AR Monitoring System

Project Plan

Team Number: Dec1714
Client: Andrew Gui
Advisor: Dr. Johnny Wong
Arbaaz: Team Leader
Ben: Key Idea Holder
Sam: Key Idea Holder
Nipun: Communication
Patrick: Webmaster
Dheeraj: Communication
dec1714@iastate.edu
dec1714.sd.ece.iastate.edu
February 16, 2017
Version 2

Introduction

1.1 Project statement

With the advancement in technology the ability to simplify life has become easier. With the possibilities of AR, we can minimize the human labor and make the tracking/oversight of autonomous vehicles easier. The intention of this project is to design an augmented reality monitoring system that will be integrated into the cab of an autonomous tractor.

1.2 Purpose

This project aims to provide an easy to use and vertical solution to remotely monitor and/or control autonomous vehicles. With enough refinement, the solution could be used for efficient oversight of a work force or autonomous fleets.

1.3 Goals

Upon completion of the project, we hope to have a complete set of software and hardware needed to remotely manage, store, and visualize a wide array of devices and machinery. This would include but not be limited to a lightweight device mounted on a monitored machine, a centralized server, and software written for the Microsoft HoloLens. We also hope to gain a greater understanding and appreciation for AR in general and to improve our abilities to be effective team members.

Upon completion of the project, we hope to have a complete set of software and hardware needed to remotely manage, store, and visualize a wide array of devices and machinery. This would include but not be limited to:

- HoloLens application
    - Intuitive and Easy to use
- Centralized server
    - Secure and ensures only the appropriate devices access the system components
- Remote solution
    - Custom tailored device to be placed on a monitored object
    - Provides visual feedback
    - Unhindered by remote locations

2 Deliverables

By the end of the spring semester we plan to have a flow chart and wiring diagram for all hardware integration as well as a rough prototype for our application which demonstrates the primary functionalities which we plan to bring to completion by the end of the second semester. By the end of the fall semester of 2017 we plan to have the capability to both create and save user profiles, use head tracking technology to control a 2-axis camera gimbal, view a 2D map in 3D, and show where monitored machines are on Google Earth in real time.

Server

- Authenticate connecting devices
- Handles and sets up all communication from gimbal setup and hololens

Raspberry Pi/Remote Device

- Have an assembled gimbal
- Research controlling the gimbal with streamed accelerometer data from Hololens - implement as proof of concept if have time
- Transmit GPS data from Raspberry Pi to server
- Transfer video output from Raspberry Pi to server
- NOTE: The Hololens will not communicate directly with the Raspberry Pi nor vice versa - instead all communication will pass through the server for both directions

Hololens App

- Draw a scrollable 2D map in visual space
- Display simplistic 3D models to represent monitored vehicles on 2D map
- User authentication on server

3 Design

3.1 Previous work/literature

Development for the Hololens started on March 30th, 2016 so complex applications have only just started to be released. One of the applications which we have drawn inspiration from is the Hololens maps application which displays cities and their buildings in 3D so that you can view them on a table. We would like to use LiDAR cameras to map sites and create the equivalent of a maps application with custom rendered maps.

There are also architecture companies that use an app called SketchUp to view their buildings and projects from the inside as well as outside. This is an interesting idea for us to consider because this application may be targeted towards construction companies in the future. Tying this in with the hololens maps, we could create custom maps and view them for each company's site.

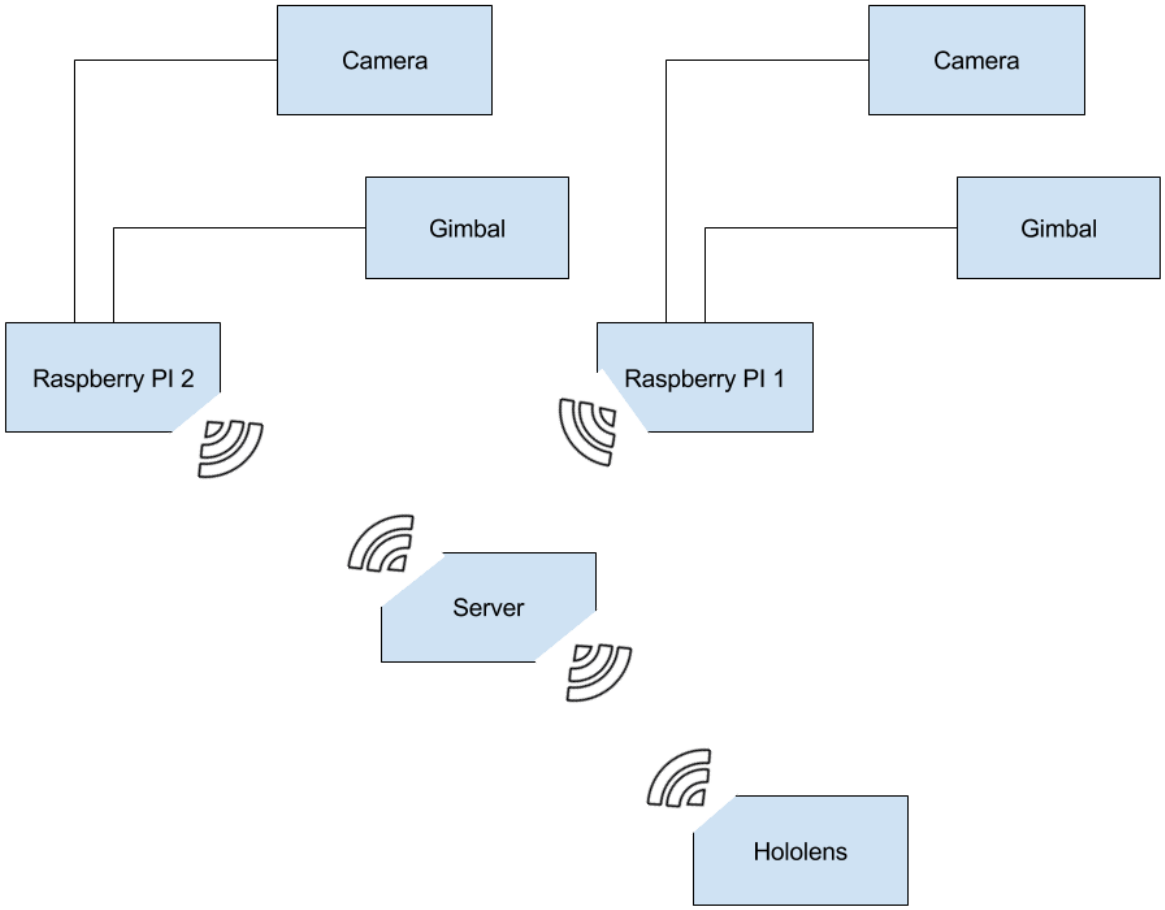
Microsoft has also used a light reflecting tape placed around the edge of a table to stabilize an AR component. This was seen during their E3 demonstration for minecraft. This would be a useful application of technology for our application because it would allow for more stabilized maps and viewing experience.

We plan to use a gimbal to control the in-cabin camera that is streaming to the hololens. We have been researching different gimbal, motors, and Raspberry Pi-compatible video streaming components.

en.wikipedia.org/wiki/Microsoft_HoloLens
https://youtu.be/xgakdcEzVwg?t=2m26s
https://hobbyking.com/en_us/multi-rotors-drones/camera-gimbals.html

3.2 Proposed System Block diagram

The following image shows the overview of how our final product should look like. The Raspberry PI and all components that are physically connected to it, is the gimbal system. Whereas the Server and Hololens communication is meant to be done through an app.



3.3 Assessment of Proposed methods

There are many existing partial solutions to our whole that we can take advantage in designing our product. Many high-tech industrial vehicles are already equipped with their own communications systems to communicate with each other in larger areas of operations. In smaller areas, there may be existing wifi connections or one can be created via ad-hoc. High-tech machines normally also have standardized ports for debugging that expose a lot of the equipment's sensory information. We can install our own device to process and communicate the data to a remote server. Direct communication to the HoloLens is not an option as the device will not always be online and available and wouldn't be able to be reliably exposed for devices to connect to. The HoloLens can connect to the server to retrieve data on various devices in the field.

3.4 Validation

At the highest level, we can connect a GPS device to our system and physically move it around. The HoloLens should display a map with the GPS device being tracked in real time. Additionally, we have made a signed deliverables document signed by both the client and advisor that will help assess our progress at the end of the semester.

4 Project Requirements/Specifications

4.1 Functional

- Ability to view monitored machine on map using Hololens app
- Ability to view a custom area map on the Hololens app
- Ability to assess machine status from Hololens app
- Ability to control gimbal/camera with Hololens app

4.2 Non-functional

- The software should be able to be adapted for many different purposes and inputs.
- The software should be secure. Unauthorized devices should not be able to feed false data nor should they be able to view device data.

4.3 Standards

Given that our project's goal is to allow better oversight in large work sites, we believe that our project is very unlikely to intrude on the ethical space.

5 Challenges

- Limited bandwidth on some forms of communication
    - The gimbal/raspberry pi unit will be mounted on vehicles, so it is likely that we will run into network connectivity issues.
    - Even when a network exists, we might not have enough bandwidth to stream real-time video.
- Custom mapping requiring extra processing
    - Generating a 3D model of an entire worksite from sensor data may be very expensive
    - The compiled data may be too detailed to directly display and needs to be converted to a lower resolution.

6 Timeline

To see our full timelines please look them in the Reference section. The following are a brief summary of what we wish to have accomplished.

6.1 First Semester

By the end of the spring semester we plan to have a flow chart and wiring diagram for all hardware integration as well as a rough prototype for our application which demonstrates the primary functionalities which we plan to bring to completion by the end of the second semester. The timeline chart below shows a very broad image of what we plan to be doing this semester and when we plan on doing it.

6.2 Second Semester

By the end of the fall semester of 2017 we plan to have the capability to both create and save user profiles, use head tracking technology to control a 2-axis camera gimbal, view a 2D map in 3D, and show where monitored machines are on Google Earth in real time.

7 Conclusion

This semester for the project, our goal is to understand how Hololens works and the technology that drives the augmented reality. With this understanding, we hope to be able to accomplish our task in designing and building the hardware and software need for use to be able to use Hololens to track and see what our machines are doing.

8 References

Version 1.0		Semester 1 TIMELINE			Arbaaz Khan, Ben Meis, Sam Altier, Nipun Dayanath, Patrick Mosebach, Dheeraj Nalluri	
Planned Dates		Actual Dates		Team Responsible	Who Responsible	Task
Start	Finish	Start	Finish			
1/10	1/10	1/10	1/10		Everyone	Form Team
1/10	1/17	1/10	1/17		Everyone	Choose a Design Project
1/17	1/24	1/17	1/27		Everyone	First Meeting with Advisor
1/24	1/25	1/27	2/3		Everyone	First Meeting with Company Sponsor
1/17	3/24	2/3			Everyone	Research
1/16	3/10				Everyone	Hololens
1/16	3/10			EE People	EE People	*Gimbals*
1/16	3/10					Motors
2/13	3/10					Flight Controllers
2/14	2/24					Project Proposal
2/14	2/17	2/16	2/24			Project Statement
2/14	2/18	2/16	2/24			Purpose
2/14	2/19	2/16	2/24			Goals

2/14	**4/26**					**Deliverables**
1/25	**4/28**				**Everyone**	***Class***
2/14	**2/24**	**2/14**	**2/24**		**Everyone**	**Project Plan (V1.0)**
2/18	**3/10**	**2/28**	**3/10**		**Everyone**	**Design Document (1st)**
2/21	**4/1**	**3/23**	**4/1**		**Everyone**	**Project Plan (V2.0)**
4/11	**4/28**				**Everyone**	**Design Document & Project plan (Final)**
1/25	**3/10**					***Project***
2/21	**3/24**					**Website**
3/6	**4/26**					**Gimbal Done**
3/6	**4/26**					**2D map with gps within hololens**
1/25	**3/10**					**Design**
2/6	**3/3**					**Server Block Diagram**
2/7	**3/3**					**Gimbal block Diagrams**
2/8	**3/9**					**Circuit Diagrams**
2/9	**3/9**					**Bill of Materials**
	4/26					**Prototype**
3/20	**4/26**	**3/25**		**EE People**	**EE People**	***Gimbal***
3/6	**4/1**	**3/6**	**3/12**	**EE People**	**EE People**	**Parts**
3/25	**4/1**	**3/25**			**Everyone**	**Prototype Gimbal Code**
3/31	**4/26**				**Everyone**	**Finalized Gimabl Code**
3/25	**4/1**					**Prototype Accelerometer Code**
3/31	**4/26**					**Finalized Accelerometer Code**
3/6	**4/26**					***Hololens App***

3/6	3/10					Hololens recognizes table
3/10	4/7					Map projected onto table
4/7	4/21					marker on map with dummy data
4/7	4/26					read gps data through server
4/3	4/18			Everyone	Everyone	Powerpoint
4/11	4/28			Everyone	Everyone	Final Project Plan

Version 1.0		Semester 2 TIMELINE		
Planned Dates		Actual Dates		Task
Start	Finish	Start	Finish	
8/28	8/28			First Meeting with Advisor
8/28	8/28			First Meeting with Company Sponsor
9/7	9/15			Define Deliverables
10/2	11/3			Prototyping
11/3	12/1			Testing