# Icarus
# Project Proposal

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# 1 Introduction

Since the beginning of time humans have watched birds soar through the air and have dreamed of doing the same. However, the laws of physics have conspired to make that dream difficult, if not impossible, for a single human under his or her own power. Fortunately, we are not constrained by physical law in virtual worlds so we can come close to fulfilling this dream for many. Our primary objective for this project is to allow a person to navigate a virtual world as if they were flying by flapping their arms like wings. A secondary objective for this project is to minimize the equipment that a user must interact with in order to experience self-powered flight. Ideally the user will be able to enter a virtual reality CAVE, start the program and fly. There are some technological hurdles that may keep us from this ideal but we are sure we can come very close.

There are many possible benefits to this project—the most obvious being the "cool factor." Another is the incorporation of physical activity into a traditionally passive activity like playing video games. Also, this project allows us to hone the skills we are learning in HCI 575x.

Previous work in capturing the user's motion to produce changes in a virtual world has primarily concentrated on outfitting the user with a set of sensors or markers. There are very good reasons for adopting this approach. Currently these methods are very accurate and most can operate in the full three dimensions of space. Requiring the user to don a sensor harness in order to interact with a virtual reality program is cumbersome and in some applications, such as those with a high user throughput, impractical. We hope that our method will lead to an unencumbered experience for CAVE users.

# 2 Methods

We will be using VR Juggler in conjunction with OpenSceneGraph for rendering our virtual environment. For vision processing we will be using the OpenCV library. We will use the webcam to capture video of the user from behind. We will segment the person from the background and threshold the image. Next we will skeletonize the region that represents the user's silhouette. From the skeleton we will extract the position of the arms as vectors. The arm vectors will be sent via a TCP/IP socket to the virtual reality cluster. Using

Figure 1: Icarus and Daedelus

these vectors we will calculate thrust forces in a very simplified model of flight. See figure 2 for a diagram of this data-flow.

## 2.1 Equipment

Equipment to be used will consist of three main pieces. The C4 virtual reality environment at Iowa State University, a camera set up to block out visible light and let infrared light pass, and finally an infrared light source.

The first item, the C4 virtual reality environment, comes as is, with a choice of setup in either a U-shape or in a long wall. The environment will be set up in the U-shape to give the user a four sided (three walls and the floor) virtual environment in order to navigate. This also allows for a convenient place to view the user in the scene. The camera and IR light source will be setup to view the back of the user so that arm movements and overall body position can be easily captured. The C4 is being utilized mainly because of its availability over the similar six sided virtual environment known as the C6. The C6 will be undergoing a full rebuild and thus will be unavailable for use for a majority of the time in which this project is taking place.

To view the user as they interact with the virtual scene, a camera will be set up to view the users from behind, as mentioned above. The camera will utilize an IR pass filter to filter out light in the visible spectrum. In its first configuration, the camera will use a piece of exposed color film negative to block out all visible light, but let infrared light pass.[1] This filter method has

[1]See `http://homepage.ntlworld.com/geoff.johnson2/IR/` for an example of this

been used primarily as proof for the concept of IR illumination in the C4. The method was tested and agreed upon to be feasible.

The camera to be used is an off the shelf Unibrain Fire-i firewire webcam[2] (see figure 3). This particular camera is ideal for this project as it will pickup light in the infrared spectrum without modification. It is also, conveniently, already purchased and not being used.

The next step is to combine an optical IR filter with a IR emitter. It is important to get a filter that passes the same wavelength that the source emits. The IR light emitter is a the critical piece of equipment for this project to function correctly. We will need a light source that does not emit any light in the visible spectrum but also needs to be bright enough to illuminate the entire C4 environment with IR light. To do this an special lamp will need to be purchased. These generally consist of a large number (20 to 100) super bright light emitting diodes. Commercial products which advertise an illumination range of 20 to 30 feet will be sufficient. These are commonly used in outdoor security systems, in conjunction with an IR camera, to view ones surroundings in complete darkness.

One additional piece of equipment that may be needed, in the case of poor IR illumination, is a reflective jacket. This will aid in the reflection of IR light and make it easy for the camera to pick up user movement. The use of more reflective material will have to be determined experimentally once both the filter and light source are purchased. See figure 4 for a diagram of our equipment setup.

# 3 Evaluation

For overall testing of The Icarus Project, we will need to split into two modules: virtual reality and user input.

For testing the virtual reality module, we will simply need to be able to navigate a three dimensional environment using conventional user input. This will primarily consist of a keyboard and mouse combination, similar to any 3D game.

To test the user input, which will ultimately be based on gesture recognition, we will use a separate system built on a laptop. This will allow us to test

"hack."

[2]The specifications for this webcam are available at `http://www.unibrain.com/Products/VisionImg/Fire_i_DC.htm`

the gestures in environments outside of the C4. The most important item to the project will be the proper detection of movement in the users arms, thus this aspect will be heavily tested both in and out of the C4 environment. To test this, the computer vision algorithm will need to be continually tweaked until it reliably and accurately detects motion in the user.

## 3.1 Participants

Participants of the test should include a variety of individuals in differing in both size and skin color. The goal of this project is not to have this work for only one person, but to have a wide variety of individuals step into the C4 and start flying, without any customization and little added to the user in terms of attached sensors. That being said, a reflective jacket may need to be worn by the user if they are wearing clothing that is not reflective in the IR light spectrum.

## 3.2 The Definition of Success

In this project, success will be defined as by a successful flight in a virtual environment by arm movement. For the virtual reality module to be successful, the user will need to navigate the environment with ease, without any abnormalities in the graphics. The user input module will be a success if we can capture and detect user arm movement and map that into control commands for the virtual environment. If each module is working correctly, and communicating with each other, then the overall project, of a simulated bird flight, will be a success.

## 3.3 Possible Improvements

If it turns out that the IR illumination is not as successful as hoped, the user may be required to wear some IR reflective clothing while interacting with the project. Another addition to the project would include an additional camera to view the user from above. By adding an additional camera, the user can be better tracked and more motions detected. This will enhance the users experience in the project by providing more control inputs.

# 4 Qualifications

## 4.1 Ethan Slattery

Ethan has an undergraduate degree in Computer Engineering from Iowa State University and has worked with electronics for a number of years. As far as computer vision goes, the only experience that he he admits to is what has been taught in class up to this point. He also has access to a large machine shop and can make things utilizing that resource if need be.

## 4.2 Kevin Godby

Kevin has bachelor of arts degrees in psychology and technology management, an associate of applied science degree in computer systems/networks, and is currently a PhD student in the Human–Computer Interaction program.

## 4.3 Jesse Lane

Jesse has bachelor of science degrees in computer science and mathematics from Iowa State University and is a first year PhD student in Human–Computer Interaction, also at ISU. Jesse has been programming for more years than he would like to admit and is proficient in a number of languages including Java and C/C++ (the language this project will be developed in). For the last year he has been working on a virtual combine simulation in partnership with John Deere using VR Juggler and the actual combine input hardware.

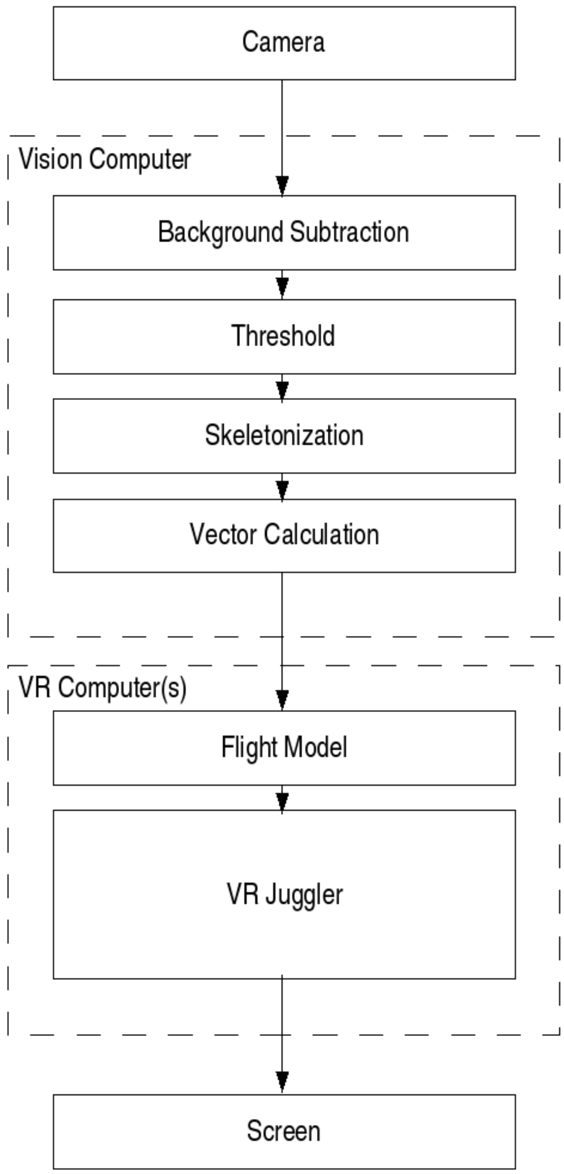


Figure 2: A diagram of the data flow.

Figure 3: Unibrain Fire-I firewire webcam

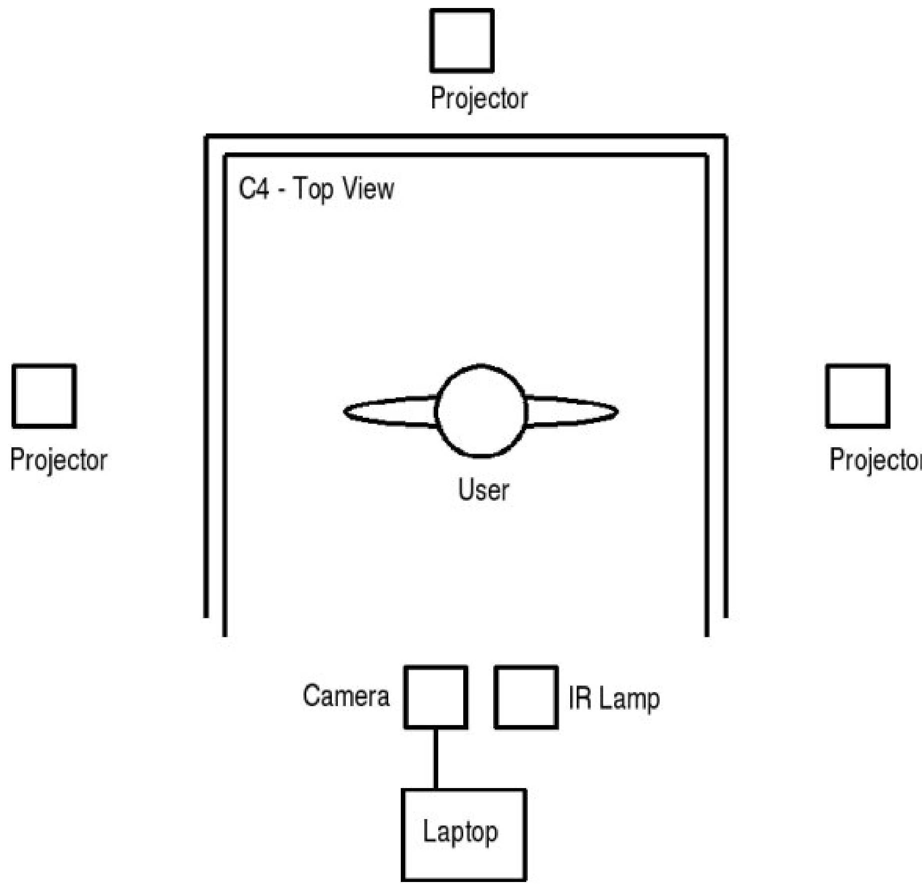


Figure 4: A diagram of our equipment setup. We will provide the laptop, webcam, and IR light source.