Appendix 2: Tender Documents

School of Electrical and Information Engineering
University of the Witwatersrand, Johannesburg
ELEN4002/4012: EIE Investigation (Capstone Project) 2022

Tender Bid for Project Number: 22P59

Project Title: Which Hand?

Group Number: 22G05

Project Overview:

In order to begin the design and implementation of the hand drawing analysis, sufficient research must be done to understand the effects of Parkinson's disease on a person's motor functions, and how this would affect their drawing ability. Research on image processing would also be important to understand the data provided for the project. The project will require image processing in order to convert the hand drawing data into a comprehensive database that can then be utilized for machine learning. The actual implementation of the project will involve the analysis of the data provided and the creation of an artificial intelligence program that is capable of interpreting the information and determining what stage of Parkinson's a specific subject is at. The final stage of the project will be testing the application against known values in order to ensure a product of high enough accuracy. Any necessary changes and improvements to the image processing and machine learning will need to be implemented. The resulting data will be used to efficiently analyze the effectiveness of Focused Ultrasound as a treatment for Parkinson's disease. The machine learning program can be used to compare the patient data before the start of the treatment to the data 2 years into the treatment. The program should effectively display the difference between the stages of Parkinson's displayed in each case.

Preliminary Budget & Resources:

In order to successfully implement this project, access to extensive data on the effects of Parkinson's disease on hand drawings, as well as images drawn by patients that can be used to produce a machine learning database will need to be provided by the university. The effectiveness of the program will need to be verified by comparing the results of patients in known stages of Parkinson's. It will therefore be necessary for the known stage of Parkinson's disease to be provided for the image data.

An image processing library will be required to analyze and manipulate the image data provided for the project. This library will need to convert the images into a data format so as the machine learning database can be developed. OpenCV is a commonly used image processing tool for machine learning, it is open source and therefore free to use.

A database will need to be developed with the hand drawing image data; this will require databasing software. Open-source software such as MySQL and Cassandra are available and free to use.

The development of the machine learning program will be done in Python as many machine learning related resources support this language and are readily available.

Weekly Milestones:

Week 1: Perform thorough research into the Focused Ultrasound (FUS) treatment, Parkinson's disease and Essential Tremor to better understand the subject matter. Further research into the software requirements and solutions, as well as the computational and statistical analyses that will be used to provide quantitative analytics and results. Ensure all plans and deliverables are completely in-line with the standards, ethics and requirements of the professionals and data providers.

Week 2: Start designing image processing techniques (if necessary) and finalize what software will be used.

Week 3: Start applying the data preparation and image pre-processing to generate a comprehensive dataset so as to develop the dataset that will be further analyzed as well as data analysis techniques.

Week 4-6: Start developing the software: further image processing, data analysis, signal processing, output, etc. Ensure to develop tests and other checks that always ensure the utmost accuracy and quality output.

Week 7-8: Finalize the software and start performing final quality and accuracy tests.

Risks and Mitigation:

This project is attempting to replace subjective, non-standard, labour-intensive task of an expert physician evaluating the effectiveness of the specific Parkinson's treatment. However, this means that the results of this project need to be reliable enough to be relied upon in a medical environment. Thus, the biggest and most important risk to consider regarding this project includes having an error margin that is too large, as this would result in unreliable results that could mislead physicians and patients. This risk can only be mitigated if the error margin of the final product is small enough, according to the professionals within this field, so that the results can be confidently and consistently relied upon. If this error margin cannot be achieved, then disclaimers and other ethical considerations must be discussed with all parties involved before using any of the results of the final product.

As mentioned, the use, analysis and result-distribution of the data provided offers ethical considerations that must be adhered to at all times. Ethics waivers and agreements must be drafted up and agreed to by all parties before the commencement of this investigation.

School of Electrical and Information Engineering
University of the Witwatersrand, Johannesburg
ELEN4002/4012: EIE Investigation (Capstone Project) 2022

Tender Bid for Project Number: 22P30

Project Title: Sign Language Translator for the Hearing and Speech Impaired

Group Number: 22G05

Project Overview:

In order to fully appreciate the extent of this project, research will have to be undertaken regarding South African sign language (SASL). While it is not (yet) one of South Africa's official languages, it is recognized as a teaching-subject in schools and universities across South Africa. With all this in mind, it is obvious that developing systems that will enable the translation of SASL into audible speech is invaluable to not only the deaf community, but all communities of this country. Further research will be conducted to discover if there are any current solutions to developing such a system (that can, for example, translate hand signals and movements). The design of the image capturing techniques, separation and analysis of the inputted data will need to be planned and complex algorithms developed. A dataset and database will need to be captured, designed and developed that will best contain and allow for ease of analysis of the data. From here, software will need to be investigated and designed that will convert the processed signals into audio speech signals (and text output if possible). This entire system will need to be one self-contained and portable program. As with any video recording and use of personal data, ethics applications and waivers will need to be developed and agreed to by all parties. The final stage of the project will be testing the system in order to ensure a product of high enough accuracy, as incorrect translations would be detrimental to such an important project.

Preliminary Budget & Resources:

Fortunately, the University of Witwatersrand (Wits) has many of the required resources for this project readily available. The incredible ESD laboratory and other computer and software components available to students allow for the cost of this project to remain low.

If anything, the major cost will include any costs of software not provided by Wits that is required to perform the image capturing, data processing and data conversion required. However, since Python is the preferred programming language for such applications (especially in the machine learning field), most libraries are open source and free to use and develop further.

An image processing library will be required to analyze and manipulate the input (video data for example) and convert it into a data format so that a database can be developed. This will require database software; fortunately, open-source software such as MySQL and Cassandra are available for students for free.

Depending on how the data is captured, and whether it must be done within this project (or if it is provided beforehand) hardware resources might be required, such as a camera.

Weekly Milestones:

Week 1: Perform thorough research into SASL, as well as the software requirements and solutions. Ensure all plans and deliverables are completely in-line with the standards, ethics and requirements of the deaf-community.

Week 2: Start designing image processing techniques (if necessary) and finalize what software will be used.

Week 3: Begin collecting data (if necessary) and storing it into the database – develop the dataset that will be analyzed as well as data analysis techniques.

Week 4-6: Start developing the software: image processing, data analysis, signal processing, audio processing and output, text generation and output, etc. Ensure to develop tests and other checks that always ensure the utmost accuracy and quality output.

Week 7-8: Finalize the software and start performing final quality and accuracy tests.

Risks and Mitigation:

The biggest and most important risk to consider with this project includes the miss-translation of the inputted sign language. A high rate of miss-translation is unacceptable and will not be considered a successful solution. Mitigating this will require accurate data input, well-programmed software solution, and continuous input from the deaf-community and professional SASL contact that checks the accuracy of the output of the system. Fortunately, one of the students has a SASL contact that would be willing to provide this quality assurance if Wits is unable to provide such a person.

Further, the emotions conveyed when communicating with SASL are often entirely based on facial expressions and body gestures, which is incredibly difficult to convey using a generated audio and text output. This is another risk that is related to the miss-communication of such a system and must be closely monitored to ensure that the inaccuracies are minimal.

As mentioned, the use of video recording and use of personal data provides ethical considerations that must be adhered to at all times.

School of Electrical and Information Engineering
University of the Witwatersrand, Johannesburg
ELEN4002/4012: EIE Investigation (Capstone Project) 2022

Tender Bid for Project Number: 22P21

Project Title: App to scan pool water test strips

Group Number: 22G05

Project Overview:

In order to begin the design of the app to scan pool water strips, sufficient research will need to be done to understand the possible outcomes displayed by the pool water strips and their corresponding courses of action. Research on image processing and effective image capturing in different light conditions will also be important for this stage. The design of the image capturing techniques and separation and analysis of each testing strip segment will need to be planned and complex algorithms developed. After the design stage, a database will need to be developed with the use of the processed image data. This data will be used to train the artificial intelligence program to recognize the colors present on the testing strips and will be used to determine the appropriate course of action for each color. The database will need to consider different light conditions in the images. The actual implementation of the project will involve image capturing, processing and utilizing machine learning to analyze the pool water testing strips and advise on a plan of action. This project will be developed into an application. The final stage of the project will be testing the application against known values and making any necessary changes to the coding and image processing.

Preliminary Budget & Resources:

Since this is a machine learning project, the majority of the resources that will be required are software based.

The image capturing stage will require the use of a cellphone camera and will not require any resources to be provided by the university.

An image processing library will be required to analyze and manipulate images. This library will need to convert the images into a data format so as the machine learning database can be developed. OpenCV is a commonly used image processing tool for machine learning, it is open source and therefore free to use.

A database will need to be developed with the test strip image data; this will require databasing software. Open-source software such as MySQL and Cassandra are available and free to use.

Application development can be done with the use of Unity which is free for students. The application development will be done in Python as this is the most common language used for machine learning and comes with many supporting resources.

Weekly Milestones:

Week 1: Research on pool water test strip outcomes and possible solutions. A plan on image processing techniques and how the app development will take place.

Week 2: This week will focus on a general project design, highlighting the image processing section and determining the software required for each stage of development.

Week 3: Image processing design; this week should focus on capturing the image data and designing an image processing approach.

Week 4: This week will focus on implementing algorithms to capture and analyze the pool water test strip images, developing a dataset.

Week 5: This week will focus on the implantation of machine learning and application development.

Week 6: This week will focus on finalizing features and ensuring application covers requirements.

Week 7: Testing of application with the use of test strips in various lighting conditions.

Week 8: Making any necessary adjustments to project and finalizing project report.

Risks and Mitigation:

Several risks exist in the implementation of this application. Although these risks are not necessarily harmful, they could pose a risk to the success and usefulness of the application.

It is essential that the final application meets the project requirements and provides a correct course of action for the chemical ranges on the testing strip. If the image processing is performed incorrectly, the result determined by the machine learning program could suggest an incorrect course of action for the pool water correction. This could be avoided by thoroughly testing results against known values, ensuring the image processing and image analysis with the use of machine learning has been performed correctly and accuracy.

An important project requirement is that the application is able to work successfully to analyze images in all light conditions. If this requirement is not carefully considered, the program could mistake a specific color for another. In order to ensure that this does not take place, it will be necessary to thoroughly test the application with test strip images in different light conditions.

Software advancements could mean that the app becomes unusable in coming years. The solution to this is to ensure the software is adaptive.