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Carppet – An AR Tour Guide System in Autonomous Car

By Ming Hui Lin

A Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master
of Fine Arts in Visual Communication Design

School of Design
College of Art and Design

Rochester Institute of Technology
Rochester, NY
August 2021

Committee approval:

_____ Date: _____

Adam Smith

Associate Professor/ Graduate Director of Visual Communication Design/ Thesis Advisor

_____ Date: _____

Mike Strobert

Senior Lecturer/ Thesis Advisor

Abstract

Over the last decade, modern transportation systems have evolved to a considerably larger scope and higher complexity, brought by a wave of innovation in technologies and a revolutionary shift in how mobility is perceived and realized – giving rise to a strong orientation towards services.

This thesis imagines a time when cars can drive fully autonomous. Drivers no longer need to drive. So, what else can we offer passengers during the time when they are sitting in the car? The purpose of this project is to introduce a concept of mainly using Augmented Reality and AI recognition to create a virtual tour guide in autonomous cars that will provide educational knowledge and immediate assistance through AR windshield and side windows. Imagine a time when you are sitting in an autonomous car, and you get to know your surroundings through AR windshield and side windows. People can now explore the world as if a real tour guide is always around.

Keywords:

Autonomous Cars, Travel, Education, Augmented Reality, Artificial Intelligence

Introduction

The project was inspired by a personal experience of being a driver and tour guide on a 2-week road trip. I would never forget how tiring it was to be a driver and a tour guide at the same time. Travelers usually want to have an unforgettable trip, but they neither do not want to make travel plans nor be a driver. If you ask them if they rather join a group tour, they will say the schedule isn't flexible and there is no freedom to adjust itinerary.

The best way to have flexibility and freedom during a trip is to go on a self-guided tour, but it usually starts from searching information on the internet, making itinerary, booking hotels and flights, and to long driving hours. There are a lot of existing resources to help travelers find a good place to go, make their own itinerary, and comparing booking prices. However, the solution to long driving hours for now is merely to stay awake during the long drive by staying hydrated, eating healthy snacks, keeping passengers entertained, etc. There are not any solutions that could resolve the fundamental issue — long driving.

Over the past decade, autonomous technology has rapidly changed our perception of commuting. In this project, I imagined a time when autonomous cars can fully drive by themselves. Drivers will no longer need to drive and they can also be passengers. What else can we offer passengers to create a meaningful trip?

The AR tour guide system (Carppet) intends to combine AI recognition with Augmented Reality Head Up Display and other technologies and apply those on autonomous cars. The purpose is to create seamless and painless pre-trip planning processes. In addition, the tour guide system provides interactive and educational experiences during the trip. The AI recognition system can immediately recognize attractions to provide corresponding background knowledge of what's appealing to the riders via the head up display on the windshield and side windows.

Critical Analysis

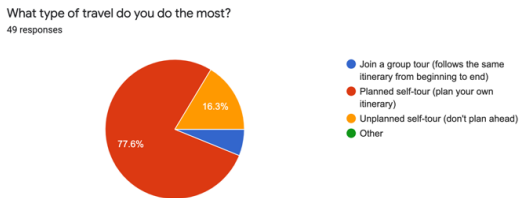
In order to validate the assumption, I started the project with an online survey to reach travelers who like to go on a road trip all around the world. The survey questions mainly focused on different types of travelers, current travel trends, and specific expectations of their travel. Through the survey results, I can have a deeper understanding of potential users who would use my service. According to the responses of 49 participants, the travelers can be divided into 3 user groups, people who like to join group tours, people who like to go on planned self-guided tours, and people who like to go on self-guided tours but don't plan ahead. The survey result showed over 90% of the people love to go on a self-guided tour and 81% of the people said that gaining knowledge throughout their journey is important to them. There are even more than 40% of people who think making an itinerary is overwhelming. In this case, we can clearly see that people like to go on self-guided tours, but almost half of the people think trying to come up with a solid trip plan is overwhelming. This validates my previous assumption that travelers always want to have an unforgettable trip, but they neither want to make plans, be a driver, nor join a group tour because the schedule isn't flexible.

With the insights and findings from the online survey in mind, I also need a deeper understanding of the itinerary planning process, so I conducted interviews on Zoom to talk about the interviewees' most recent travel experiences. 5 travelers were interviewed. The result showed schedule flexibility, knowledge acquisition, and transportation as the top three topics people are concerned about. At the end of every interview I always ask a question, ***“How do you imagine our travel experience will look like in the future”***. It is interesting to see their responses align with my concept for this project where AR Technology is introduced to the travel industry and making future traveling more seamless and painless.

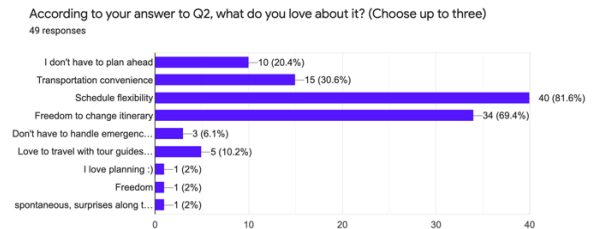
Given the insights from the user research, the project was able to validate the assumptions and create a solution according to travelers' needs. The specific aim of this project is to create a solution for people to customize itineraries, be free from driving, and earn educational experiences in autonomous cars. In short, the goal of this project is to help travelers travel without preparing.

Objectives and rationale

Since 75% of the people who responded to the online survey I created were people who usually like to go on planned self-guided tours, the project aims to focus on that particular group of people and make solutions for them by creating a persona, Natasha, and map out her user journey to see how an end-to-end planned self-guided tour looks like.



[Figure 1. What type of travel do people love the most? Image downloaded from the survey I created.]



[Figure 2. Why people love to travel in certain type? Image downloaded from the survey I create.]

With these three frustrations from Natasha's travel journey, 3 objectives were created to help Natasha go on her ideal trip. Resourcefulness, customization, and knowledge acquisition are three design principles that will penetrate the entire project. The first objective is to help users filter out useless information and provide relevant information to travelers based on their interests. The second objective is achieved by offering customization and personalized options that allows travelers to change or adjust their schedule based on their needs, mood, or situations. The last objective can be achieved by providing immediate information whenever and wherever travelers see something interesting on the way.

With the three design principles in mind. The AR windshield and side window displays have undergone three iterations. The first iteration is an AR windshield and side window assist with a large panel at the front of the vehicle where it shows all the educational information at the same time. However, the travelers suggested that if they still need to move their eyes from one screen to another, it will be no different from if they browse the information on their phones. The second iteration moves the educational information directly onto the windshield and side windows which makes the information closest to the objects passengers see from the windows, but this 2D style UI can only provide limited online information for the audience due to limited space, which consists of a picture and a short summarization. The last iteration I made was to eliminate remove the frame limitation create by windshields and side windows. By projecting texts, icons, texts, and all the other relevant information in a 3D space would make the entire experience more realistic and immersive to the audience.

The initial challenge I faced with was information visualization. The way we used to learn knowledge usually requires large amount of content, but it is not applicable in a moving car. Carppet combined information visualization, motion graphic, and voiceover to fix the issue and make even stronger connections between the objects we see and the contents we desire. Another challenge I encountered was testing on autonomous vehicles and project my design on AR windshield and side window. With the limited resources I had, I was only able to simulate my design by mirroring the screen on a TV and ask people to sit on chairs in front of the TV.

If I am able to continue to invest my time in Carppet in the future, I hope that I can have an even deeper understanding of travelers' behavior during trips or go on a trip to collect more insights from the experience. These would allow me to create user flows based on realistic situations.

Conclusion

Learning through travel is one of the best means of education outside the classroom. The project introduces a new way to efficiently explore our world and easily obtain knowledge for a successful trip in the future. My ultimate goal is to create a comprehensive travel experience that can ease the preparing time and gain educational knowledge effectively during the trip.

The three main objectives of the design: resourceful, personal, and educational, all contribute to solving the problem of helping people travel painlessly and gain educational knowledge without preparing in advance. Throughout the entire project, there is a focus on gaining knowledge, getting travel recommendation, and receive immediate assistance during the trip through AR windshield and side windows in autonomous cars. This way, the downside of self-guided tours and group tours could be completely resolved.

I truly believe that this project can demonstrate an initial idea of a potential travel experience and the impact the AR tour guide system (Carppet) can have on the entire travel economy which benefits people in terms of individual development, educational attainment, and future career growth.

Appendix A - Bibliography

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Carppet

A concept of adding **AR tour guide** features to autonomous cars to help people travel painlessly.



Carppet is an AR tour guide system that combines AI recognition with Augmented Reality Head-Up Display and applies those technologies to autonomous cars.

Project Type

Thesis Project

Team

Just me 🧑

Timeline

01 - 08 / 2021

Tools

Figma, Illustrator, Photoshop, After Effect



Have you ever been on a
road trip?

Prompt

As someone who personally
love to do road trip once a year, I
would never forget how tiring it
is to be a **driver and a tour
guide** at the same time.



(me and my travelmates)

Problem

I want my trip to be unforgettable, but...



Planning is frustrating.



I don't want to be the driver.



I also don't want to join a tour group.



Because schedule isn't flexible.

Hypothesis

In this project, I was imagining a time when automobiles no longer need drivers and are able to **help people tackle the one biggest problem on a road trip — long driving hours**

What else can we offer passengers to create a meaningful travel experience?

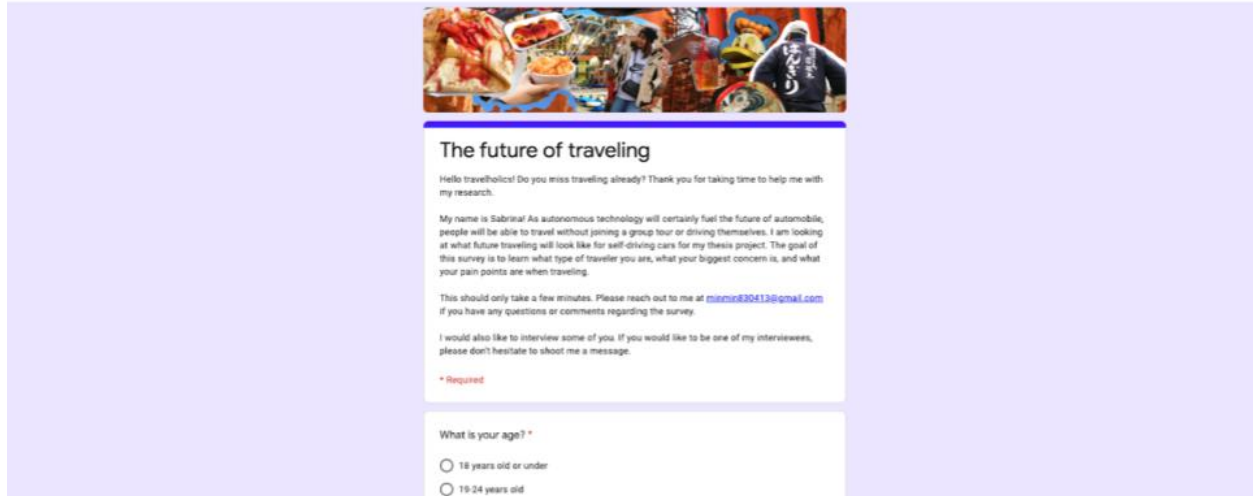
Solution Overview



Research

Primary Research – Survey

*Answered by 49 participants.



Understand traveling trends through **49 survey responses**



77.1%

people usually go on **self-guided tours**.



81.3%

people think **gaining knowledge** is important during a trip



41.8%

people think **making** an appropriate **itinerary** is **overwhelming**.

Learn about the itinerary planning process through 5 interviews

People care about:

01. Schedule flexibility
02. Acquiring knowledge
03. Transportation



Affinity diagram used for analyzing interview findings

Additional Thoughts From Interviewees

“How do you imagine our travel experience will look like in the future”

The self-driving car will be not only a driver also a **tour guide**, and also we people don't need to find a parking space to waste time. The car will be able to find a parking area itself and catch we up in any place.

Give **local travel advice and detailed introduction** about food, and have the function can combine those options, finally generate the **best route suggestions**

AR, siri, i can **view the information without a phone**, whenever i want, no need to type or speak.

Google rates are important. But some of them might not be as good as they rated. More and more self-planned travel.

By taking auto self-driving car, we can take advantage of **flexibility, personal transportation**. The system can auto suggest me the **ideal itinerary** based on the place I love to visit, weather, budget. It can also give me more introduction about local culture during trip(we then taking self-driving car)

User Group



Anne, 58
Group Tour

"I usually travel twice a year, I join group tours because I don't have to plan ahead."

FRUSTRATIONS

- 01 Not enough sightseeing time.
- 02 I can't leave even if I feel bored.
- 03 I can't hear what the tour guides say, they are usually too far from me.

MOTIVATIONS / GOALS

- 01 I can decide where to stay longer.
- 02 Able to visit every famous place.
- 03 Don't have to plan myself.



Natasha, 37
Planned self-Guided

"We did family reunion road trips at least once a year which usually lasts 2 weeks. I like to plan my own traveling schedule to ensure I can go to all the places I want to visit."

FRUSTRATIONS

- 01 I don't have time to go through all the travel recommendations.
- 02 Unsure about which is the best route.

MOTIVATIONS / GOALS

- 01 I wish someone can drive for me.
- 02 I wish someone can have knowledge about the place already..



Nick, 23
Unplanned Self-guided

"I like to spend my vacation somewhere new. I don't like to plan ahead because I love to explore places that are not widely known. I usually ask local people for recommendations."

FRUSTRATIONS

- 01 It is kind of time-consuming to ask someone or google by myself.
- 02 Don't have knowledge about the place.

MOTIVATIONS / GOALS

- 01 I wish someone can give me a full introduction of the place.
- 02 I would like to travel with someone knowledgeable.

User Journey



Natasha, 37
Accountant

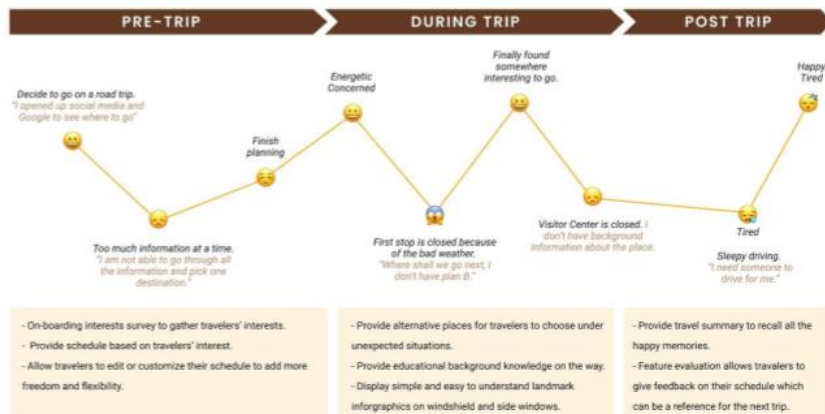
- Living in Los Angeles.
- I have a son and a daughter.
- Busy on work and chores.

She is planning to give her children an educational road trip, but...

GOALS:

- Don't want to be a driver.
- Spend least efforts on planning itineraries.
- Get background knowledge of the places without Googling.

User Journey





Define

HMW...help Natasha go on a meaningful trip without preparing?

Planning is overwhelming



Resourceful

Itinerary isn't free and flexible



Customized

Lack of background knowledge



Educational

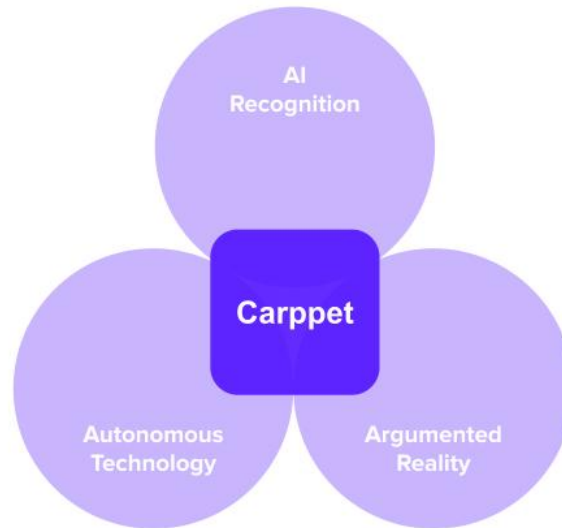


Brainstorming Ideas

Any questions?

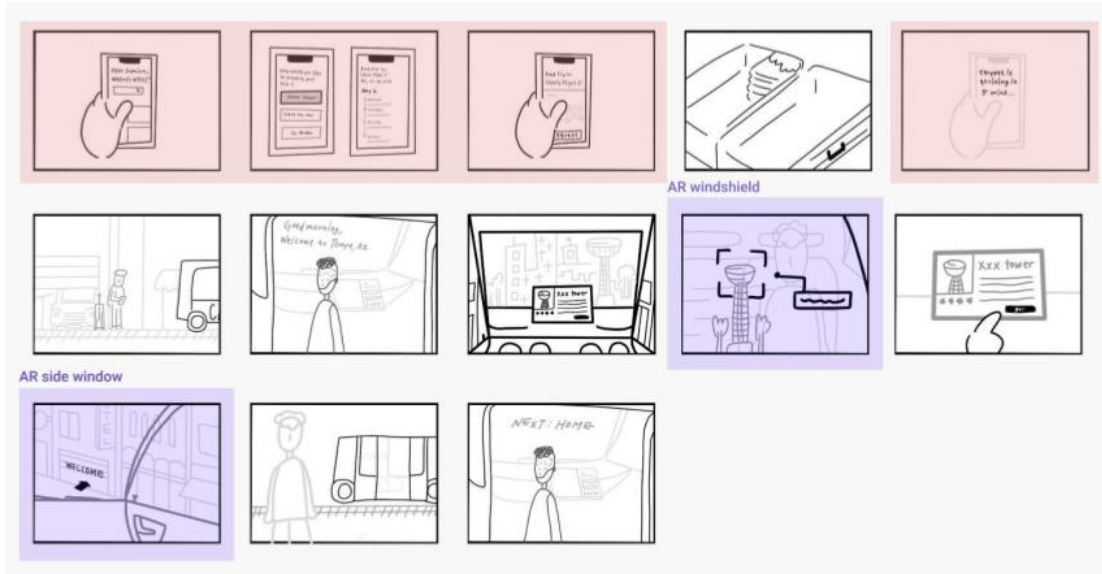
Ideating Solutions

The concept is an interactive AR system in autonomous vehicles which provides travelers immediately information and assistance.



Initial Idea

(End-to-end travel process)



How did I get to design?

Design iterations

Car Dashboard Screen



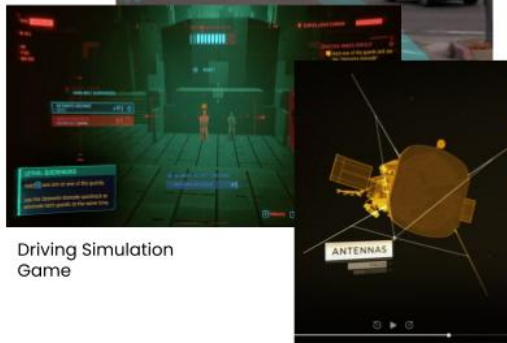
(X) No different than browsing on phone

2D style UI

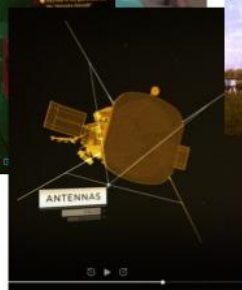


(X) Information is no different than searching on Google

AR navigation



Driving Simulation Game



National Geographic

Attraction Infographic



Visit museum



Physical billboard

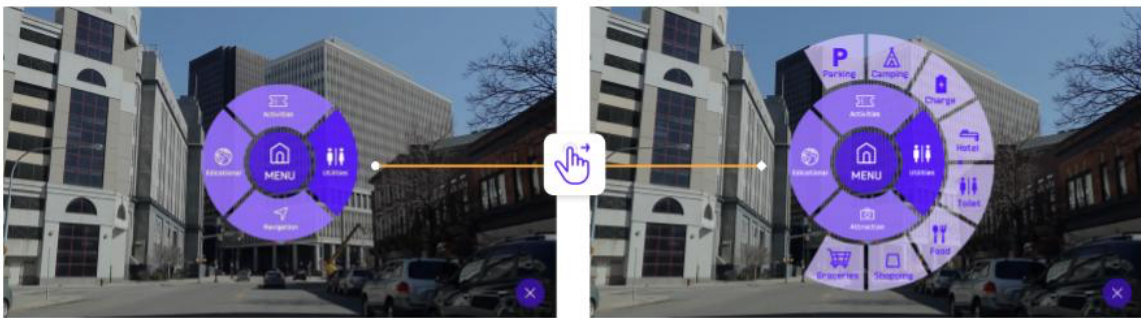


Let's walk through Natasha's journey together





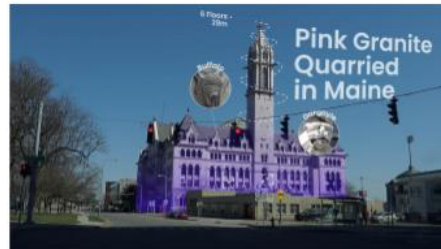
01 Pick what to see



02 Navigation



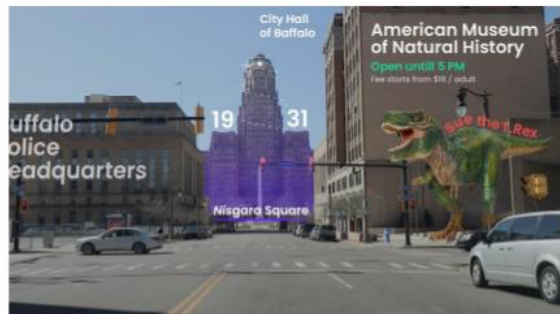
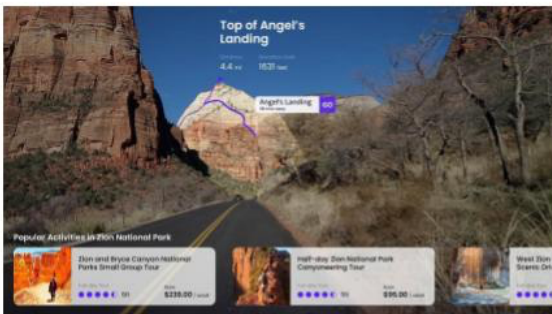
03 Education



04 Utilities



05 Activities





Is my idea too far-fetched?

Usability Testing



Test on Tesla?



Remove front seats?



Car gaming setup

Appendix C – Thesis Website



Thesis Project

CarpPET - An AR Tour Guide

CarpPET is an AR tour guide system that combines AI recognition with Augmented Reality Heads Up Display and applies them to autonomous cars. The main goal for Carppet is to help travelers having a meaningful travel experience.

Committee /

Adam Smith, Mike Strobert

Tools /

Figma, After Effect, Illustrator
Photoshop, Cinema 4D

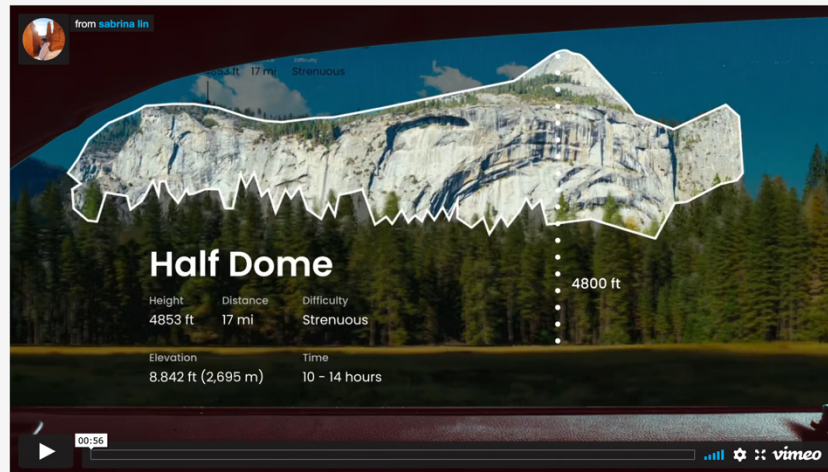
Role /

Research, Usability testing,
Design

Year /

Feb - ongoing, 2021

Concept Video (WIP)



Prompt

As someone who personally loves to go on a road trip once a year, I would never forget how tiring it is to be a driver and a tour guide at the same time.

Expectation: I always like to travel with somebody who love to plan travel schedule ahead so that I don't need to worry about where to go and how to get there. If there is someone who personally love to drive that would even better!



Problem

People want their trip to be unforgettable, but...



Planning is frustrated.



I don't want to be the driver.



I also don't want to join a tour group.



Because schedule isn't flexible.

Hypothesis

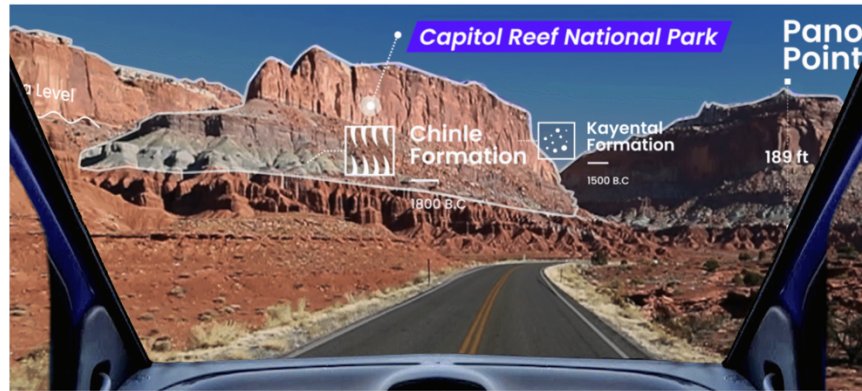
Today, autonomous technology has been more mature than it was in the past decade. Companies are utilizing this space as a third place and thinking what can offer to drivers when they no longer need to drive.

In this project, I was imagining the time when automobile can totally driveless and able to help drivers tackle the fundamental problem — long driving hours on a trip.

What else can we offer passengers to create a meaningful travel experience?

Solution Overview

Create a **built-in AR tour guide system** for autonomous cars so people don't have to worry about their transportation from point A to point B. Furthermore, the in-car tour guide system would allow travelers to travel like having a tour guide with them but with more flexibility to adjust their own trips to their liking.



(Augmented Reality Windshield and side windows)

Who are our users?

First, I started with online/secondary research to understand the **travel planning process** and what the **pain points** are. I wanted to gain insight into what the current end-to-end travel looks like.

45 surveys - learn about current travel trend



The future of traveling

Hello travelholics! Do you miss traveling already? Thank you for taking time to help me with my research.

My name is Sabrina! As autonomous technology will certainly fuel the future of automobile, people will be able to travel without joining a group tour or driving themselves. I am looking at what future traveling will look like for self-driving cars for my thesis project. The goal of this survey is to learn what type of traveler you are, what your biggest concern is, and what your pain points are when traveling.

This should only take a few minutes. Please reach out to me at minmin830413@gmail.com if you have any questions or comments regarding the survey.

I would also like to interview some of you. If you would like to be one of my interviewees, please don't hesitate to shoot me a message.

Insights:

For many travelers, they usually plan ahead before traveling. The typical way to form a travel plan is to extract information from **online resources including Google, Instagram, and blogs.**



93.9%

people usually go on **self-guided tours.**



81.3%

people think **gaining knowledge is important** during travel.



41.8%

people think **making an itinerary is overwhelming.**

4 Interviews - learn about expectations and concerns

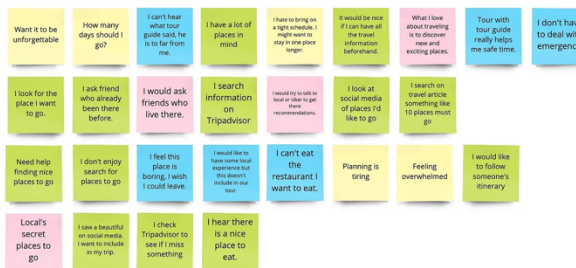
With insights obtained from survey responses, I was curious about -

1. Why travelers stick to certain types of travel? What are the pros and cons?
2. Details of how they plan a trip.
3. What travelers are looking for and concerns during a trip.

Insight:

- Understand **pain points, sweet spots, and expectations** from three types of travel style: group tour, planned self-guided tour, and unplanned self-guided tour.

- **Knowledge acquisition, schedule flexibility, and transportation** are 3 major elements people concern about.



Additional thoughts from travelers

By taking auto self-driving car, we can take advantage of flexible, personal transportation. The system can auto suggest me the ideal itinerary based on the place I love to visit, weather, budget. **It can also give me more introduction about local culture during trip(we then taking self-driving car)**

The self-driving car will be not only a driver also a **tour guide**, and also we people don't need to find a parking space to waste time. The car will be able to find a parking area itself and catch we up in any place.


AR, siri, i can view the information without a phone, whenever i want, no need to type or speak

Google rates are important. But some of them might not be as good as they rated. **More and more self-planned travel.**

Give local travel advice and detailed introduction about food, and have the function can combine those options, finally generate the best route suggestions

User Group

With the information extracted from these conversations, I used personas to list out each type of people to help me organize their frustrations and goals.


Anne, 48
Retired


"I usually travel once a season, I love to join group tours because I don't have to plan ahead and worry about transportation. Group tours have tour guides that help us acquire knowledge."

FRUSTRATIONS

- 01 Not enough sightseeing time.
- 02 I can't leave even if I feel bored.
- 03 I can't hear what the tour guides say, they are usually too far from me.

MOTIVATIONS / GOALS

- 01 I can decide where to stay longer.
- 02 Able to visit every famous place.
- 03 Don't have to plan myself.
- 04 Don't have to drive myself.



Natasha, 28
Software Engineer

FRUSTRATIONS

- 01 I don't have time to go through all the travel recommendations..
- 02 Unsure about the best route.

MOTIVATIONS / GOALS

- 01 I wish someone can drive for me.
- 02 I wish someone can have knowledge about the place already.


Nick, 23
Freelancer

"I am a freelancer who usually travel when my working season is over. I love to explore places not widely known and I don't like to plan ahead. For these reasons I usually ask locals for recommendations."

FRUSTRATIONS

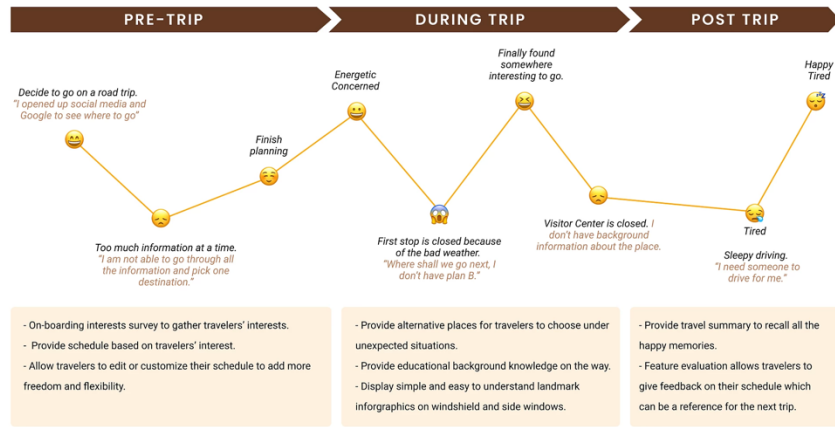
- 01 It is time-consuming to ask people or google by myself.
- 02 Don't have knowledge about the place.
- 03 Wasting time on transporting to a destination.

MOTIVATIONS / GOALS

- 01 I wish someone can educate me about the attractions
- 02 I would like to travel with someone who is local or knowledgeable

Synthesize

To summarize all my findings, I synthesized through key findings and identified critical issues. This session helped me brainstorming and iterate my designs.



Defining the problem with "HMW..."

Taking all my research and product goals, I developed "how might we?" statements to articulate the problems I am solving. These statements prepared me for ideation.



How might we simplify online resources into useful information that people want to know?



How might we provide users with travel plans based on their interests?



How might we provide and present educational knowledge during the trip?

Design Principle

01

Resourceful

Simplify massive information from Google, TripAdvisor, or social media that travelers might want to know during the trip.

02

Personalized

The system is able to give travelers multiple travel options based on their interests and feedback.

03

Educational

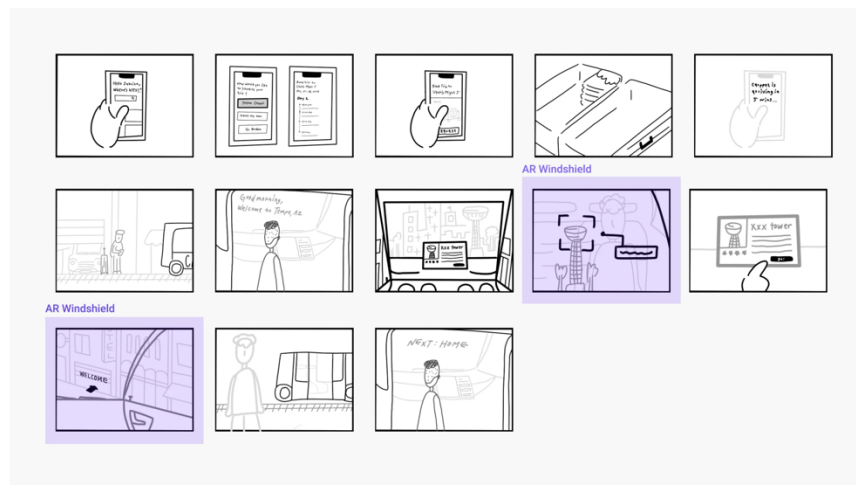
AR side windows and voice assistance provide educational background information about places during commute.

🧠 Brainstorm

An AR tour guide built-in autonomous cars

When I started this idea it was fresh and new to the market. I first tried to use a conventional way to tackle this problem but after talking to my professor, we believe we could think outside the box to make traveling more engaging.

Creating a tour guide that is resourceful, personalized, and educational is crucial. The concept I came up with is an AR windshield and side windows where travelers can immediately get background knowledge of what's appealing to them.



Early exploration of end to end process

Support Technologies

Incorporate technology that could help travelers gain knowledge painless during the trip.

Since the purpose of this project is to give travelers a completely relaxing experience without worried about not having a real tour guide around. I wondered what kind of technology could be also include in the system to help travelers travel painless.

Ultimately, Carppet aims to provide a comprehensive travel experience whether the travelers want to have a tour guide or want to travel spontaneously.



Augmented Reality



Image Recognition



Hand Gesture Recognition



Eye Tracking



Voice Assistance



GPS System



Autonomous Technology



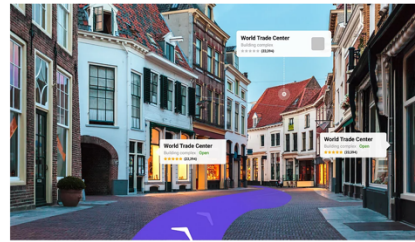
4DX

🌈 Design Iteration



1. Car Dashboard Screen

I started with car dashboard design because it is the easiest way to put all the content onto a screen. However, when interviewing with several travelers, they mentioned that if they still need to move their eyes between windshield and dashboard it isn't any different from browsing information on their phone.



2. 2D Style UI

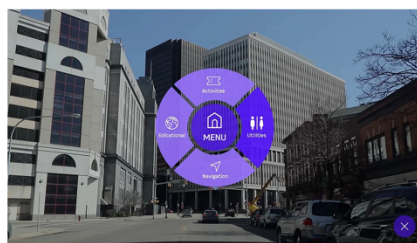
I then tried applying 2D style UI on the windshield and side windows. But again, since I am designing a Heads Up Display there are plenty more style other than mobile that I could play with.

Final Design

*The following images are from the perspective of a traveler sitting in an autonomous car.

01. Pick what to see

Travelers are able to pick what to see from one of the categories. The categories include education, navigation, utilities, and activities. This could avoid too much information at a time and also filter to information travelers are really looking for.



Pick a category

We provide 4 categories for travelers to choose from: Education, activities, navigation, and utilities. Travelers are able to switch to one another based on their interests and needs anytime.



Detail Choice

If travelers want to have more specific needs, we also offer plenty of sub categories for users to choose from.

02. Navigation

For security reasons, current autonomous cars still provide navigation features for users to understand the decisions autonomous cars are making.



Arrival Welcome

It is hard to tell what the animal is while there is nobody around you that knows the answer. Carppet is able to recognize animals and provide corresponding introduction of those animals.

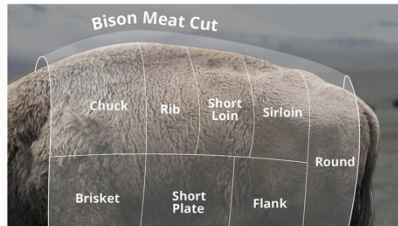


Surrounding Traffic

If travelers want to have more specific needs, we also offer plenty of sub categories for users to choose from.

03. Education

Learning through travel is one of the best means of education outside the classroom. Carppet introduces a new way to explore world efficiently and easily obtain knowledge for a successful trip.



Animals

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Plants

Unlike animals, since some plants only bloom in particular time of the year, it is even harder to identify them when there isn't an expert around. Carppet can recognize characteristics like size, form, leaf shape, and flower color to help you identify them even if it's not in the blossom season.



Building

We usually have to go inside the building to know its name and history. But now through Carppet, travelers are able to gain those information while stopping at a red light.



Geology

We usually go to visitor centers to obtain knowledge on geology. But what if visitor centers are closed? Carppet provides real-time information for users to learn anytime during the trip.

04. Utilities

No matter how well you plan your travel ahead, there will always be all sorts of emergency situations that you might run into. For example, finding restrooms, gas stations, or a plan B for a restaurant.



Highlight Places

Highlight special services above the attractions. Increase visibility for people who might be interested in those services that is not in the plan.

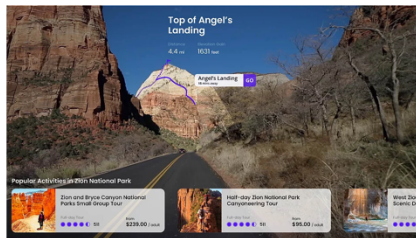


AR Billboard

AR billboard decreases the traditional billboard that was not able to see when drive passing by in the car. AR allows stores to add dynamic advertisement to catch passenger's eyes.

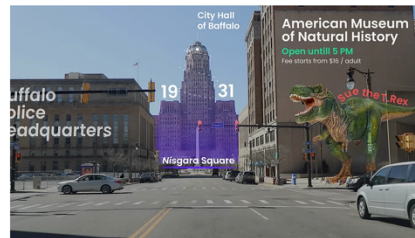
05. Activities

Although you might go through all the travel information, there will always be something you missed. Carpet indicates activities that are popular online, so travelers are able to always change their schedule according to their current mood.



Hiking Trail

Carpet not only shows current activities but also available activities that are near you so that travelers can make a most informed decision on where to go next.



Visit Museum

It is always a pain to visit a museum only to find that the exhibition doesn't match our interests or don't know what to look at. We use AR to showcase exhibits that only relate to travelers' interests.