

**Computer Science Department**

**Kickoff Document**

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| **Proposer:** | Olzhas Zhumabek |
| **Topic:** | Using eye gaze as pointer via webcam |
| **Team Members:** | Olzhas Zhumabek |
| **Executive Summary** |
| *In this part, you should:*1. *Outline the problem you will try to solve – the motivation for the project*
2. *Briefly state your proposed solution at a very high level*
3. *Provide some more details about your solution and how you will conduct the project*

*You can use parts of the original project proposal description for this, but be sure that you elaborate so that you clearly address the three item above.*Inaccurate mouse is perhaps the most annoying tools to use. It is often the case that typists reach out to their mouse only to miss it/hit it hard and push it over the table/or just be terribly inaccurate in pointing it. It also causes great strain on the shoulder, causing all sorts of traumas in long term. The other class of problems are introduced by being bound to a place with hard surface for it to accurate work. There are already solutions that combine keyboard and mouse onto a strong carcass that serves double duty as surface for mouse, but they are nowhere near the joystick/controller in ease of use.I am proposing a system that will use eye gaze as mouse input. The eye gaze tracking will be performed by a webcam, and there will be a special poster behind the person that will orient the webcam and get calibration data to understand how far the webcam is and under what angle it is positioned. This project will aim at solving the mouse problem without binding the person to laboratory conditions, e.g. barely any setup needed and the ease of use is very high. The main trick is to place an object in sight of camera that will have precise dimensions known at the time of calibration. The rest is handled by calculating distortion due to angle and distance. On top of that eye gaze tracker will be built, e.g. the head will be matched against the poster behind, which will help with orientation of the face and eye pupils. |
| **System Description** |
| *This part should outline the different parts (conceptual or actual) of the proposed hardware and/or software system and their interactions. The purpose of this is to make clear what needs to be developed during the next two semesters, and to help establish the overall scope of the project.*The system will consist of the following modules:1. World coordinate calibration
2. Eye pupil tracker
3. Geometry system to map the direction of eye pupil to point on the screen
4. Linux or Windows pipe that will pipe the output of (3) as mouse input

**Methodology:*** 3D Euclidian geometry
* Fast feature tracking

**Functionality:**1. World coordinate calibrator
2. Face and eye pupil tracker
3. Pupil direction to point on screen mapper
4. Pipe to OS input

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| **Hardware and Software Requirements** |
| Hardware:* Standard PC
* Webcam
* GPU

Software:* OpenCV
* C++
* Python
* CUDA
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| **Evaluation Criteria and Plan** |
| *How are you going to evaluate if the thing you are creating actually does what it should? Projects that involve the development of algorithms might be easier to evaluate in an objective way, but other kinds of projects should at least have some “test cases” that could be used to evaluate overall functionality.*The system will be evaluated according to three main criteria: accuracy, precision and speed. The goal for accuracy and precision might be more or less clear, but the speed needs to be real-time inorder to fully replace mouse pointer, as it can be used even in shooter, and very high dpi ones are used by professionals.  |
| **Risks and Contingency Plans** |
| *Sometimes, things don’t go as planned, and that includes software and hardware development projects. For your project, you need to identify and list the main risk factors, and write a brief contingency plan if the risk becomes a reality.**In particular, for projects that have certain software or hardware requirements, an alternative must be provided in the case that the hardware breaks or is not available (example: in the case critical components of your project are not available (e.g. hardware) or results leading toward next step are not possible).*It might be a good idea to lower some of the three evaluation criteria, but otherwise I believe it will be mostly quality issue and not existential issue. |
| **Objectives** |
| *List the things that you want to accomplish each semester***Fall 2019*** Literature review of eye pupil tracking
* Find available software for non-stereo pupil tracking
* Write a step-by-step report that explains the approach we use

**Spring 2020 (tentative)*** Design and implement world coordinate calibration system
* Design and implement settings saving system, e.g. for screen size, resolution, pixel density, etc.
* Create a basic application that will be used to view which part of the screen is looked at
* Optimization of algorithm to get closer to real-time
* Create a piping system to send data to OS as input
* Evaluate approach, and make appropriate adjustments as needed
* Write a final report outlining results
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| **Tasks to be Accomplished** |
| *Tasks are the things that need to be done to accomplish your objectives. Here, provide the task list for Fall 2019, along with tentative deadlines, and which group members will be responsible – tasks and milestones should be managed through Redmine.**Also outline the tasks that should be completed by the end of Spring 2020, though you don’t need to assign them to individual group members at this time.***Fall 2019*** Kickoff document
* Feature matcher review
* Interim presentation
* World coordinate calibration system
* Final presentation

**Spring 2020 (tentative)*** Face and pupil tracker
* Pupil direction to screen coordinates
* Input pipe
* Poster
* Final presentation
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| **Deliverables** |
| *What are the “work products” that are going to be produced over the course of the project? Items that are specifically required for all projects are underlined below.* **Fall 2019*** Kickoff Document (this document)
* Literature review
* Specification and Design Document
* Web application
* Feature matchers review
* Interim Presentation
* World coordinate calibration system
* Semester Final Presentation, Report and Deliverable (the system itself)

**Spring 2020 (tentative)*** Project Plan Revision Document
* Face and pupil tracking system
* Pupil direction to screen coordinates mapper
* Input pipe
* Project Poster
* Final Project Presentation, Report and Deliverable (the system itself)
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| **References and Further Reading** |
| 1. <https://www.researchgate.net/publication/239398674_An_Isotropic_3_3_Image_Gradient_Operator>
2. <https://en.wikipedia.org/wiki/Hessian_matrix>
3. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.434.4816&rep=rep1&type=pdf>
4. <https://www.researchgate.net/profile/Hanno_Scharr/publication/220955743_Optimal_Filters_for_Extended_Optical_Flow/links/004635151972eda98f000000/Optimal-Filters-for-Extended-Optical-Flow.pdf>
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Senior Project advisers should create *at a minimum* the following five essential team milestones in the Redmine system.

* Kickoff document -- September 18 (W)
* Specification and Design of the SW and/or HW system -- September 27 (F)
* Interim evaluation -- October 21 (M), tentative
* Iteration 1 (also considering interim presentation comments) -- November 4 (M), tentative
* Final report and deliverable for the semester -- November 22 (F)

Additional milestones should be added to Redmine for individual and group tasks.

Senior Project advisers should meet with their groups on a weekly basis and keep a sign-in and comments sheet to track who participated in meetings, and to also document project progress and potential issues.