Interactive Simulation WS15/16
Project Proposal

EYES - Exchange Your Vision Simulator

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1. INTRODUCTION/MOTIVATION

- Give people the opportunity to experience other perception systems than the human eye $\Longrightarrow$ understanding why moths are caught by light, why flies fly in your eye while bicycling, why flies fly against glass...

2. CONCEPT

- At least 2 other visual systems to choose from
- One or more tasks to solve using those available systems.
  - Find a flower or some sweets (Bee/Wasp)
  - Find something and return to the colony as fast as possible (Ant)
  - Go as far as possible in the night without dying (moth)
  - Find an exit to the room/café/drinking glass (caught by some human)/...
  - Cross the highway
- Model the visual systems as realistically as possible.
- Use oculus rift / Google Cardboard to address each eye individually $\longrightarrow$ different modes:
  - Both human eyes see the same images to have a flat, monitor like view
  - For binocular systems: One-to-one mapping of the eyes For multiocular systems: Map them somehow to the two human eyes

2.1 User Experience

3. PROJECT REQUIREMENTS

Cite this whole shit

The pinhole camera model used in most computer graphics software to mimic the human visual perception is a rather crude approximation to the real world. We do not recognize this most of the time, because we are used to it. In other words, our brains do

Figure 1: Qualitative retina image captured by an apposition eye.

(a) Rendering of an environment as seen by a bee.

(b) Panorama rendering of the scene.

Figure 2: Renderings generated by InsectVision [MSZ15].

a lot of preprocessing. One example is the *blind spot* where the optic nerve exits the eye. In this area there are no photoreceptor cells and thus no visual information is available. Yet, we don't notice this in everyday life since the brain merges the information of the left and the right eye and compensates this lack of information. Other effects are optical distortion or color sensitivity which is not uniform over the retina. Nevertheless, using this pinhole model yields better results on computer screen or a virtual reality device, actually the ones we expect. In contrast, displaying the image captured by the retina of a human eye would not yield satisfying results (describe them?). Yet, the only thing we can do about other animals visual systems is reconstruct this image as closely as possible and invent mappings of those images to our eyes which we believe come close to the actual perception. This is especially evident when looking at species with more than two eyes.

The same goes for the perceived range of the visual spectrum. If the perceived range exceeds the spectrum visible to humans, a remapping is required.

Give the user/player the freedom to design or influence this retina image to human-eye mapping? E.g. the spectral mapping could be influenced quite easily because it's from $\mathbb{R}$ to $\mathbb{R}$.

The eyes of honey bees are already well studied. There are measurements of the ommatidial density on the eye ellipsoid as well as the spectral sensitivity of the ommatidia. Therefor an accurate model can be derived. Scientist of the German Aerospace Center in cooperation with the Australian National University, for example, implemented a renderer which renders a panorama image from the view of a bee [MSZ15] in order to study the way bees navigate almost without any depth perception and low image resolution. Another project at the University of Sussex realized a VR-game where the player is supposed to find as many flowers as possible in a given time period [Wil]. Yet, both of these project did not take the spectral sensitivity of the bees into account. Therefor this project's novum is to represent the bee's spectral perception in some way.

Unlike humans, bee's are less sensitive to red but more sensitive to green and ultra violet wavelengths cite. They are even capable of recognizing the polarization of the light because the photoreceptive cells in each ommatidium respond to different polarizations differently. Altough all of this is really interesting, we don't know yet to what extent those aspects are going to be realized. This is due to our current lack of technical knowledge about Unity3D and the principal difficulty how to display these effects.

Gamification - Search targets with different eyes. Different species have different ẗandardc̈tivities. Implement one/two/... which can be solved with any vision system. I.e. All n vision systems can be chosen in all m species specific activities, or to put it differently: Equip character with another vision system. E.g. Ant foraging: search food and return to base as fast as possible. - Possibility to create your own vision system by configuring n eyes(cameras) and attach them to the model (ant, spider, whatever) and choose a layout for the 2D-screen / oculus. This lets the user test and develop better, task specific visual systems. Of course: save/load - Species-task specific companions/enemies which need to be simulated

Complexity - In combination with the oculus rift: visual complexity in processing/perceiving the environment. - learning about the visual systems of other species - Dunno about model complexity, yet.

Aesthetics

4. TIMELINE

References

[MSZ15] Elmar Mair, Wolfgang Stürzel, and Jochen Zeil. *InsectVision*. Deutsches Zentrum für Luft- und Raumfahrt e.V. 2015. URL: `http://www.insectvision.org/flying-insects/bee-model` (visited on 10/20/2015).

[Wil] Lucas Wilkins. *beepilot*. URL: `http://www.lucaswilkins.com/beepilot/index.html` (visited on 10/21/2015).