CS39440: Project Outline

"Comparing image quality assessment algorithms with human perception for optimising image compression for ExoMars"

Charlie Curtis (chc73)
Computer Science – G400

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Project Description:

The European Space Agency, in September of this year, will be launching the ExoMars rover, as part of its mission to ascertain as to whether there is or has been life on Mars. An integral part of the rover is the camera system - PanCam. It will be used to collect images of the surface of the planet, which will then be returned to Earth. However, the images must be compressed in order to reach Earth, too much compression and the images are un-useable by the teams involved in analysing them.

The purpose of this project is to compare the results of a human study into subjective quality assessment by humans with standard Image Quality Assessment (IQA) algorithms on a subset of images, ultimately to try and find an optimal level of compression that minimises the amount of data being sent/received, whilst maintaining the useability of the images. This is likely to be done through, initially a large amount and sustained process of researching relevant pieces of literature to better understand; what IQA algorithms are available, how these IQA algorithms work, and the standard of results produced by these algorithms, the next stage will be to conduct some numerical and statistical analysis of both the human study and sample images run through a selection of IQA algorithms in order to compare them against each other and try to reach the answer to the question of how much compression is suitable for the different functions that the camera system will be performing.

Finally, the project will result in the creation of a report. This report will go into detail describing and explaining the method, results, and also discussing any conclusions or findings from the research. The report will follow the research-based project report template as found within the module information.

Proposed Tasks:

Some of the anticipated major tasks involved in this project may include:

- **Initial and sustained research of IQA algorithms and surrounding disciplines** – Since the project is a research project, plenty of research and reading is going to have to be conducted into IQA algorithms and which methods are used in different fields which also rely on high quality imagery (for instance medicine), as well as possibly into inter planetary communications in order to establish if this may have any effect on the data being sent from the rover.
- **Establishing and managing version control/backup** – Given the volume of references and notes that will mostly likely be accumulated and written. Having some sort of version control to save this information to, will prove invaluable when it comes to revisiting it and reusing it. As well as making sure that the information collected is secure.
- **Creation of tools/scripts for statistical analysis** – Since the research is original, tools to analyse and compare numerical information or results from the human study and output from the selected IQA algorithms will likely have to be written. These will most probably take the form of some simple scripts, however, may develop past this.

- **Writing of the final report** – The project report is going to follow the template prescribed as part of the module's learning materials. It will be the report that consolidates all the information collected over the course of the project as well as presenting the findings of the analysis process, it is the report that will be the crux of the project.
- **Maintaining a log/diary** – Given the nature of the project such a document will prove useful when writing the methodology section of the report and will definitely be beneficial if any adjustments to the route the project is taking need to be made, since having knowledge of what has already been tried will aid in identifying what *hasn't*.

Project Deliverables:

The following is a list of key deliverables that are anticipated to be created as part of the project:

- **The final report –** This is going to be the most substantial deliverable, as well as the main evidence of the work that will have been done. It will contain the process and results of the work that was conducted including the relevant references that aided in the research.
- **A log/diary for the project –** Given that there isn't much scope in the project to produce a particular technical work or a piece of software, this diary will mainly be necessary to demonstrate progress particularly in the Mid term demonstration. It may contain reference to small documents or scripts that may have been created and may point to literature that has been used to an extensive degree at a given stage of the project.
- **Bank of references –** A simple text file possibly, containing all the references that have been deemed 'useful' or 'necessary' as part of the work to be done in the project. Maybe recording reasoning for the references inclusion, also it will act as a centralised space to review the various pieces of information that will ultimately end up contributing to the final report.

Initial Bibliography:

1. https://exomars.wales/
   The website containing the basic background information regarding the contribution of Aberystwyth University to the ExoMars Mission.

2. https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/ExoMars/Steady_driving_towards_ExoMars_launch
   The ESA's website giving general information regarding the ExoMars mission.

3. https://www.liebertpub.com/doi/full/10.1089/ast.2016.1548
   A paper discussing the workings of the PanCam camera system including but not limited to, the objectives of PanCam and the instruments involved in the functionality of PanCam.

4. https://essr.esa.int/project/whitedwarf
   The compression algorithm that will be used on the ExoMars rover and as such, by the PanCam camera system.

5. https://pubmed.ncbi.nlm.nih.gov/22436596/
   A paper discussing the effects of image compression in a medical setting, given the high risk environment, taking inspiration from the medical field may be a good place to start preliminary research.

6. https://www.sciencedirect.com/topics/nursing-and-health-professions/lossy-compression
   Papers on Lossy compression, the sort of compression that is employed on the ExoMars rover.

7. https://ieeexplore.ieee.org/abstract/document/8847307
   Paper comparing various IQA algorithms, also describes different types of algorithms and uses various datasets of differently distorted images for testing.