Initial Plan: Data Analysis of impact and patterns of medical practitioner's experience on medical image reading behaviour

CM3203: One Semester Individual Project 40 credits

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1. Project Description

Medical imaging consists of various imaging techniques e.g. X-ray, ultrasound, thermography, magnetic resonance imaging (MRI) to produce images of the interiors of subjects in order to be interpretable by the human eye. The intention is to aid medical practitioners in diagnosis, monitoring change and in devising treatments.

The ability to interpret and analyse medical images is a complex skill that takes many years of practice to develop to an adept level. Therefore, this brings the risk of a deficiency in the number of qualified practitioners being able to deliver appropriate assessment and care, risking potentially negative consequences for the health status of patients. Furthermore, insufficient training or simply lack of expertise can also lead to misdiagnosis or false negatives due to the incompleteness in the accuracy of human perception, one study citing a 30% false negative rate diagnosis rate [1].

Therefore, it is important to understand the underlying factors which influence, control and steer expert behaviour to be able to aid in the construction of more accurate diagnosis practices. One way this can be done is by comparing expert's behaviour to other groups of practitioners. Through analysing and contrasting behaviours during diagnosis', we can extract and evaluate meaningful information that can be used to construct systems that will aid practitioners in exhibiting more precise diagnosis.

The project aims to analyse visual attention data derived from 3 groups of participants: Expert Radiologists, Trainee Radiologists and Medical Physicists. The data itself is comprised of 3 data sets from the individual groups, containing Euclidean coordinates and durations of where the participants eyes were fixated when looking at mammography images - mammography images being low-energy X-rays of human breasts, the goal of mammography is to detect breast cancer in an early stage.

The use of eye tracking technology was employed to acquire the data, it provides a mechanism for recording eye movements of image readers to track how they interact with visual information. This information can be used to not only reveal insight into experts' behaviours but distinguish key differences between different levels of expertise as well as potential errors and where room for improvement exists in experts' practices, this information is essential to developing more accurate diagnostic image practices [2].

The goal of the project is to complete two technical tasks, expand on the second task by completing deeper analysis on the methodology used, as well as providing a comprehensive analysis of the results gathered through written investigation.

1. Visualise the recorded fixation points of participants from the dataset onto the mammography images, and report on findings
2. Calculate saccade amplitude d and orientation φ from the dataset and construct visualisations including histograms and other formats to display differences between participant groups

Using the resulting visualisations and new information, attempt to understand and construct further visual and verbal analysis of the results, elucidating and trying to understand the differences of results and their causalities as well as evaluating the methodology used to visualise the data and attempt to measure its utility for this sort of research.

2. Project Aims and Objectives

Stage 1: Background research, declare technologies to be used and begin final report

Compile a store of research materials and references to be used and referenced in the final report. Finalise the decision on which technologies are to be used in the execution of this research project and begin writing immediately the final report and maintain it as progress continues. This is imperative as this project is research based.

Stage 2: Create visualisations of participants fixation points on mammography images and write an analysis of findings in the report

Using the decided upon technologies plot the participants fixation points found in the dataset onto the mammography images. Display and contrast the differences between the different groups visually, and in the report discuss findings, including potential reasons behind the differences.

Stage 3: Use the dataset to calculate saccade amplitude and orientation and construct visual information graphics, and analyse findings in written report

Use the dataset to calculate saccade amplitude d as expressed in a degree of visual angle, from the Euclidean distance between two consecutive fixation points and saccade orientation φ as the angle, expressed in degree between two consecutive fixation points. Plot the acquired data in the selected visual information graphic and add to report.

Stage 4: Conduct analysis of methodology used in stage 3 as a method of discovering useful information regarding the dataset

Analyse the data acquired in stage 3 and its utility. Evaluate the visual information graphics used as a method of acquiring useful information from saccade amplitude and orientation. Contrast and explain the differences between the groups.

Stage 5: Research and test alternative methodologies as replacements or compliments to data analysis methodology used in stage 3

Using the resulting evaluation of the saccade amplitude and orientation data analysis methodology and the utilised information graphics, research and investigate the potential consequences of its usage and whether any substitutes may be more suitable or would operate well as compliments in finding further useful information from the data.

Stage 6: Finalise research and report

Ensure all research is in an intelligible and organised structure, finalise evaluations, write conclusions on the project and submit.

3. Work Plan

The final submission date is 10th May 2019. All required materials must be submitted by that date including the final report. Easter recess period will still include work towards the project.

Week 1: 28 January
MILESTONE: INITIAL PLAN SUBMITTED

- Complete initial plan

Week 2: 4 February

- Strengthen understanding of the problem
- Gather and examine initial resources and research materials to be used
- Decide upon which technologies are to be used to conduct research

Week 3: 11 February
MILESTONE: STAGE 1 COMPLETE

- Finalise any incomplete background work from previous week
- Familiarisation with technical tools and components
- Begin writing report
- Implementation of plotting fixation points

Week 4: 18 February
MILESTONE: STAGE 2 COMPLETE

- Report and analyse results from fixation points plotting
- Evaluate results from previous task

Week 5: 26 February

- Use data to calculate saccade amplitude and orientation values
- Analyse available visualisation solutions for the derived data, compare and justify in the report choices

Week 6: 4 March
MILESTONE: STAGE 3 COMPLETE

- Implement visualisation of saccade amplitude and orientation values for all participant groups
- Identify differences between resulting visualisations in the report

Week 7: 11 March

- Using resulting differences from previous week using research construct potential explanations and formulate arguments in the report
- Conduct further experimental analysis of data derived from visualisations and results

Week 8: 18 March
MILESTONE: STAGE 4 COMPLETE

- Evaluate and report on the value of calculating saccade amplitude and orientation values
- Analyse the utility of the visualisation methodology in the report

Week 9: 25 March

MILESTONE: STAGE 5 COMPLETE

- Identify potential gaps in report and knowledge
- Conduct experimentational further analysis of data with different visualisation strategies

Week 10: 1 April

- Focus on report write up
- Evaluate efficacy of the report in meeting requirements of deliverables
- A meeting with the supervisor to conduct a thorough examination of thus far progress and address any salient points regarding the research and report

Week 11: 8 April

- Continue on report write up
- Address any issues highlighted in the meeting with the supervisor from the week before

EASTER RECESS PERIOD

- Use period to prepare for oral (viva) assessment
- Address any remaining issues

Week 12: 6 May
MILESTONE: STAGE 6 COMPLETE

- Proof read and submit report

4. Risks and Ethical considerations

4.1 Risks

Risk	Impact (Low, Medium and High)	Chance of event occurring (Low, Medium, High)	Mitigation plan
Project going in the wrong direction	**High**	**Medium**	Weekly/regular meetings with supervisor
Data corruption or loss	**High**	**Low**	The majority of the data that will be used in the project is readily available currently and already backed up, any further acquired data I will ensure secure backups are maintained
Illness	**Medium**	**Medium**	Ensure the work schedule has sufficient leverage to not impose any significant risks if any stakeholder in the project becomes ill
Lack of time for completion	**High**	**Low**	Apply appropriate time management techniques (i.e. scheduling daily slots do dedicate towards work) and plan accordingly
Equipment damage	**Low**	**Low**	Technical work will most likely be done on Jupyter notebook thus will not require any specific equipment other than access to a computer with python and appropriate libraries

4.1 Ethics

The data which will be used in this project has been gathered prior to the start of this project and the acquisition was not my responsibility, therefore it does not require ethical approval. Furthermore, the data does not refer or hold onto any personal information.

4.2 Deliverables

- Final report including (but not only):
    - Visualisations of fixation points superimposed on mammography images
        - Discussion of derived data, including analysis, comparison and evaluation of differences between participant groups
    - Visualisations of saccade amplitude and orientation
        - Discussion of derived saccade amplitude and orientation values from the dataset
        - Discussion of derived data, including analysis, comparison and evaluation of differences between participant groups
    - Written and technical analysis of saccade amplitude and orientation utility
- Code implemented for analysis

REFERENCES

[1] A. Brady, “Error and discrepancy in radiology: Inevitable or avoidable?”, Insights Imaging, vol. 8, pp. 171-182, 2017.

[2] E. Krupinski, “Current perspectives in medical image perception”, Attention, Perception & Psychophysics, vol. 72, pp. 1205-1217, 2010.