Eye gaze compatible photography and editing

IN COLLABORATION WITH ALYN HOSPITAL

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Problem Definition

● What is the problem or need?

For many disabled people, the ability of photography and editing is impossible because there is no existing product for people that can't use theirs hands.

● Who has the problem or need?

A lot of disabled people that cannot move their hands due to motoric disabilities. The need came from ALYN hospital that take care of disabled children.

● Why is it important to solve?

For disabled people, the little things that are trivial for everyone else are important. The ability to take a picture and edit it just like every other child is important to the children of ALYN hospital. It is a hobby that can improve different abilities and help them feel that they are children like everyone else.

BACKGROUND

There are several things that should be mentioned to understand our project better. First, we will explain what the eye gaze technology is. Eye gaze or eye tracking is a technology that allows a computer to know where a person is looking. It can detect the attention and focus of the user and by that allows the user to control the computer with their eyes. This technology is especially useful for people who do not have the ability to speak or use their hands, because it allows them access to computers and everything that comes with that. As part of our research on the subject, we were unable to find any similar software that allows the user to take photographs with eye gaze technology. We were able to find a hands-free photography technology called Neurocam, that automatically records "moments of interest" in the user's life by analyzing the user's brainwaves.

RELATED WORK

After a thorough research, we have not been able to find any related projects that provided similar solutions to our problem. As mentioned in the background, we did find a technology called Neurocam (http://neurowear.com/projects_detail/neurocam.html), that records small video clips by analyzing the users brainwaves.

SOLUTION

Overview:

The first approach for solving the problem is by eye gaze technology.
as mentioned in the background section, by using eye gaze technology people can control the computer without using their hands. And in particular disabled children will be able to take pictures and edit them.
The main difficulty is the suitability of the software to eye gaze technology.
another possible component which might be difficult to implement is the editing feature. The technology is based on the amount of time the user looks at a certain place on the screen, so it will be hard to implement a scale with which users can control the editing of the pictures they took.
The advantage of this approach is that the user can control the computer with all the features it has without the need of special equipment except the eye gaze technology. therefore, after the installation of the eye gaze on the computer it is possible to use multiple software in different fields.

Another approach is to use technology based on an analysis of the user's brainwaves. This approach will be accessible to a wider range of users including users with more minimal abilities. By reading the analysis of the user brainwaves the user will be able to take a picture and edit it. The main difficulty is the suitability of the software to the technology. A key component is to implement a software that uses this technology and allows the user to edit a photo. There is already an existing camera that uses this technology.
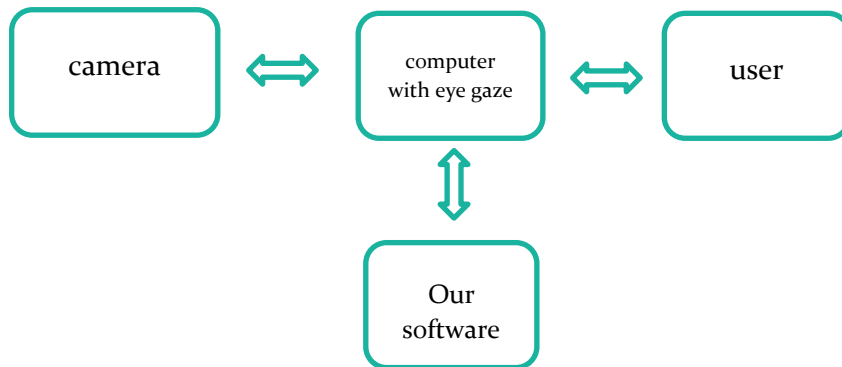
Proposed Solution:

We decided to go with the first approach. The main reason we chose it is because we believe that it is more likely to succeed in creating a finished product while using eye gaze. Another reason is that we work in cooperation with ALYN hospital and they have the eye gaze technology in their Innovation Center so we will be able to test the product there.
The children that will use this software are kids with cognitive disabilities and therefore the features should be simple. One of the disadvantages of this approach is that the technology is limited and does not enable fine tuning (such as editing

photos with more personalization). Because of the user's character it does not decrease from what we expect the product to do..

Key Components:

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┌──────────┐      ┌──────────────┐      ┌──────────┐
│  camera  │ ⟺    │   computer   │ ⟺    │   user   │
│          │      │ with eye gaze│      │          │
└──────────┘      └──────────────┘      └──────────┘
                         ⇕
                  ┌──────────────┐
                  │     Our      │
                  │   software   │
                  └──────────────┘
```

1. The user will interact with the eye gaze software, that will allow them to access the computer with our software on it.
2. Via our software, the user will be able to activate the camera, take photos and perform basic editing on them.
- Computer with eye-gaze technology – a computer with an eye gaze technology installed on it, that the user can interact with.
- Our software – the software that we will implement, that will be able to control the camera in order to take photos and perform basic editing on these photos.
- Camera – a camera that will be connected to the computer.

SOLUTION FEASIBILTY

The technologies we plan to use in our work are:

- A TOBII eye gaze product – a sensor that allows the computer to read the user's eye gaze (https://www.tobiidynavox.com/devices/eye-gaze-devices/pceye-plus/).
- PyGaze – a Python eye gaze toolbox (http://www.pygaze.org/).

Challenges and uncertainties in our project:

- Making our software accessible – Since our software is designated for children that can't talk or move their hands and that are going through a rehabilitation process, we would like it to be very easy to use, while not compromising on the software's abilities.
- Overcoming fine tuning limitations – since our software is due to be used via eye gaze technology, it will be challenging to address fine tuning that editing photos requires.
- Understanding what the end user wants the software to perform – since our end users are children that have problems with communicating, it will be a challenge to understand what they want and need from our software.
- Applying an Image processing feature – in order to make this project more interesting and to show knowledge in image processing we would like to integrate in our software one or two image processing features while not making the software harder to use as a result.

Skateboard – Bike – Car:

Phase 1: In the end of phase 1 we would like to have a working software that interacts with eye gaze technology and allows the user to take pictures.

Difficulties in phase 1:

- Making the user interface accessible and easy to use. We will test this by getting feedback from various users with different cognitive abilities.
- Interacting with the computer's camera. We will solve this problem by consulting with other people and doing specific research on the subject.
- Creating a software that uses eye gaze technology. we will solve this problem by using eye gaze toolboxes (PyGaze).

Phase 2: In the end of phase 2 we would like to have the image processing features.

Difficulties in phase 2:

- It will be hard to find a challenging yet interesting feature to implement. The easiest and fastest way to tackle this problem is to implement features based on features that we already implemented in the image processing course.

- Making these features exciting for the children in ALYN hospital. The easiest way to solve this problem will be to present the children in ALYN several options of features that are possible to implement in our software and see which of those they liked the most.

Phase 3: In the end of phase 3 we would like to have a final product that works as we expect with several image processing features.

Difficulties in phase 3:

- Due to the Coronavirus crisis we only have limited access to ALYN hospital and therefore we will have limited access to the eye-gaze technology. In order to overcome this difficulty, we will have concentrated workdays at ALYN hospital whenever its possible.

PRELIMINARY KNOWLEDGE

- Knowledge in programming – especially programming that interacts with eye gaze. In order to learn that, we have found several articles and toolboxes about this subject:
    - PyGaze - http://www.pygaze.org/
    - TOBII API and eye gaze concepts - http://www.usability-onair.com/wp-content/uploads/2008/06/init-2008-eyetracking-02.pdf
- Knowledge in image processing – In order to apply image processing knowledge. Matches subjects taught in the course "Image Processing" – 67829, which we have already taken and plan to take next semester.
- Understanding the abilities and disabilities of the end users. We are in touch with the relevant staff in ALYN hospital and they instruct us about the subject. Particularly, we are in touch with the speech therapist that raised the need for our project.

SOFTWARE AND HARDWARE REQUIREMENTS

- TOBII eye gaze sensor and software – In order to have access to the eye gaze technology.
- Image processing libraries – such as sci-py, numpy, and other python libraries, in order to create image processing features.
- User interface libraries – such as TKInter, in order to create an accessible user interface.
- Eye gaze libraries – such as PyGaze, in order to create an eye gaze compatible software

EVALUATION AND VERIFICATIONS

Evaluation:

After we will implement the Image processing features. We will check that those features work as we expect by applying them on 200 images and rate the features performances. We expect the features to give satisfying results on over 80% of all tested images.

Verification:

In order to verify that our software works as expected, we will let various people from different cognitive abilities (children from ALYN hospital) to try our software and give us feedback on it. Besides that, we will think of several edge cases and will test the software in order to see that it works as we wish.

PLAN FOR NEXT YEAR

Our minimum viable product (MVP):

Phase 1: we would like to have a basic software that allows the user to use the computer's camera via eye gaze.

Phase 2: create a simple image processing feature to our software.

Phase 3: expand the image processing features and abilities.

NEXT YEAR SCHEDULE

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Date	Task	Priority	Task	Priority
October	Research how to create accessible GUI and connect and activate the computer's camera	P0	Research how to connect and use eye gaze	P0
November	Basic GUI - open, close, and activate camera	P0	Connecting GUI to eye gaze	P0
December	Testing the software	P0	Testing the software	P0
January	User feedback and fixes	P0	User feedback and fixes	P0
February	Research and create an image	P1	Research and create an image	P1

	processing feature		processing feature	
March	Embedding the image processing feature in the software	P1	Embedding the image processing feature in the software	P1
April	Testing the software	P1	Testing the software	P1
May	User feedback and fixes	P1	User feedback and fixes	P1
June	expand the image processing features and abilities	P2	expand the image processing features and abilities	P2

REFERENCES

1. PyGaze – an open source eye gaze python library - http://www.pygaze.org/
2. Eye gaze software explanation and API example - http://www.usability-onair.com/wp-content/uploads/2008/06/init-2008-eyetracking-02.pdf
3. Neurocam – relative solution to hands free photography - http://neurowear.com/projects_detail/neurocam.html
4. TOBII - Eye gaze products - https://www.tobii.com/
5. The TOBII product that ALYN hospital uses - https://www.tobiidynavox.com/devices/eye-gaze-devices/pceye-plus/
6. TOBII Windows Control – a software that allows eye gaze to work with windows - https://www.tobiidynavox.com/software/windows-software/windows-control-2/