Appendix 2

School of Electrical and Information Engineering
University of the Witwatersrand, Johannesburg
ELEN4002/4012: Project Specification Outline

To be completed by the supervisor
Assessment:
☐ Deficient ☐ Acceptable
☐ Good ☐ Excellent

Project Title: Digital Estimation of Body Mass Index

Group Number:	35	Supervisor Name:	Prof Scott Hazelhurst
Student Name A:	Sachin Govender	Student Name B:	Darrion Singh
Student Number A:	1036148	Student number B:	1056673

Ethics:

Supervisor Signature

☐ Request for a waiver (does not involve human participants or sensitive data)
☐ Copy of ethics application attached (Non-medical) – School Committee
✓ Copy of ethics application attached (Medical) – University Committee

Project Outline: *(give a brief outline such that ethics reviewers understand what will be done, 100 words maximum)*

There is a need for an accurate way for medical practitioners to document the Body Mass Index (BMI) of a patient without having to set up measurement apparatus or asking that patient to remove their clothes. This is particularly cumbersome in a non-urban clinic environment whereby there is a large volume of people who require consultation and limited time to for practitioners to provide consultation. This project aims to provide a means of accurately estimating the BMI of a person from a photograph of them. The person would not have to remove their clothing, and there would be no need for a measurement related equipment to be set up to take the BMI measurements.

Project Specification:

Overview:

Weight measurement is an effective way of tracking progression or identifying the presence of an illness as well as tracking malnutrition. Physical equipment has their own constraints through accessibility (i.e. patient being physically unable to be assessed on equipment), measurement errors and the time required to take the patient's weight. In situations where these constraints prove to be consequential, a robust solution is required to accurately measure one's weight with a high level of certainty. In efforts to pursue this solution the School of Electrical and Information Engineering alongside the Perinatal HIV Research Unit have requested the development of software that make use of various images of a patient in order to retrieve their weight, height and subsequently their Body Mass Index (BMI) with a high level of accuracy.

Objectives:

- Obtain weight, height and BMI through images of a patient
- Accuracy of BMI must be within 2%
- Data/Image collection of the patient must be done in a minimal time to maintain robustness of solution – a good estimation would be less than 30 seconds
- Should cater to patients who are not minimally dressed or wearing tight fitting clothes
- Camera is only equipment for data collection of patients

Assumptions

- Patient can stand in necessary positions for data collection
- Software does not need to be implemented on an application
- Patient does not need to obtain BMI immediately after image capture
- Patient is willing to remove excess clothing items such as a jacket, jersey and head accessories – provided that the weather conditions permit so
- Cameras on modern smartphones have enough image quality
- The school will provide height and weight measurement equipment when required
- Training data is provided (discussed is methodology) and has a broad spectrum of subjects in terms of gender, age height and weight
- Computer used for image processing requires a suitably high-performance GPU
- Computer will not be sponsored by the university (i.e. required to find a suitable PC or use our own)
- Software used for machine learning development is open-source or has been provided the university.
- Collected data must be confidential and anonymised

Methodology:

- Prof. David Rubin of the School of Electrical and Information Engineering has graciously offered us to use his dataset. This dataset contains silhouettes of people without clothing, and their associated height and weight.
- In addition to that, pending ethics clearance, we hope to collect the photographs, height and weight of at least 40 students within the Faculty of Engineering and the Built Environment. These students will be clothed.
- Various Neural Network (NN) models will be researched and the most appropriate will be used. Now, it appears that the types that have the highest likelihood of success is the Convolutional Neural Network, Feedforward Neural Network, and the Kohonen Self Organizing Neural Network.
- The NN models will be trained with the baseline training data provided by Prof. Rubin, as they will would contain a baseline model of the human body BMI relationship without clothes.
- Once the NN's are trained, further training will be conducted with a portion of the clothed dataset. At this point, testing will be performed with the original dataset and the portion of the dataset just used to train the NN.
- This step will be repeated with new portions of the clothed dataset until the clothed dataset has been used both in training and testing.
- This methodology provides us with the most amount of testing data, which will be tracked between tests.
- In this way, we can track the performance of the various NN models, and therefore choose which model, as well as which version of the model, is the most generalized and therefore the most likely to return the most accurate BMI estimation.

Milestones:

- Ethics application approved
- Receive initial training data
- The neural network implemented and trained with training data
- Collection of data from enough subjects (Range of 40-50 is suitable)
- Initial Assessment of the neural network's performance with collected normal clothing data achieved
- The neural network is further trained with collected data
- Accuracy within 2% is achieved

Preliminary Budget & Resources:

- Two smartphones with cameras with specifications of 20-megapixels and 16-megapixels respectively.
- Two computers with enough capability of image processing:

Specification	PC 1	PC 2
Storage	128 Gb SSD + 1 Tb HDD	500 Gb SSD+ 1 Tb HDD
RAM	8 Gb	16 Gb
GPU	Intel-integrated 620	NVidia GTX-1050 TI
Processor	Intel i5 7200	Intel i7 7700k

- Open-source software (Python, TensorFlow, Keras)
- Fully licensed access to MATLAB and all relevant toolboxes
- Weight and height measurement equipment provided by the school
- Training data provided by Prof. Rubin

Risks / Mitigation:

- Ethics approval could be delayed and affect project progression – this could be mitigated through submitting ethics application as soon as possible.
- 2 % accuracy may be excessive considering the amount of data available – cannot be mitigated unless revised success criteria is considered.
- Insufficient time to complete project – mitigate through finishing data collection and software-related research before allocated 6 weeks.
- Measurement equipment provided may not record data accurately – cannot be mitigated.
- Delay in collecting enough data due to people being uncomfortable with pictures and weight recording – mitigate through explicitly telling subjects that their data will be confidential, and images will be pixelated for anonymity.