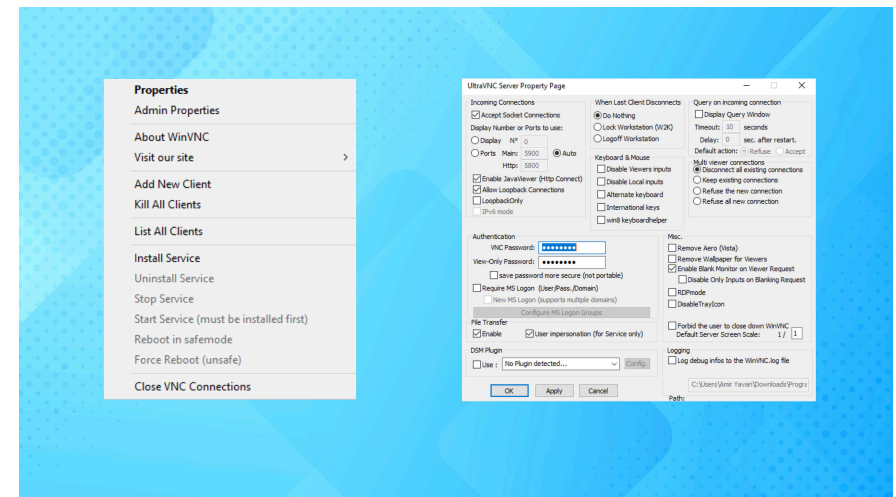
CASE STUDY 01

REMOTE DESKTOP

SERVER PROTOTYPING

First I implemented a simple plan for the server section (end users connection with repeater). The part that the user is going to use should have a simple and understandable design. We have also tried to consider the simplest steps for the user, so that users only need to click on the connection button and announce their ID. To do this, you need to design the script from scratch and design a new page. In other sections, the settings need to be adjusted automatically according to the company's repeater, and also the unique ID should be assigned automatically. To assign an ID, I replaced my innovative algorithm that can assign a unique nine-digit ID to each user. For a secure connection, the user needs to provide a password for their connection that they will announce to the person when connecting. This prevents anonymous people from connecting to the user's system even if they have an ID. 256-bit encryption is used for the security of packets and their invisibility. The user does not need to be involved in doing these things and are among the basic needs of a secure connection that is done by default on the initiative.

The first four images are the original open source program, which, as can be seen, has features that are not very useful and do not even have the necessary features such as encryption. It has a very complex user interface that requires training to work with. On the other hand, as shown in the last photo, I have changed the user interface a lot and the user only encounters this page in the whole program, which is very simple and has greatly reduced its complexity.

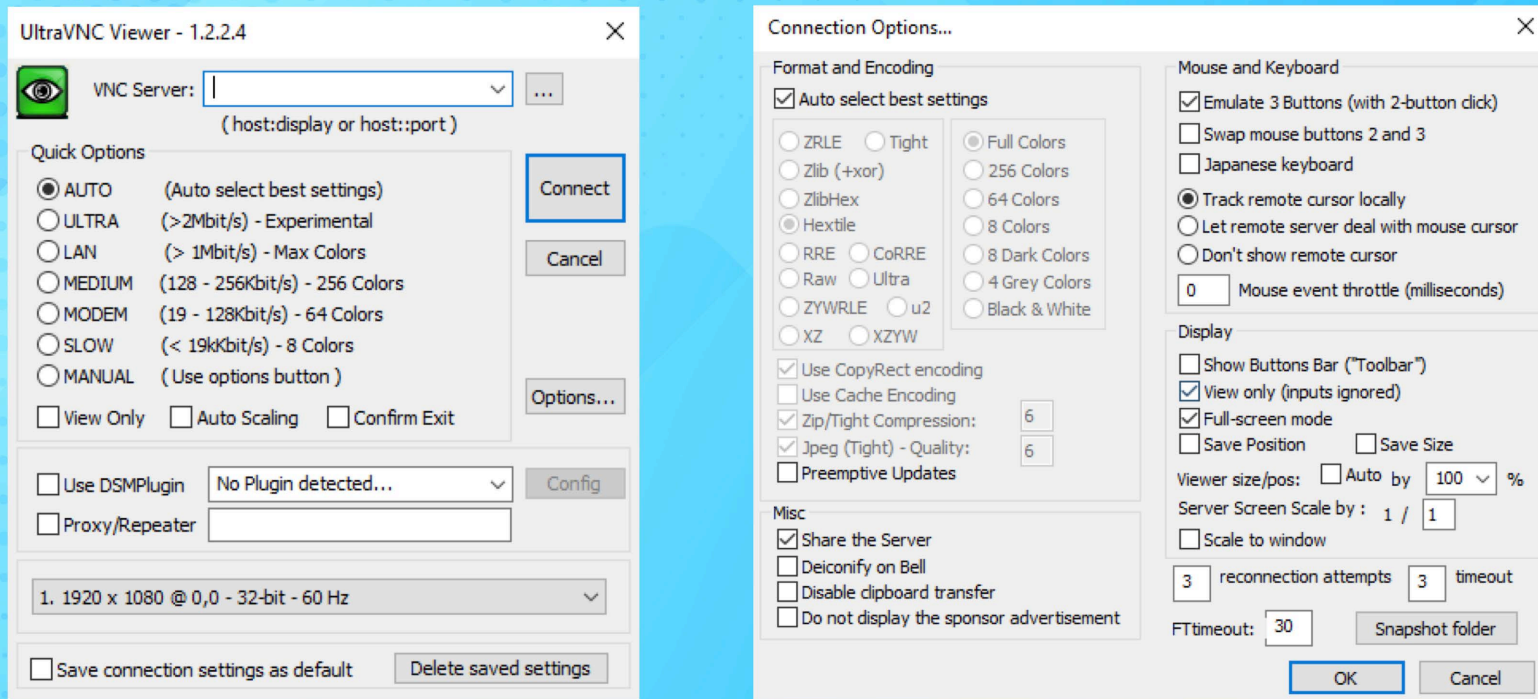


CASE STUDY 01

REMOTE DESKTOP

VIEWER PROTOTYPING

On the support side, there was no need to change the design much for the initial version, as it was easy to work with. In addition, the users who use them are the company's employees who can be trained. So I put my main focus on expanding security as well as structural changes that resulted in the least bugs and crashes from the original version.

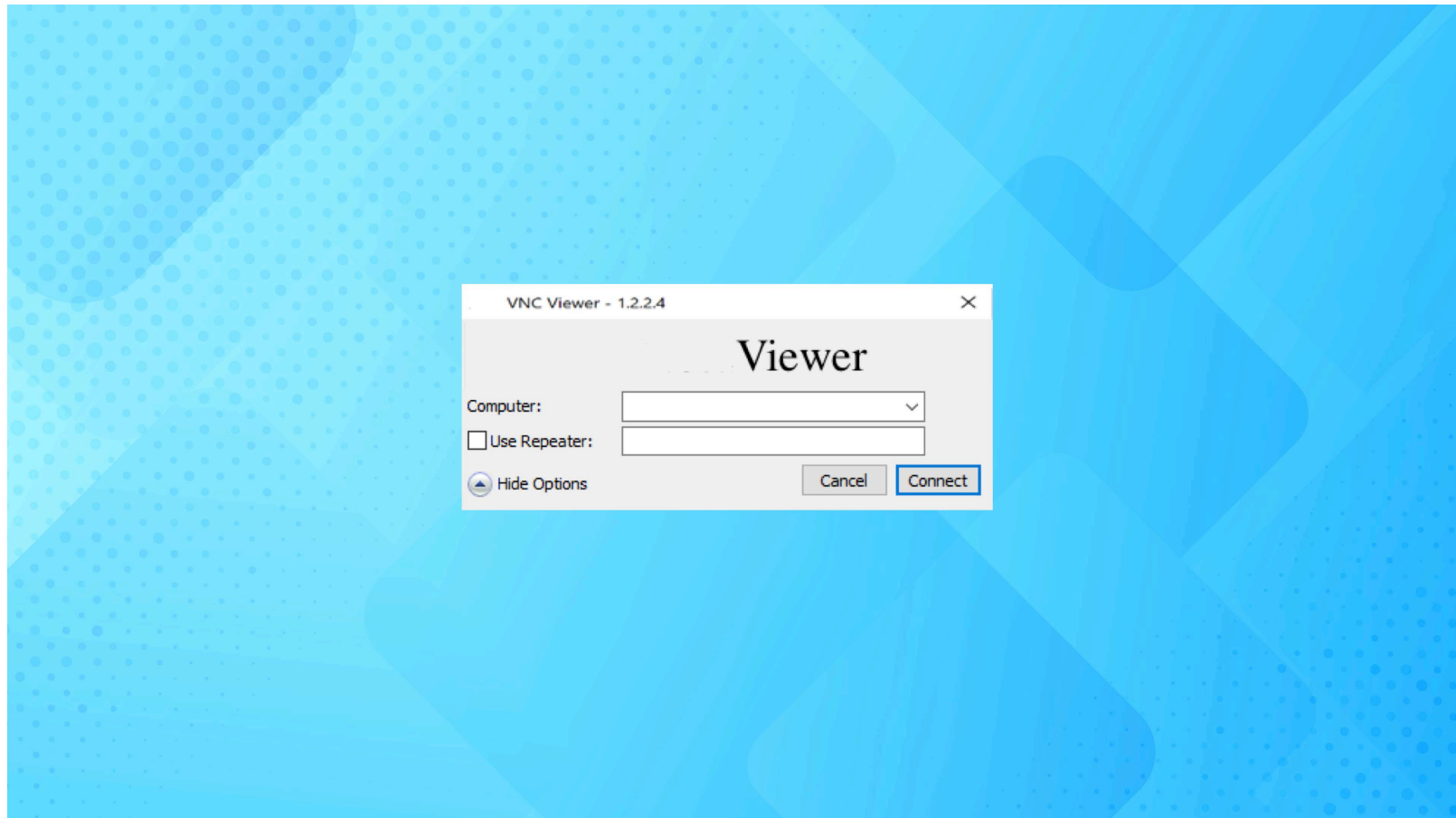


CASE STUDY 01

REMOTE DESKTOP

VIEWER PROTOTYPING

As is with the case of cognitive overload, I decided to simplify the interface by reducing the menus in such a way that all services could be accessed within one click. Here, I've showcased the high fidelity design of the app. The first iteration of the app uses the older design, a two-tabbed design with large images for users to understand the types of services that they will avail.

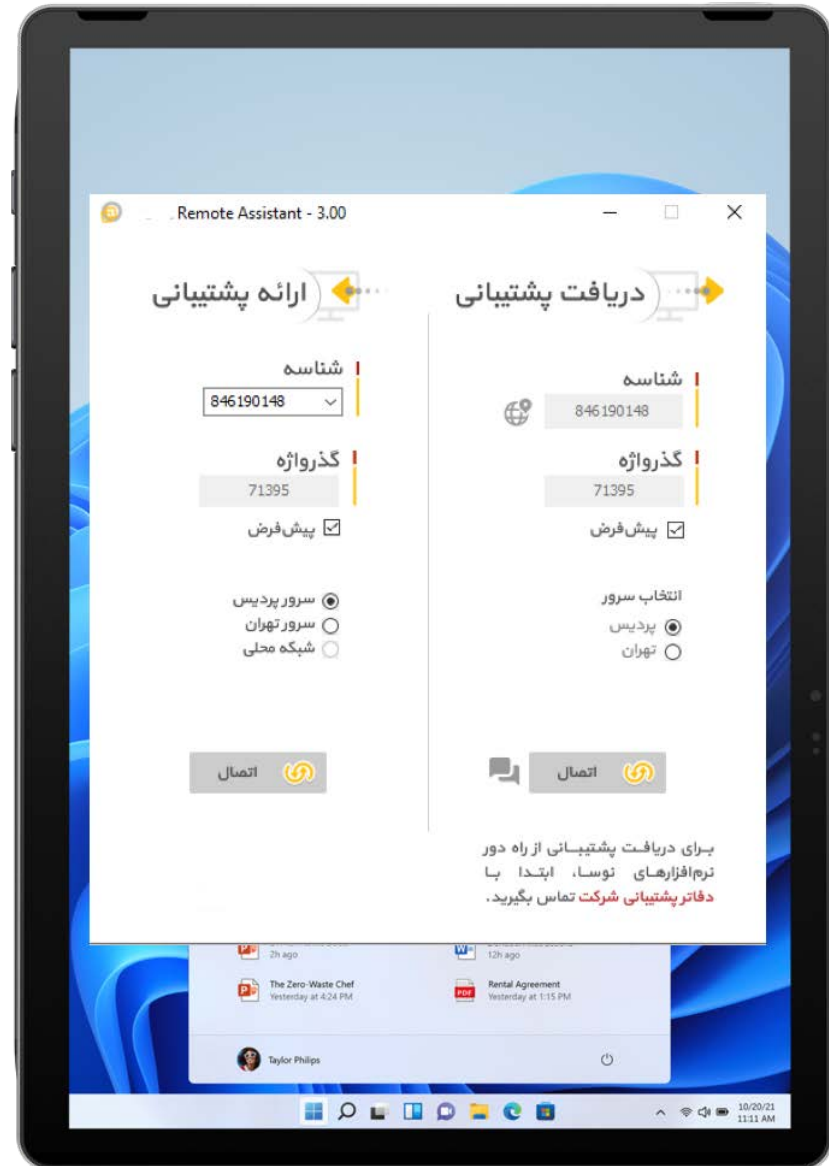


CASE STUDY 01

REMOTE DESKTOP

MAINTENANCE AND UPDATE

After presenting and testing the program, it is important that the new needs and problems are addressed. Also, most programs try to provide more features to users in the form of one program. In this case, I came up with the idea of offering a super application that could implement both Viewer and Server applications in one app, like the existing commercial platforms, which led to the releasing a new version that is currently in use.



CASE STUDY 02

RAILROAD CAR DETACHMENT

BACKGROUND

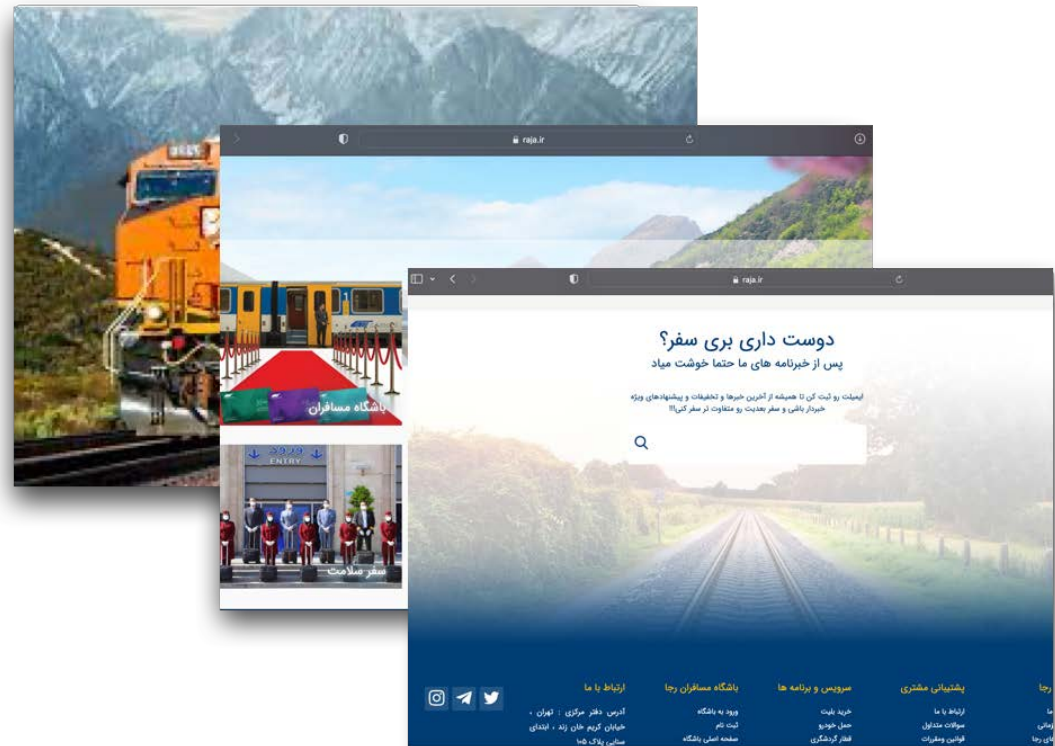
In the summer of 2021, I had the opportunity to work with Raja Company to solve one of the most catastrophic rail accidents for my undergraduate project. My project was based on IOT and designing whole system.

PROBLEM

The issue of rupture and escape of train wagons (separation of a number of wagons) has been one of the most accident-prone issues in the railway industry. The use of the end lights of the train and the counting of the axles mentioned that the use of the above-mentioned methods has a low safety factor, which has led to accidents.

SOLUTION

In this project, it is intended to introduce an intelligent (innovative) method based on wireless communication, a suitable solution with a high reliability to solve the problem of rupture. "Obviously, in the event of a rupture, the connection between the two antennas will be delayed and disrupted and then disconnected. Here we are going to measure the delay. If a significant increase in delay occurs, this We report the issue to the human factor as a rupture. The results of the research will be evaluated in several stages of the examination.



CASE STUDY 02

RAILROAD CAR DETACHMENT

PREVIOUS WORK

It can be said that some work has been done in this field but it is not practical or it has a high cost of implementation.

The actions and implementations done in the past can be divided into three groups:

1. One of the solutions that was considered is the microwave antenna that works in direct vision, the drawback of this method is that this type of antenna works in direct vision, which causes errors. In situations such as train movement in the tunnel, movement in the arc and the absence of the train in a straight line, this system gives a false warning of rupture.
2. Another method used was the wagon counting system, which in addition to the high cost it imposes, has many weaknesses, including theft of equipment and complexity of implementation. In fact, any system that is implemented outside the train car can be stolen.
3. Another solution that is currently used is to install a light at the end of the train, which the locomotive driver is obliged to confirm the existence of this light every 2 minutes in the mirror and make a note in their checklist. This method requires that the light always be in the view of the locomotive driver, which is not seen like a microwave antenna if the train is in an arc. Also, according to reports during the day, the presence of this lamp is not very useful because its light is not visible. Unfortunately, in some cases, there are reports that shows locomotives not being accurate, which, regardless of the rules and checking the lights in the mirror, try to register a report confirming that the lights have been seen.

CASE STUDY 02

RAILROAD CAR DETACHMENT

WORK FLOW

My goal is to implement a scalable and reliable alarm system that can alert you disconnection in an instant. My intention is to get things done automatically to reduce human error. To achieving this goal, we defined the work flow steps. When the train starts, the project starts automatically. Initially, it tries to establish a connection between the antennas. Then, after communicating, they start pinging each other, which causes them to calculate the delay. If the connection is lost, the locomotive driver will be alerted. If driver receive a warning, it means that the wagons are separated from each other, and the train driver should investigate this issue and fix the problem. Since the timeout system may sometimes make a mistake, it tries to reconnect several times after failing to communicate, and if it fails, it will be warned.

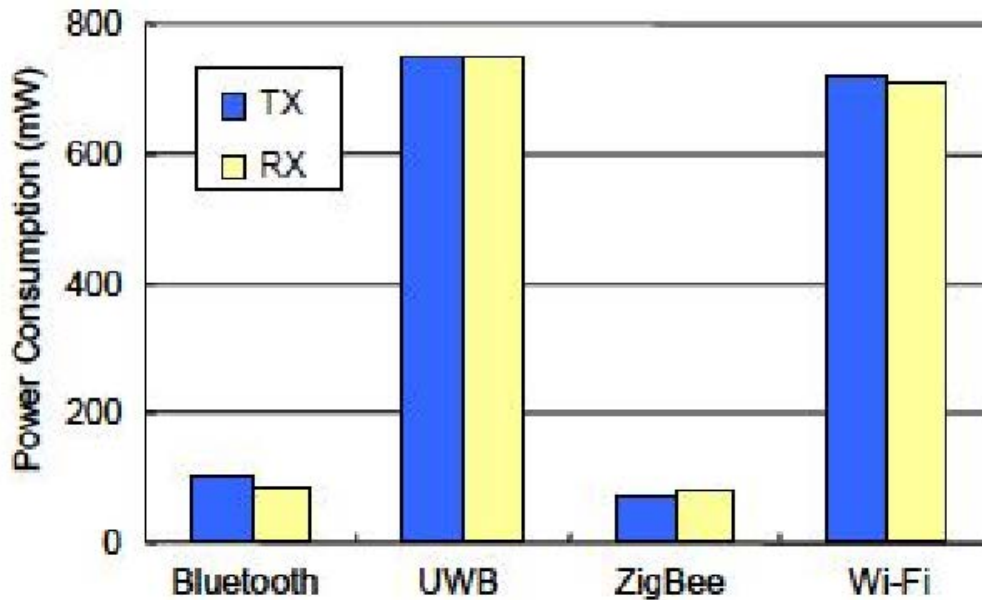
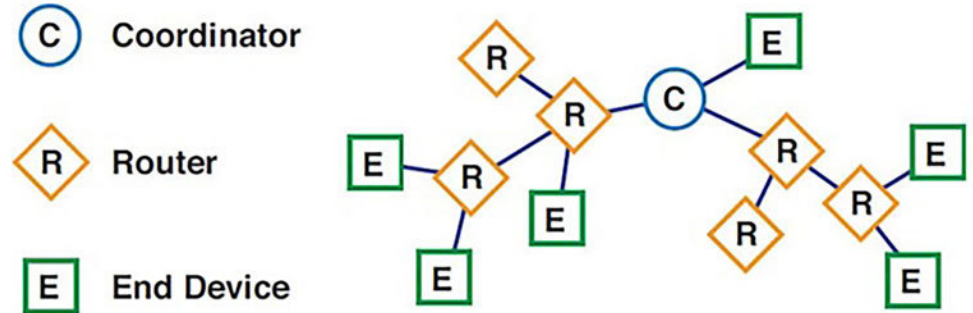


CASE STUDY 02

RAILROAD CAR DETACHMENT

WHY ZIGBEE

ZigBee is intended to be easier to use and less expensive than existing personal network technologies like Bluetooth. ZigBee is a wireless network technology that is both inexpensive and energy-efficient. It uses a mesh network topology, which allows for excellent reliability and an acceptable range.



Standard	Bluetooth	UWB	Zigbee	Wi-Fi
IEEE spec..	802.15.1	802.15.3a	802.15.4	802.11a/b/g
Frequency band	2.4GHz	3.1-10.6 GHz	868/915 MHz; 2.4 GHz	2.4 GHz; 5 GHz
Max signal rate	1 Mb/s	110Mb/s	250kb/s	54Mb/s
Nominal range	10 m	10 m	10-100 m	100 m
Nominal TX power	0 - 10 dBm	-41.3 dBm/MHz	(-25) - 0 dBm	15 - 20 dBm
Number of RF channels	79	(1-15)	1/10;16	14(2.4GHz)
Channel bandwidth	1MHZ	500MHz-7.5GHz	0.3/0.6 MHz; 2 MHz	22MHz
Modulation type	GFSK	BPSK, QPSK	BPSK (+ ASK), O-QPSK	BPSK, QPSK, COFDM, CCK, M-QAM
Spreading	FHSS	DS-UWB, MB-OFDM	DSSS	DSSS, CCK, OFDM
Coexistence mechanism	Adaptive freq. hopping	Adaptive freq. hopping	Dynamic freq. selection	Dynamic freq. selection transmit power control (802.11h)
Basic cell	Piconet	Piconet	Star	BSS
Extension of the basic cell	Scatternet	Peer-peer	Cluster tree-mesh	ESS
Max number of cell nodes	8	8	> 65000	2007
Data protection	16-bit CRC	32-bit CRC	16-bit CRC	32-bit CRC

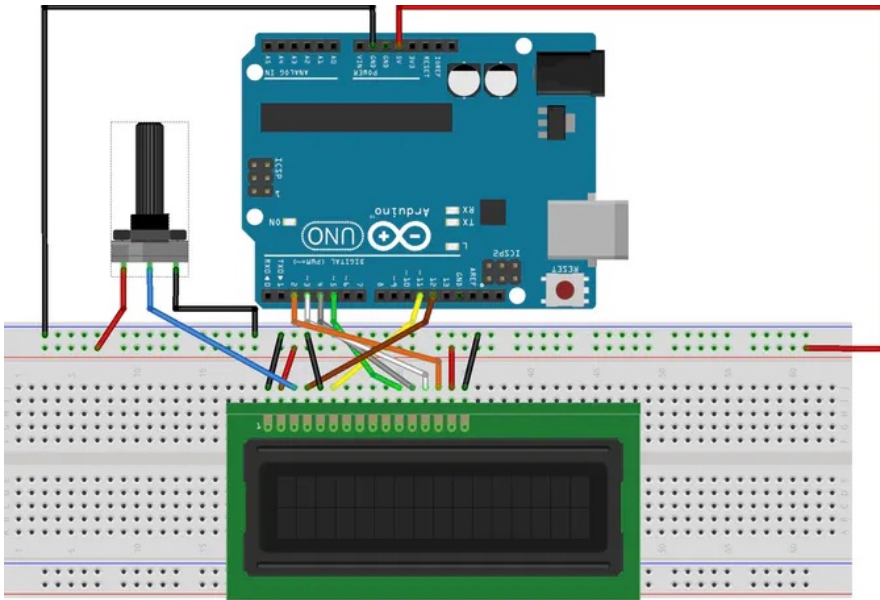
From the comparison of the above tables, it is easy to understand that ZigBee offers acceptable security along with the lowest energy consumption. Also, thanks to its star topology, this network has a high expansion capability that can provide a longer range while consuming less energy. We can also determine the frequency we want to be in that range with the least interference.

CASE STUDY 02

RAILROAD CAR DETACHMENT

HARDWARE DESIGN

Hardware design is an important part because we need to be able to take advantage of ZigBee communication, especially in this project. There is a need for a decision-making and planned section to ensure communication and in the event of an interruption. Therefore, we have used the Arduino board according to the issue of energy consumption and implementation cost.



Arduino UNO R3 board description	Using microwatt-meter		Using multimeter			Difference (%)
	Supply voltage range (V)	Power (W)	Supply voltage (V)	Current (mA)	Power (W)	
Regulated power Atmega328P PowerDown	8.0–8.8	0.394	9.3	41.1	0.382	3
Unregulated power Atmega328P PowerDown	4.1–4.7	0.150	4.9	32.3	0.159	6
Regulated power chip removed from board	8.0–8.8	0.360	9.3	41.1	0.382	6

Atmega328P ADCs disabled when powered down. PRR register=0xFF.

	UNO	Leonardo	Nano 33	Nano	Nano Every	Mega 2560	UNO WiFi	MKR WiFi
Ease of Setup	✓	✓	-	✓	-	✓	-	-
Ease of Learning	✓	✓	✓	-	-	-	-	✓
Availability	✓	✓	✓	-	-	✓	✓	✓
Compatibility	✓	-	✗	✗	✗	✓	✓	✓
Cost	\$23	\$21	\$23	\$21	\$14	\$40	\$45	\$32
Starter Kits	✓	✗	✓	✗	✗	✗	✓	✗
WiFi / Bluetooth	✗	✗	✓	✗	✗	✗	✓	✓
Speed	-	-	✓	-	-	-	-	✓
Memory	-	-	✓	-	-	-	-	✓

The Zigbee module also has a serial port that can be connected to the Arduino Uno through this port. For programming, it is appropriate to first use a three-hand shaking to ensure module connected successfully. After securing the temporary connection, we run an aging program on the Arduino, which I have implemented optimally. After ensuring a successful connection, we run a ping program on the Arduino, which I have implemented optimally.

CASE STUDY 03

3D AUDIO RENDERING

PROBLEM

Over the last few years, virtual reality (VR) industry has gained some growth while its audio experience has been limited to existing stereo sound. The limitation extends towards the ability to localize where the sound is coming from further limiting the ultimate virtual reality experience in gaming and entertainment. Realistically sound is perceived by each individual differently. Therefore the feeling of being in a virtual environment would not be truly possible without a localize sound sources.

SOLUTION

To Fix this problem I wanted to ease the measurement of HRTF and combine it with Head tracking feature in Android devices. To be more exact, Head Related Transfer Function (HRTF), is a frequency response function that characterizes how an ear perceives sound when from a particular source in space. Originally, calculation of an individual's HRTF is done in more sophisticated environments. With technological advancement in machine learning, 3D modelling and cloud computing, it is possible to build HRTF by using high quality phone cameras. Sound localisation is also possible by using real time head tracking and 3D geometry. Applying these transformations in real time on retail hardware will bring an immersive audio experience to a greater population. .

MY ROLE

Ideation
Creating the game in Unity
Prototyping the Android app



CASE STUDY 03

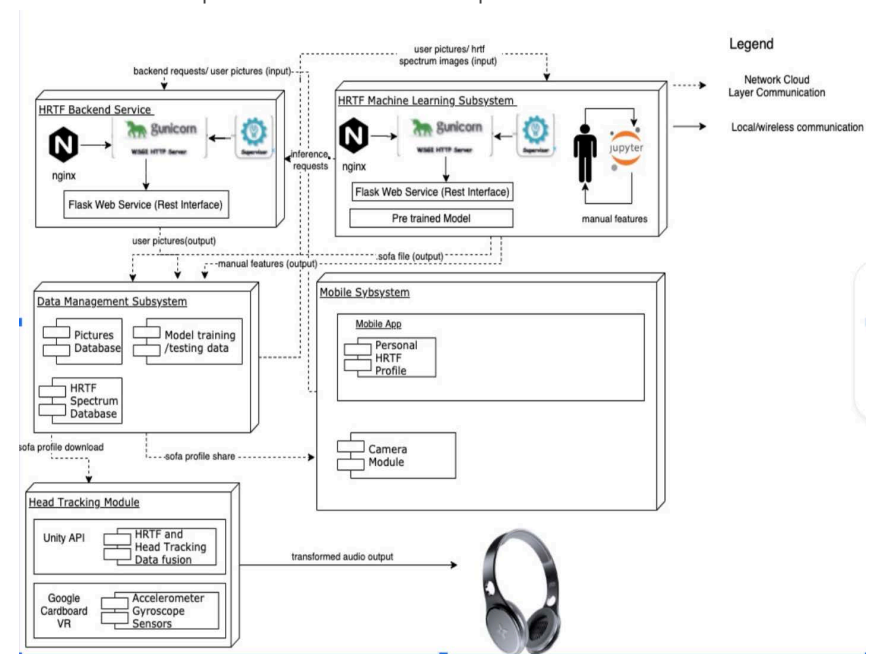
3D AUDIO RENDERING

PROJECT OBJECTIVE

The objective of Project Odyssey is to create a 3D audio rendering software that uses recent technological advancements in audio engineering for Head-Related Transfer Function (HRTF), 3D modelling, machine learning, and real-time head tracking. This software will personalize sound for each individual, massively expanding the spatial depth and simulating sound localization. A machine learning algorithm would be developed that correlates the user's ears and head anatomy to their HRTF profile. This will require the use of a pre-existing database of Head-Related Transfer Function (HRTF) based on anatomical features which are publicly available. We will be able to synthesize the HRTF profile for the individual user that would otherwise take hours and costly special equipment to measure. The profile will then be paired with real-time head tracking to create immersive 3D sound.

BLOCK DIAGRAM AND SYSTEM ARCHITECTURE

In the initial proposed design, an android application to run the audio rendering software was proposed. It is connected with Google Cardboard VR (head tracking subsystem), a backend service (HRTF synthesis subsystem), and a data management subsystem. The backend service and the machine learning service were coupled which gave us less flexibility to iteratively change and improve both components separately. I was responsible for developing the android application and the Unity game so I will focus on explaining those in this design.



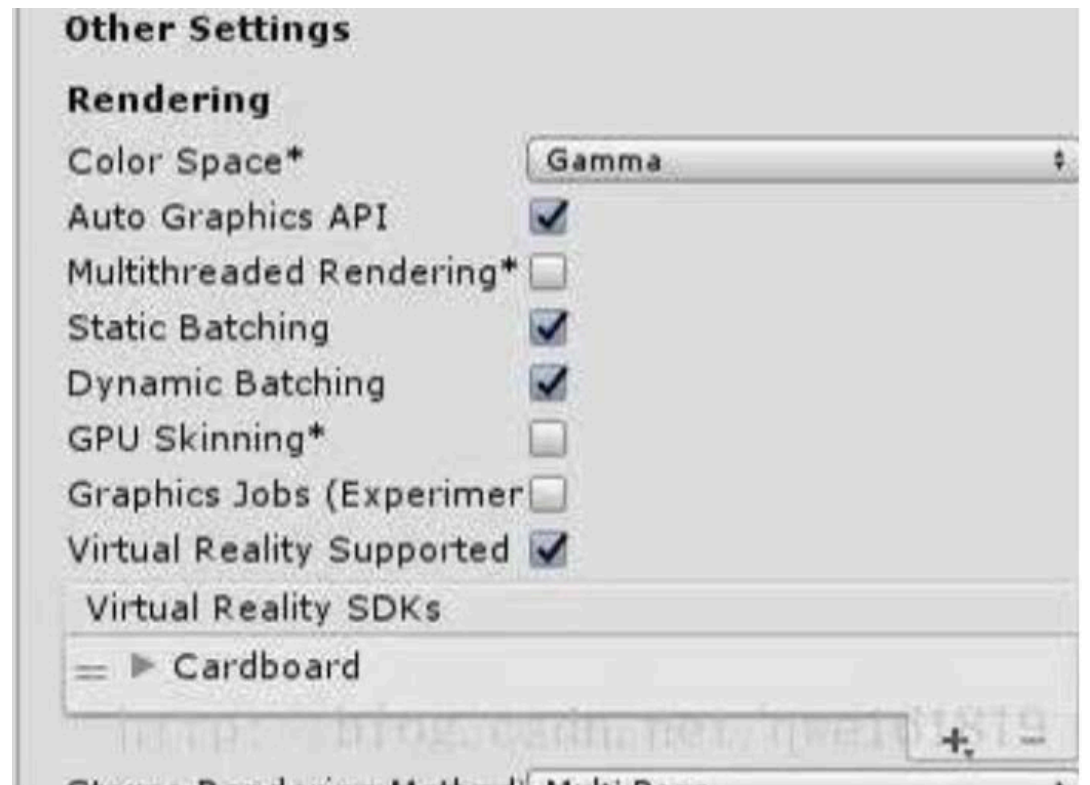
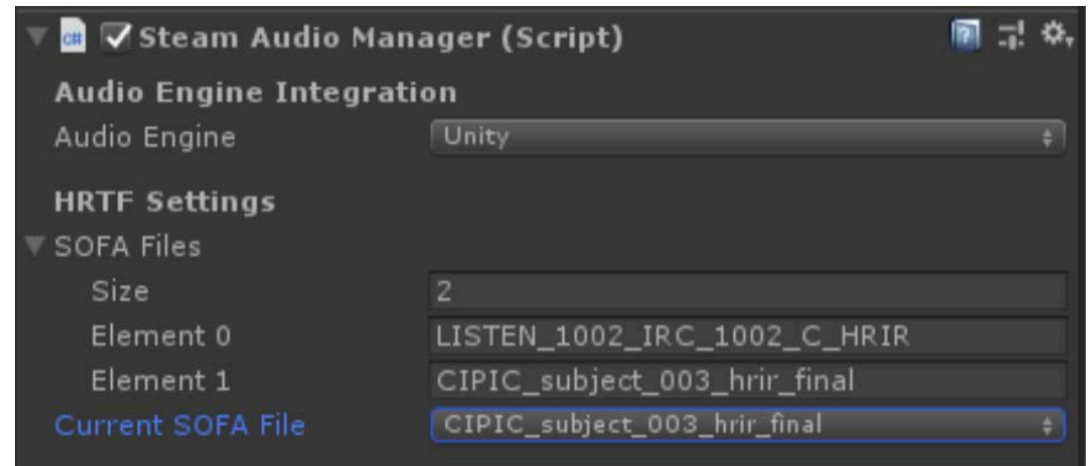
The mobile subsystem comprises 2 major components which work together. The first component is the camera module that is used to take pictures. Second is the mobile application that is used to interact with the camera module of the mobile subsystem to take pictures of their ears and head. This data is securely transmitted to the backend using the HTTP interface provided by the backend. This data will then be stored in the data management subsystem. This application also allows the user to download the HRTF profile after inference is complete and a predicted HRTF profile is available for download. The user can also launch the second app to run 3D audio, which is explained in the head tracking subsystem. The head tracking subsystem includes 2 major components. First is the Google Cardboard VR component that provides sensor data for head tracking. The second component is the Unity API that helps localize the head relative to the environment. It used the HRTF profile and performed data fusion to generate the 3D spatial sound.

CASE STUDY 03

3D AUDIO RENDERING

DETAILED DESIGN

The unity part can play the video or switch to the next/previous video by gazing at it for 3seconds. We can turn our head and jump to some positions that we chose. At different points you can feel the 3D audio effect based on the different sofa files and the source of the sound is the TV. Firstly, we found many FBX models (3D model saved in the Autodesk Filmbox format) online and imported those models to unity project. Our previous design was that the person could walk in the room. However, when we started the project, we realized the only way to interact with this software is gazing. We cannot move in the room so we picked some points in the room and we could jump to that point by gazing at it for 3 seconds. We avoided the drift problems by using this way because we can only turn our head and we are not allowed to move. The latency is very small. During the testing ,we cannot feel the latency when we turn our head. Secondly, for handling the hrtf sofa file. We found the steam audio can help us to do it. After we downloaded the steam audio, we could import it to the unity project. Then we implemented google headtrackign audio API so when the user would turn their head it would localize the sound accordingly.

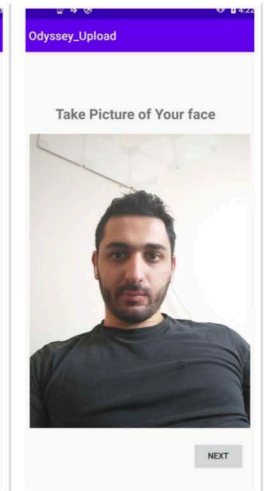
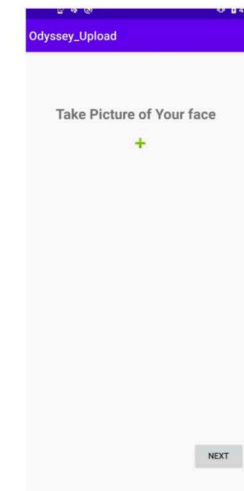
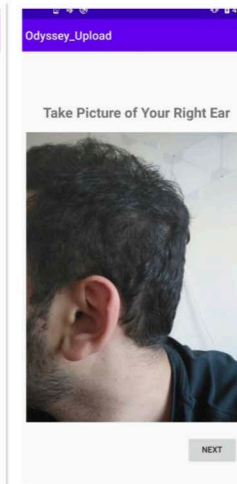
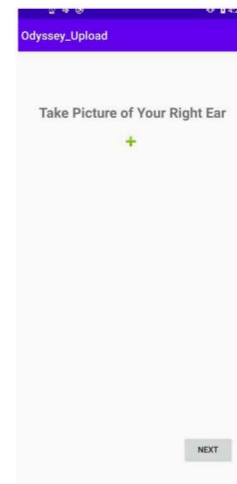
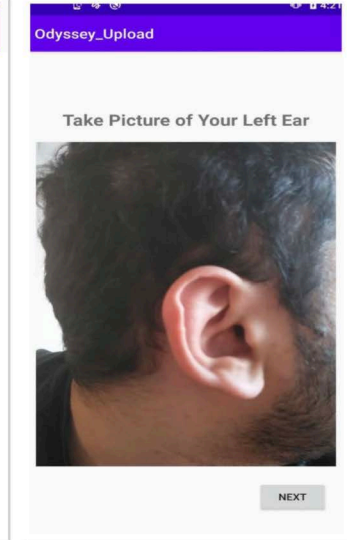
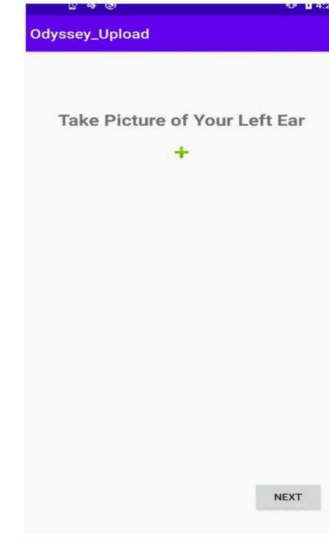
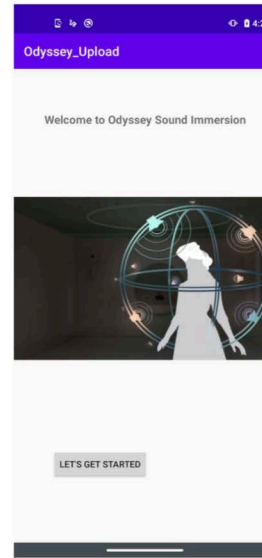


CASE STUDY 03

3D AUDIO RENDERING

APP FUNCTIONALITIES

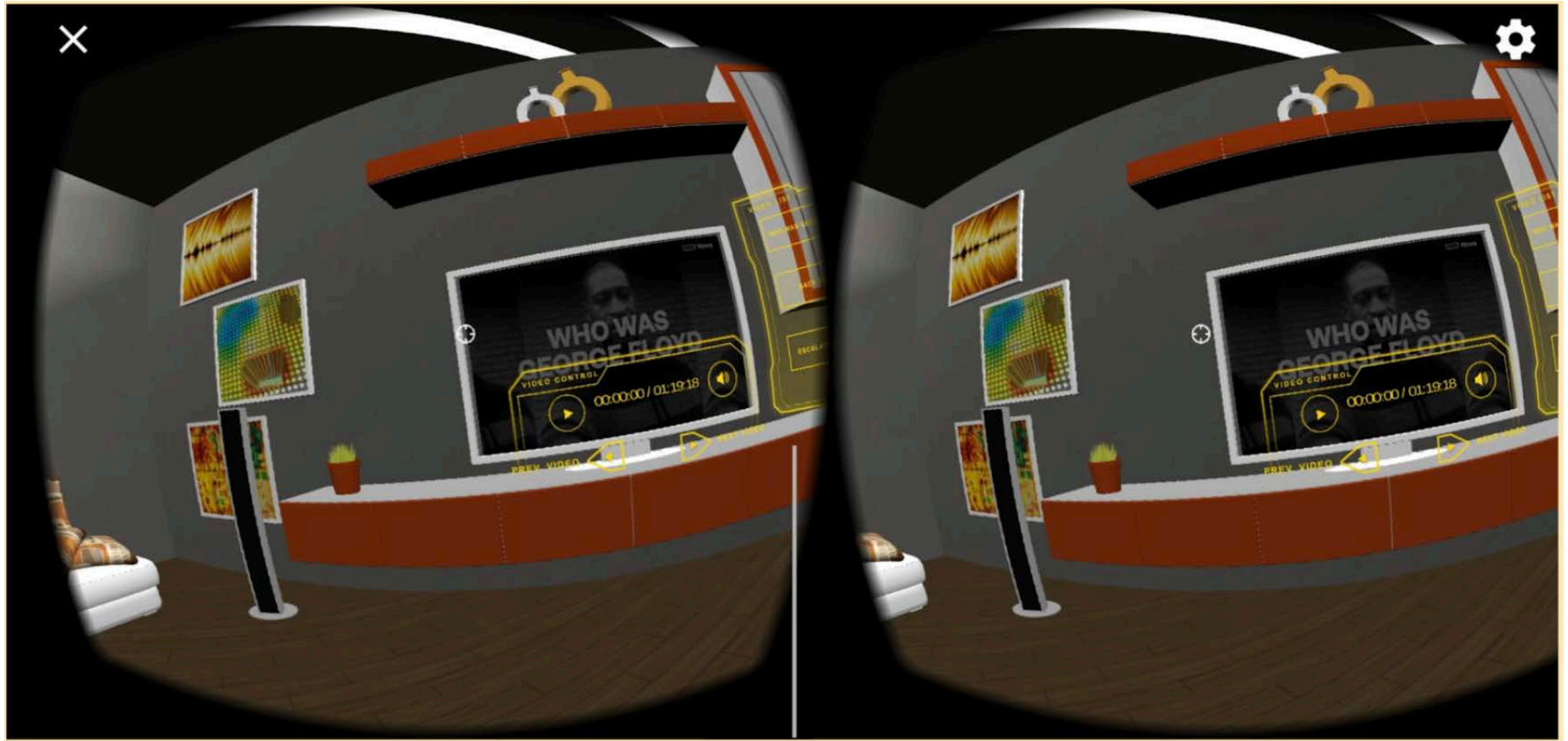
The user will first prompt with a welcome page that shows how they should position the cardboard on their head and also a visual picture of what to expect from using the app. Next, user will be prompted to the pages where they need to take a picture of their ears and their face. After each step we are using a retrofit library to communicate the data to the backend. This part will be discussed in detail in the Backend portion of the mobile app. After the user has uploaded all 3 pictures, they will be prompted to the final page where they can download the link to their HRTF profile and also use that to launch the Unity app where the demo of 3D audio will be played for them. Therefore, we have 5 different activities where user is guided and the required information to create the HRTF profile is collected from the user. and then the user will be forwarded to the main virtual environment shown below where they can interact with the environment and play sound from different places in the room.



CASE STUDY 03

3D AUDIO RENDERING

HI-FI PROTOTYPING



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