CS39440: Major Project

Outline Project Specification

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# **Project Description**

My project is to create a system to producing real time holograms from a camera feed using the pepper’s ghost pyramid technique. The system is intended for use at the Aberystwyth Science Week next year, but a prototype could potentially be displayed at this year’s event held in mid-March. This project should be a show case of the way an interesting technique originally used in stage and theatre productions can be adapted with computer science to make an impactful visual display.

The system will take real-time data captured from one, or multiple, cameras from a staging area which will consist of a black background and appropriate lighting to illuminate the subject. The video feed will then be processed to ensure that the background is black, as due to lighting it is likely to be grey, and then the feed will be displayed to a large monitor to work with a ghost pyramid of appropriate size. The pyramid is square based, made of Perspex, clear acrylic, or similar and open ended at both the top and bottom. The pyramid is placed on the monitor and the videos reflect through each side of the pyramid creating an illusion of a hologram in the centre.

To make the demonstration more interactive, the display will have an accompanying system that allows users to play a charades style game. This would display a topic to act out to the user in the stage and then others viewing the hologram would be able to guess what the activity being performed was. This would require a system capable of taking multiple different string inputs (guesses) from users simultaneously and feeding back to the user if their guess is successful.

Additionally, as a further extension into the project I would like to investigate the use of multiple cameras to build up a 3D object as opposed to several 2D images viewable from each side of the pyramid. This would be investigated at the end of the project most likely and will start with an investigation into both feasibility and suitability for the specific application. The main reason for assessing the suitability is to ensure that value will be added by using a 3D object as I already have a concern that there is not much information to object from the back of someone when playing charades.

# Proposed Tasks

## Research and spike solutions

I have already begun some basic research into the creation of video feeds that work with the pepper ghost pyramid, but I will require some additional research to implement some of the more complex features that that I am considering. In the basic case, I will research the best ways in which to separate the background and foreground of the image to enable the background to be removed from the video. Initially I will consider the computer vision techniques that fall under background subtraction to do this and, based on their success, seek further research were required.

I plan to use OpenCV and python to implement the corrections required for the video feed. Whilst I have a work proficiency in python, I have not used the OpenCV module in detail. I plan to begin working on a spike solution to test how I can obtain/load a video feed and process it. Some examples (including edge detection and similar techniques that can be used for background subtraction) that can be adapted were provided in the CS34110 Computer Vision module. Furthermore, I must also research how to gain real-time images from an external camera. This may require some knowledge of what camera is being used.

## Main tasks

The main tasks for the project are separable into 3 major categories which will all output deliverables: scene and hardware, image processing and display and the charades game.

As mentioned in the description, a staging area will be required for users to stand in. This will require thought regarding lighting, background as well as camera position to enable the system to work. Furthermore, the hardware such as the camera, machine to performing the processing and the display medium must be considered. Some discussion will most likely be required to establish what the department may already have available.

I wish to handle the image processing in OpenCV. I would like to take an adapted Feature Driven Development (FDD) approach to this where the system is built iteratively feature by feature using continuous integration. As this project has the possibility of displaying a prototype and the Aberystwyth Science week, then a continuous integration (CI) strategy would suit it well, furthermore FDD offers an appropriate up front design for the system. I wish to also use Test Driven Development (TDD) as I feel it great compliments CI and will pair well with FDD. The consideration I must consider when adapting the methodology is the reduced contact with an on-site customer as well as not having teams. Whilst this is a large mitigation from the original methodology, I believe it should still work for the project.

Finally, the charades game, which will most likely be developed as an extra feature to the original system, will require the use of several technologies. To implement this, I will consider how users will interact with the system (specifically focussing on the audience), the platform for the system (most likely an android application or simple web interface) and how the messages (guesses from users) are sent around the system. I intend to continue using FDD, TDD and CI for this stage of the project.

# Project Deliverables

**Design:** I plan to produce an overall model of the system and a full feature list as part of the adaptive FDD methodology I wish to use. This will most likely be comprised of various UML diagrams to build up a view of the components of the system architecture. Due to the various parts of the system, my initial thought is to use a component diagram and use case for the most abstracted view and then and activity diagrams and class/object diagrams where appropriate for internal parts of the system.  
**Produced by:**

**Staging area:** A technical design for the staging area set up will be provided. During the project the staging area will also be produced for use in the final presentation.  
**Produced by**: (Design) / (Implementation)

**Software and prototype:** As mentioned, a prototype (not including the charades game) will be produced earlier in the project and this will form the base of the final full system. The full software system containing functionality to perform video feed processing and a charades style game will be included. This will also come with a full test suite to ensure correct program functionality.  
**Produced by**: (Prototype) / (Full system)

**Documentation:** Software documentation as well as the final technical report will be produced. The software documentation will be created alongside the code and will aid the understanding of anyone reading the code. The technical report will be delivered at the end of the project and will most likely include a technical study to summarise the research undertaken to explain the pepper’s ghost effect.  
**Produced by:**

# Bibliography