**PROBLEM DEFINITION**

**Problem Statement:**

The Palouse farming region is characterized as having rich, fertile soil and rolling hills. The geography of the Palouse presents a unique challenge to optimize effective cultivation and preservation of the region’s landscape. Precision Agriculture utilizes emerging technologies to optimize farming practices in the Palouse for better crop yield and responsible land management.

The focus of our project is to create Virtual Reality Simulation to be used as a tool in the classroom for students to learn and practice Precision Agriculture techniques in a safe, cost effective and engaging learning environment.

**Product Requirements**:

For this project we have tasked to create a virtual reality environment that replicates the Cook Farm. We have been provided with the Cook Farm elevation data for it to be translated into our application.

The simulation is to provide the students with experience driving a tractor with an attached sprayer boom used to apply chemical to the field. The tractor is to be equipped with GPS location controls which have the ability to map where the spray has been applied to field.

For classroom use, the simulation should have an autopilot or demonstration mode so that students can learn the optimal application techniques and pathing before practicing on their own.

A data collecting tool should also be developed to provide students with feedback as to how their experience compared to the optimal application. The optimal application would have the greatest fuel and spray efficiency.

The Virtual Reality Simulation will eventual be utilized by 4-6 classroom laboratory workstations. The hardware and software need to be able to replicated and installed.

**Product Specifications:**

The project should utilize an Oculus Rift Headset and use a Logitech Steering Wheel and Floor Pedals for navigation.

**Expected Deliverables:**

At the end of the project we should provide our sponsor with a Virtual Reality Simulation Application, a GitHub Repository and proper documentation for hardware setup and software installation and execution.

**PROJECT LEARNING**

**Inherited Project:**

Our team was the second team to work on the project. The previous team had used a Unity Game Engine and a GitHub Repository to develop the application.

The first team to work on the project was able to import a realistic tractor model and control system, create a working terrain map and implement a spraying action from the tractor.

**First Semester Development:**

During the first semester our team focused on acquainting ourselves with the current simulation, the Unity Game Engine and the C# program language. The features our team, under the directive of our sponsor, choose to develop were establishing field boundaries, implementing crop yield and visualization and improving the tractor console navigation. We divided up the development areas and we each began to work on improving these features.

**Second Semester Development:**

In the second semester each team member continued to work on their individual tasks utilizing their own workstation and the GitHub Repository. During research our team discovered a farming simulator application that had many of the features we were trying to implement into our current simulation.

Our team decided to take this information to our sponsor and it was decided that these new technologies warranted further research. Our team discovered that Farming Simulator 19 along with the vorpX Control mod would allow a user to drive a tractor and preform various farming activities in a virtual reality environment utilizing the Oculus Rift headset.

Our team was able purchase and Farming Simulator 19 and the vorpX VR 3D Driver and complete installation and calibration of the Logitech Steering Wheel and Floor Pedals and Oculus Rift Headset.

After meeting with our sponsor, it was decided that our team would switch our focus to developing the new Farming Simulator 19 application. Immediately work began to create a map mod that replicated the GPS elevation data of the Cook Farm, create a auto path tool that can be used in developing several modes or scenarios and documentation needed for installation and execution of the current application.

**PROJECT MANAGEMENT**

**Meeting Minutes:**

Date: January 31, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Initial Team Formation

Notes: Our group met in class and it was decided to use Discord for team communication. We exchanged contact information and established the PVS Discord Server. Link was given to the previous team’s wiki page.

Date: February 5, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Initiate team meet with Sponsor Dev Shrestha

Notes: Email was formulated to send to Sponsor Dev Shrestha

Date: February 7, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan, Dev Shrestha

Objective: Meet with Sponsor Dev Shrestha

Notes: Met with sponsor today, introduced our team. Discussed each of our interests in the project and knowledge of farming. We were given the information passed on to us from the previous team. Discussed access needed for the lab.

Date: February 19, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Check up on Lab Access

Notes: Email was formulated to send to Sponsor Dev Shrestha regarding lab access.

Date: February 26, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Setup possible meet with previous team member

Notes: Set up a team meeting and project handoff with Cameron for Thursday, February 28, 2019. Later cancelled by Cameron.

Date: March 5, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Prep for Presentation, Check on Lab access

Notes: Designated information look up for presentation. Chelsea checking MindWorks, Joel Previous project binder, Brad PowerPoint setup. Set up meeting for another presentation prep. Joel gained lab access.

Date: March 7, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Prep for Presentation

Notes: Created PowerPoint presentation. Sent out so members can review and prepare.

Date: March 28, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Research Review, Lab and Computer Access

Notes: Suggested research regarding using Farming Simulator 17 with VR mod for application. Able to access lab, unable to access computer. Need to contact Dev for new passcodes.

Date: April 2, 2019

Members Present: Joel Atwood, Dev Shrestha

Objective: Meet with Sponsor to discuss project direction.

Notes: Meeting rescheduled

Date: April 8, 2019

Members Present: Joel Atwood, Chelsea Hogan

Objective: Prep for Sponsor meeting

Notes: Update current project on in lab computer. Attempt to Set up of Unity project on individual workstations utilizing GitHub.

Date: April 11, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan, Dev Shrestha

Objective: Sponsor Meet

Notes: Team asks questions regarding requirements. Dev shows us lab with real world equipment we are to be simulating. Discussed tractor set up.

Date: April 14, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: GitHub issues

Notes: Brad reissues GitHub invite.

Date: May 1, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: End of Semester requirements

Notes: Discussion of logbooks

Date: May 10, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Logbook and Portfolio Information

Notes: Logbooks and Portfolio to be turned into Bolden

Date: August 27, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Prep for Project Presentation

Notes: Discussed wiki page requirement. Discussed division of labor should be included in presentation. Brad presents code found on fertilization data. Review talking points such as objects, purpose, last semester progression and current semester goals.

Date: September 15, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Set up meeting with Sponsor

Notes: Sent email to request time to meet.

Date: September 18, 2019

Members Present: Joel Atwood, Chelsea Hogan, Dev Shrestha

Objective: New Semester goals, present research

Notes: Dev gave the go ahead for Joel to pursue research into testing Farming Simulator 19 with a VR mod. Brad and Chelsea are to continue working on the current project.

Date: September 25, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Coverage of the two class meetings

Notes: Brad is attending the snapshot meeting; Chelsea is attending the capstone class meet.

Date: September 25, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Joel Reports on Research

Notes: Joel reports Farming Simulator 17 and 19 have VR support. Both applications support custom maps and modding. The vorpX VR 3d Driver is need for set up.

Date: September 26, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan, Dev Shrestha

Objective: Joel Reports on Research to Sponsor

Notes: Joel shares his finding with our sponsor and Dev approves purchase and installation of Farming Simulator 19 and the vorpX VR 3d Driver.

Date: October 9, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Installation of Farming Simulator 19 and the vorpX VR 3d Driver

Notes: Installation of Farming Simulator 19 and the vorpX VR 3d Driver. Team members test new application.

Date: October 10, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Preparation for Snapshot

Notes: Schedules are discussed. Snapshot Requirements reviewed. Brad starts storyboard. Chelsea to work on portfolio.

Date: October 14, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Preparation for Snapshot

Notes: Discussion of snapshot contents. Failed group picture… not professional enough

Date: October 15, 2019

Members Present: Brad Whitesell, Joel Atwood

Objective: Snapshot

Notes: Snapshot Day is successful. Member share thoughts on how it went.

Date: October 17, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan, Dev Shrestha

Objective: Class meeting requirement, Meet with Sponsor

Notes: Discuss schedules. Chelsea to attend class meeting. Brad shares modding information book link. Discuss conversion of GIS data. Dev review and approves of switching to the Farming Simulator 19 application.

Date: November 21, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Presentation of Cook Farm map and topological data

Notes: Brad presents work he has done in creating a map using the GIANTS Editor. Also discussion of upcoming snapshot.

Date: December 1, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Upcoming Snapshot and General Session 6

Notes: Discussion of work needed to be done for Snapshot Day and Oral presentations. Brad and Chelsea to attend General Session 6

Date: December 3, 2019

Members Present: Brad Whitesell, Chelsea Hogan, Dev Shrestha

Objective: Upcoming Snapshot and General Session 6

Notes: Discussion of poster board, end of the year deliverables and design report. In lab, encounter problems loading Cook Farm Map.

Date: December 4, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Exchange of documentation

Notes: Joel shares instructions for installing Farming Simulator 19 and the vorpX VR 3d driver. He also shares auto pathing and handoff documentation.

Date: December 5, 2019

Members Present: Brad Whitesell, Joel Atwood, Chelsea Hogan

Objective: Upcoming Snapshot and Oral Presentations

Notes: Discussion of work needed to be done for Snapshot Day and Oral presentations. Brad shares slide deck, and uploads documentation to GitHub. The current application is reviewed and errors are fixed. Screen shots are taken.

**Timeline Summary:**

January: Project Assignment and Meet Team Members

February: Meet project Sponsor, Review Project Hand off Information, Apply to gain access to the lab.

March: Gain Access to the Lab. Learn about the Unity Game Engine, the C# programming Language, the Oculus Headset and Logitech Steering Wheel and Floor Pedals.

April: Set Project Directives, Set Up GitHub and Individual Work Stations, Learn about Farming Technologies from Dev.

May: Work on Course Work, Prepare for Summer Break.

August: Class Meetings, Regroup.

September: Reset Project Directives for the Semester. Distribute Work Load. Research Farming Simulator 19 and vorpX VR mod.

October: Farming Simulator 19 and vorpX VR 3d Driver are Approved, Purchased and Installed. Project Directives and Workload is Readjusted for Application Change.

November: Creation of Mapping Mod to Add Cook Farm. Auto-pathing Tool Added to Application. Documentation Creation for New Application.

December: Continued Documentation for Handoff, Snapshot and Course Deliverables.

**Budget:**

Intial Budget Given: $1000.00

Less Purchase of Farming Simulator 19: $34.99

Less Purchase of vorpX VR 3d Driver: $39.99

Remaining Budget: $925.02

**WIKI SITE**

… currently under construction…

**DESIGN SOLUTION**

**Hardware Components:**

The current computer is housed in the Engineering Annex building. It has an Intel® i7-6700 CPU @ 3.40 GHz with 32.0 GB of RAM and has a NVIDIA GeForce GTX 1060 6GB Display Driver.

The system also has an Oculus Rift Headset with left and right num-chuks and a Logitech Steering Wheel and Floor Pedal Assembly.

**Software Components:**

The application utilized is Farming Simulator 19 with the vorpX VR 3d Driver. Our team felt that is simulation would provide more variety in tractor and attachment variations, would allow for a larger range of future features, used newer models and updated technologies and had greater access to mod and other tools used to customize the simulation. We also felt the new application would advance the timeline to present our sponsor with classroom ready system.

**Added Mods:**

A Cook Farm Map has been created in the GIANTS Editor and has been added to this project in order to replicate the Cook Farm into a virtual reality environment.

An Autopathing tool has been added in order to simulate an autopilot or demonstration mode so that students can learn the optimal application techniques and pathing before practicing on their own.

**REFERENCES**

**Inherited Resources:**

Team 1 GitHub: <https://github.com/AgSimGit>

Team 1 Wiki: <http://mindworks.shoutwiki.com/wiki/Virtual_Reality_Tractor_Simulation>

Unity: <https://unity.com/>

Occulus: <https://www.oculus.com/>

**Additional Resources:**

UIdaho MindWorks: <https://www.webpages.uidaho.edu/mindworks/capstone_design.htm>

Team 2 GitHub: <https://github.com/palouse-agriculture-in-virtual-reality>

Farming Simulator 19: <https://farming-simulator.com/>

vorpX: <https://www.vorpx.com/>

GIANTS Editor: <http://www.modsfs2019.com/giants-editor-64bit-v8-1-0-for-farming-simulator-2019/>