De La Salle University

Image Based Height & Weight Calculation and Data Visualization for the Public Health Monitoring System of Filipino Children

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In Partial Fulfillment
of the Requirements for the Degree of
Bachelor of Science in Computer Science

by

CARDANO, Marc Daniel T.
DY, Stephanie Joy D.
LIM, Reanna Chelsey N.
PAGTALUNAN, Dominic M.

Judith J. AZCARRAGA, PhD
Adviser

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developed by:

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are submitted in partial fulfillment of the requirements of the Bachelor of Science in Computer Science degree, has been examined and recommended for acceptance and approval.

Judith Azcarraga, Adviser

12/14/2017, Date

De La Salle University

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after having been reviewed, is hereby approved by the following members of the thesis committee:

Dr. Arnulfo P. Azcarraga
Lead Panelist

Date

Dr. Judith J. Azcarraga
Panelist

12/14/2017
Date

Mr. Neil Patrick A. Del Gallego
Panelist

12/14/2017
Date

De La Salle University

The thesis entitled

Image-Based Height & Weight Calculation
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Monitoring System of Filipino Children

after having been recommended and reviewed, is hereby approved by the Software Technology Department, College of Computer Studies, De La Salle University:

Mr. Ryan Samuel M. Dimaunahan Chairperson Software Technology Department	Dr. Rafael A. Cabredo Dean College of Computer Studies
12/14/17 Date	Dec. 15, 2017 Date

De La Salle University

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Marc Daniel T. Cardano
Proponent

Stephanie Joy D. Dy
Proponent

Reanna Chelsey N. Lim
Proponent

Dominic M. Pagtalunan
Proponent

Dr. Judith J. Azcarraga
Adviser

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Abstract

The research focuses on the development of additional features of the Embodied Conversational Agent (ECA) System which is used as an aid in public health monitoring of Filipino Children. The ECA system prior to this research accommodates both health monitoring and consultation activities for Filipino children. This research aims to provide a platform for medical professionals and government authorities to view an aggregated or specific health transcript of Filipino children and provide an alternative way of measuring height and weight via image processing. The platform for viewing the data collected by the prior ECA system is a mobile application whose purpose is to show the results of the monitoring and consultation activities as raw data or as a data visualization. The data visualization implemented can accommodate both aggregated results of patients or individual results over time. The alternative way of measuring height and weight via image processing is integrated to the previous system and returns the calculated height in centimeters and weight in kilograms. The research, including the improved system, is part of the GetBetter Telemedicine System.

Keywords: visualization, image processing, health informatics, cloud computing

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Chapter 1

Research Description

1.1 Overview of the Current State of Technology

World Health Organization (WHO) found potential in information communications technology (ICT) to advance telemedicine due to its popularity and integration in day-to-day activities in present society. Telemedicine, a healthcare delivery concept, enables patients living in locations distant from health centers especially in rural areas gain access to healthcare through the use of telecommunication technologies. Developing countries whose rural population is deprived access to even basic healthcare are grounds for its tremendous popularity (Kay, Santos, & Takane, 2010).

Several telemedicine schemes have already been deployed and applied in the Philippines. One of them is the GetBetter System which allows doctors offsite to reach marginalized communities by giving instruction to nurses onsite through the use of ICT (Raduban, Azcarraga, Gendrano, & Azcarraga, n.d.). Under this system lies the Embodied Conversational Agent (ECA) System for Public Health Monitoring of Filipino Children developed by Lacsamana et al. (2016). It is a system that supports both monitoring and consultation activities with a mobile application developed for android tablets. An ECA will guide the user in accomplishing the tasks given for both the monitoring and consultation activities. The monitoring activities include the collection of quantifiable basic health metrics for children while the consultation activities generate a transcript of the patient's History of Present Illness (HPI) based on the symptoms given by the user.

Two of the quantifiable health metrics recorded by the health monitoring module are the height and weight of the patient. At this stage, the system can only record these values are through textual input therefore the height and weight must first be measured using the proper tools such as a stadiometer, weighing scale, height ruler or other measuring tools. An existing alternative way to measure the height and weight of a person without measuring tools is through the use of image processing. The research of Bipembi, Hayfron-Acquah, Panford, and Appiah (2015a), proved that the height and weight of a person can be determined using image processing wherein if an image of a person is reduced to a silhouette then the height can be calculated by measuring the distance between highest pixel and lowest pixel of the silhouette while the weight is calculated by the number of pixels in the area it occupies.

The ECA system prior to this research was composed of only one application, GeeBee, can only collect and store the results of the monitoring and consultation activities without ever displaying it. However the simple collection of the health information of children is not enough to bring attention to the various health problems encountered by children. It would be far more helpful and informative if medical practitioners and authorities alike be able to view the collected data to be able to monitor the health and growth of the children. Aside from the viewing of the health information of each patient separately, through the use of data visualization tools these information may be aggregated in the form of charts. These charts may highlight certain problems which must be put into attention and require specific services to improve (Bennett, 2014).

GeeBee prior to the research can only store the collected data in a local database which is inefficient with regards to accessibility of the data collected due to the fact that it requires the same tablet which was used to collect data to access the data collected. This dilemma can be rectified by utilizing cloud computing since it enables the access of data remotely. By applying cloud computing to GeeBee, the data it collected can be uploaded to a remote database and downloaded when needed to be accessed as is the norm in most mobile applications (Hayes, 2008).

1.2 Research Objectives

1.2.1 General Objective

To develop an image processing module and data visualization module for the Embodied Conversational Agent System for Public Health Monitoring of Filipino Children.

1.2.2 Specific Objectives

1. To develop an image processing module to be added to the existing data gathering software, GeeBee, to calculate the estimated height and weight.
2. To present the individual health information of children.
3. To implement a data visualization module for the aggregated data of children according to the specified filter.
4. To integrate the new data visualization software to the original GeeBee.

1.3 Scope and Limitations of the Research

The image processing module developed is able to calculate an estimate height and weight of a child. The image of children used to estimate their height and weight should capture the whole body of the child, from head to foot, with the child standing straight. The image processing module requires a specific set up wherein the background should be white with the reference object to the right of the subject. In this case, the reference object should be the left most object in the image otherwise the objects or noise in the left most part of the image will be considered as the reference object. Once the image is taken, it will be transformed into a silhouette to protect the identity of the child. The image processing module is able to calculate the height and weight of the child provided there is no object or noise on top of the subject.

The new software developed to visualize the data gathered by the existing system is a mobile application which allows both medical professionals and non-medical personnel to view the collected data by the previous existing system. One of the purposes of this visualization is to generate a transcript of health for each child wherein the viewer will be able to see the health progress where they can compare the latest data with the previously collected data of the same child. This progress will be shown in the form of charts. In addition to that, it should also be able to present the raw transcript of the basic health metrics of the child and an option to view the previous record of the child.

Another visualization of the collected data allows the viewer to observe the overview of the health condition of groups of children based on a set demographic such as school, municipality, gender, or educational level in relation to age. The summary of health for a group of children is presented in a simple and comprehensive manner in the form of graphs and charts.

Part of this research also includes the integration of the new visualization software to the Embodied Conversational Agent System for Public Health Monitoring for Filipino Children. It means that after integration, the whole system will undergo end-to-end testing though without field testing. In addition, the testing for the data visualization and the cloud hosting service will only use synthetic data while the test cases for the image processing module was collected by the proponents.

1.4 Significance of the Research

According to the census conducted by the Philippine Statistics Authority (2016), the Philippines has an estimated population of 100.98 million citizens. From that population, approximately 33.71% is comprised of children under 15 years of age based on the World Fact Book (2010). According to CNN Philippines (2016), there is a ratio of 1 doctor per 33,000 people in the Philippines approximating to a total of 3,060 doctors. It is even worse in the rural areas wherein the ratio is 3 doctors to 100,000 patients due to most medical practitioners migrating to other countries for higher salaries or well-established hospitals or private clinics within the cities with good equipment to practice their specializations. This research coupled with the previous research allows compensation to the problem of the lack of doctors or medical personnel to monitor health among children. Ultimately once the system is deployed among public schools or community healthcare centers, it will allow the public health monitoring system of the children without the need for constant supervision of a doctor or medically trained personnel.

This research provides a means for the health of children to be monitored if regular checkups were previously inaccessible, unaffordable, or unavailable. It is possible for the system to record the medical status and history of a child which can be stored in the database and updated over time. Although it does not check for certain conditions or diagnose illnesses of an individual, the stored records can be used by medical professionals for evaluation, interpretation and diagnosis. The improvements made by this research will allow the doctors or medical practitioners in the cities to access the healthcare information recorded in rural areas and give further instructions or referrals to specialists who can visit the patient or the patient to come to. Alternatively for rural area doctors, this can alleviate their burden for the collection of data, reviewing the it at a later date and focus more on other cases wherein their physical presence is required. This research can help both patients and healthcare providers save on time, money, and effort in regards to having to attend regular checkups for health monitoring as data can be collected and reviewed more efficiently.

This research will be beneficial to the field of Digital Image Processing due to its implementation of calculating not only an estimated height but also weight through the use of images. The image processing module can be used as an alternative way to measure the height and weight of a child without the need of external measuring tools. This can help in the productivity of health workers since there is a way to use the tablet in a continuous flow without the disruption of using external tools.

1.5 Research Methodology

1.5.1 Review of Existing Technologies

Reviewing and studying the topics to be applied in the research is required to implement the technology needed to support the research. These topics are android development, data visualization, image processing, cloud computing, and the previous research to be compounded on. This also includes the research of existing tools which can be immediately used instead of original development.

1.5.2 Data Gathering for Image Processing Module

Testing the accuracy of the image processing module in regards to height and weight was accomplished by gathering test cases for the measuring tool developed to be tested on which was gathered by the proponents.

The participants of the data collection activity were children in elementary level. To be more specific, young individuals not reaching the age of puberty whose educational level is estimated to be Grade 1 to Grade 4. In total, the proponents were able to solicit thirty (30) students from Inchican Elementary School wherein twenty-eight (28) participants were underweight and two (2) were under the normal BMI category.

During the data gathering process, the proponents complied with the research protocol of the university. This protocol requires the consent of the parent with proof of their signature allowing their children to participate in this activity. Therefore, an informed consent form was sent to them detailing the purpose, guidelines, and tasks needed to be performed by their children for the activity while another form is to be signed by the student himself or herself. Once the agreement is established, the children were led to a prepared site to capture their photos and measure their height and weight. After the data collection, a minor token of appreciation was given to participants and staff for their cooperation.

1.5.3 Development of Image Processing Module

The best algorithm with respect to the time spent for development and ease of use is selected for determining the height and weight of a child. The module developed was tested using thirty (30) samples from Inchican Elementary School following the DLSU ethical standards. The data collected for test cases were compared with the estimated height and weight that resulted by using the image processing module to calculate its accuracy and precision. It is developed as a standalone component and is integrated to the GeeBee application.

1.5.4 Development of Data Visualization Software

The different components of the data visualization application were developed in this phase. Functional testing of each functionality was also conducted to validate the functionality of various components. These components were assessed according to the technical specifications defined by the researchers. During development and testing, these specifications were adjusted as needed to better fit the needs of the system.

1.5.5 Application of Cloud Computing

Cloud computing was performed in both applications GeeBee and GeeBeeView so that they are both connected to a single cloud server and use a single database in working together. Since the database is exclusively accessed only by the two applications GeeBee and GeeBeeView, testing and development is solely done on the provided devices and emulators. Data used in development and testing is manually generated using a simple Java MySQL random population program. Data generated is at 1000 records with 5 schools and 3 municipalities chosen at random. The proponents believe that 1000 records would be sufficient to test the data handled by both the application and the server

1.5.6 Integration of Additional Features to Previously Existing System

After development, the additional features, specifically the data visualization, will then be integrated to the existing Embodied Conversational Agent for public health monitoring of Filipino children project. This includes end-to-end testing to ensure correct integration using synthetic data but not actual deployment.

1.5.7 Documentation

Documentation was performed in every phase of the research and updated as needed.

1.5.8 Calendar of Activities

Table 1.1 shows the timeline of the Research Activities (1.5) for the duration of the research, Term 2 of AY 2016-2017 to Term 1 of AY 2017-2018. Each bullet represents one week of activity.

Table 1.1: Timetable of Activities

Activities (2016-2017)	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Review of Existing Technologies	●●	●●●●	●●●	●●●	●●●	●●●●	●●●●									
Data Gathering for Test Cases in Image Processing												●●				
Development of Image Processing Module								● ●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●	
Development of Data Visualization Software								● ●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●	
Application of cloud computing												●●●●	●●●●	●●●●		
Integration of Additional Features to the Existing System												●●●●	●●●●	●●●●	●●	
Documentation	●●	●●●●	●●●	●●●	●●●	●●●●	●●●●	● ●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●	●●

Chapter 2

Review of Related Literature

2.1 Review of Related Studies

2.1.1 Telemedicine

Telemedicine is simply supporting medical services through the use of telecommunications. Telecommunications used in medical applications can be defined as sending medical information between a pair of transmitters and receivers. The earliest example of telemedicine application in literature can be traced back to 1924 when 'The Radio Doctor,' a radio program featuring a doctor giving basic medical consultation advises, first appeared in the Radio News magazine (Fong, Fong, & Li, 2011). While a simple modern example of telemedicine is a real-time on-line video consultation of a patient to a doctor.

Darthmouth-Hitchcock Health System (2015) is an advanced telemedicine system. Its goal is to change the way people interact with the health care system by seeking the patient for health care when needed instead of having the patient seek for health care when feeling unwell-—-and ultimately changing the way people think about their health. It is a cloud-based system wherein nurses and health coaches track and respond to the health status of an individual in real time by means of the data collected from sensors and activity trackers monitoring the patients' condition such as blood pressure and pulse rate. When the condition of a patient exceeds a custom-prescribed threshold, a nurse is alerted; then the alerted nurse reaches out to the patient via phone call, video chat or secure text -—-often before the patient even realizes there is a problem (Adams, 2015).

2.1.2 Data Visualization

Data visualization is a way to see or visualize a summarized data that is gathered by the system. There are many different types of data visualization that are being used nowadays. However, selecting the right type of visualization is not an easy task because each type of visualization has its own benefits and downfalls because each chart emphasizes and excludes certain types of information such as changes over time, differences between two sets, contribution to a whole and etcetera. Data Visualization is beneficial in a way that it should make the collected data more meaningful and comprehensive even to non-professionals who have a hard time in interpreting the data which is out of their specialized field. (Holland, 2015)

2.1.3 Image Processing

One approach for taking the height measurement is using Smart Measure. It is an App developed by Smart Tools Co. that calculates the distance and height of the target using trigonometry as seen in Figure 3.1.

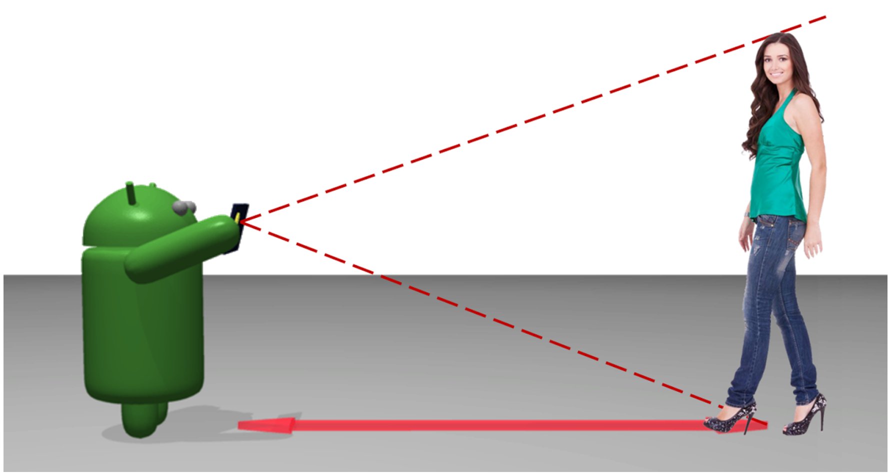


Figure 2.1: Trigonometry example used by Smart Measure (boy, 2015)

Another approach is using the study by Honade which managed to calculate the height of the person using a snap of a computer's webcam with the use of

(a) Snapshot of background with person (b) Image converted to black and white

Figure 2.2: Images taken from (Honade, 2013)

MATLAB's image processing tool. The webcam takes a snap shot of the plain white background without the person and then captures a second shot having the person with the plain white background (Figure 2.2a). The image is then converted to black and white (Figure 2.2b), and the pixel with value 1 will be the pixel for the head of the person. From there it will be assigned to the particular row with the corresponding height.

Another approach is the study of Criminisi et al. using a CCTV in order to determine the height. The algorithm used to compute the height is based on projective geometry. The study mentioned that one can compute by using a reference height. The reference object serves as a constant to address the perspective difference. To calculate the height, the height of the reference object is used; this reference height is the length of both the top and base points in a vertical direction. Figure 2.3 shows the picture of a person standing next to a phone box. The phone box, having a standard known height, is used as reference object in computing the unknown height of the person.

A recent research proposed an approach that not only calculates the height but also the weight of a person. The research suggested capturing the image of a person and then converting it into a silhouette. The height and volume is then determined using silhouette analysis by getting the number of pixels contained in the silhouette. The volume and height serve as input parameters to calculate the weight of the person by using a camera alone (Bipembi, Hayfron-Acquah, Panford, & Appiah, 2015b).

Figure 2.3: A reference height taken from (Criminisi et al., 1999)

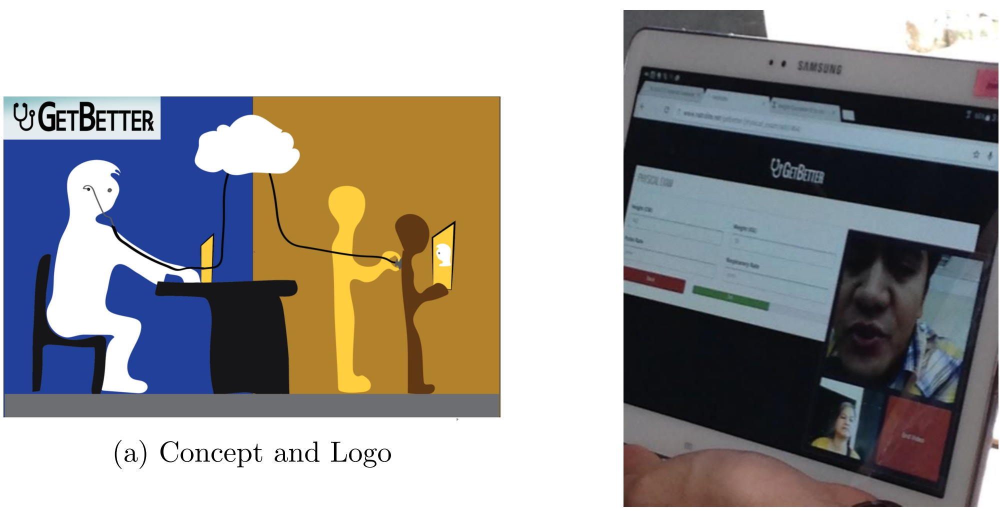
2.2 Review of Related Software

2.2.1 GetBetter System

The Philippines, like many places in the world, faces several severe challenges in providing access to quality health care programs and services especially to the remote and marginalized communities in the provinces, and even in some depressed poor urban communities. These challenges include the lack of qualified doctors in many parts of the country and the frequent inability to properly diagnose, and provide appropriate and timely treatment especially for early-stage medical cases that can be managed without the need for sophisticated hospital equipment and expensive laboratory tests.

There are two radically different approaches to the design of modern Web-based tele-diagnosis systems. One option is to assume that the attending physician, usually generalists, is physically present with the patient in some rural location which lacks modern healthcare facility and the attending physician refers the medical cases to specialists and sub-specialists working in large hospitals and research institutes. Referrals are done using land-line telephones or mobile phones, but these are now largely replaced by the internet to either email queries or upload entire medical dossiers. The second option is when the patients are face-to-face with a nurse, midwife, or health worker but is attended to and diagnosed by a medical doctor who is physically located somewhere else. Using ICT to connect the doctors to the patients, the doctors can instruct the nurses to perform diagnosis and treatment for a number of common illnesses and diseases.

The GetBetter System is a telemedicine system that allows the tele-presence of medical doctors to assist nurses in remote and marginalized communities (Raduban et al., n.d.). It is funded by the World Health Organization—Tropical Diseases Research (WHO-TDR) in Geneva. The first version of the GetBetter System is a cloud-based web-service designed based on the latest internet web-access protocols at that time. Since then, the system has been enhanced by the addition of an offline version unhooked to the internet using android-based tablets that integrate seamlessly with the online subsystem of GetBetter even under conditions of difficult and intermittent internet access (see Figure 2.4).



(a) Concept and Logo

(b) In Android Tablet

Figure 2.4: GetBetter Telemedicine System

2.2.2 Embodied Conversational Agent for Public Health Monitoring of Filipino Children

The Embodied Conversational Agent (ECA) for Public Health Monitoring of Filipino Children is a thesis by another group developed as a subsystem under the

GetBetter System (Lacsamana et al., 2016). The ECA system is a mobile application, entitled GeeBee, developed for Android tablets to interact with patients using an embodied conversational agent for health monitoring and consultation purposes. It consists of two interactive modules, monitoring module and consultation module, in both modules the recorded data are stored in a local database.

Embodied conversational agents are animated characters in a software that interact with the users by simulating verbal and non-verbal behaviors present in human face-to-face interaction (Utami & Bickmore, 2013). It is able to communicate verbally using a synthetic voice and non-verbally through hand gestures, facial display and gaze. In the case of GeeBee, the ECA converses using English language as the medium of instruction and was specifically designed for the purpose of interaction with children though it is still advised to have a medical assistant or adult to assist or monitor the children while going through the modules to make remarks to record any information which the program was unable to capture. These remarks can either be textual input or voice recording.

In the monitoring module, the child is simulated to undergo a regular check up. The first part is the general health monitoring of the child such as the BMI calculation using the height and weight of the child with the ECA commenting or giving recommendations based on the result, the current picture of the child, and a picture of their vaccination record if available. The other half is a series of tests common in a medical check-up specifically visual acuity test, color vision test, hearing test, gross motor test, and fine motor test (see Figure 2.5a). The second module, the consultation module, is an expert system that generates a history of present illness (HPI) which is the deduced impression of the illness based on the symptoms present (see Figure 2.5b). The expert system only covers common child illnesses using the knowledge base of Dayupay (2015). The HPI of the child is recorded as well as the symptoms accompanying it.

2.2.3 Visualizing Health

Visualizing Health is a project of the Robert Wood Johnson Foundation and the University of Michigan Center for Health Communications Research aiming to suggest the best visuals, which may come in the form of graphs or charts, depending on where the data is going to be used and who are the people involved in using it (Bennett, 2014). The objective of this project was to make health information be of more sense to individuals who have a hard time in interpreting

(a) Motor Test in Monitoring Module (b) Consultation Module

Figure 2.5: ECA System (Lacsamana et al., 2016)

the actual results of the raw data. However, it is not easy to manipulate data that have a large volume. The speed, size, and variety of the data, and the cardinality of the columns have to be considered as well (Holland, 2015). The difficulty with visualization arises on how to display the data when it is too large. It is difficult to plot a graph containing billions of samples, which will also affect the time, making it take too long to process.

2.2.4 Cloud Computing

Cloud computing is basically the use of servers on data centers to process data instead of the client who is availing of the said services. Cloud Computing has two main components; both of which are essential for a service to be called a Cloud Computing service. One component is the hardware and software systems that the application will be running on. While the other component is the application must be delivered over the internet. These are to be considered as the resources that are to be used in the Cloud Computing service (Armbrust et al., 2009).

There are three main cloud service categories that can group cloud computing: *software as a service*(SaaS), *platform as a service* (PaaS), and *infrastructure as a service* (IaaS). **IaaS** is a cloud service in which the services given are actual resources or actual hardware. Examples of these services are Amazon EC2 and GoGrid. **Saas** is a cloud computing service to host a Software in the cloud meaning that clients who wants to use the software will not be required to install much in order to use the such software and allows access even with only their browser to avail of it. Lastly, **Paas** is a cloud service that hosts platforms or operating systems on the cloud. With an operating system in place one can set up a database in the cloud (Zhang, Cheng, & Boutaba, 2010).

Table 2.1: Summary of Related Literature

Title	Concept	Contribution or Findings
Telemedicine Technologies: Information Technologies in Medicine and Telehealth (Fong et al., 2011)	Origin and basic concept of telemedicine	Telemedicine is simply the use of ICT to render healthcare services from advisory to diagnosis.
Dartmouth-Hitchcock ushers in a new age of proactive, personalized healthcare using Cortana Analytics Suite (Adams, 2015)	A sample telemedicine system applied abroad	Dartmouth-Hitchcock Telemedicine System monitors patient's vital signs 24/7 and alerts monitoring personnel to ask the patient to come to the hospital for further diagnosis when abnormalities are observed.
Data Visualization Techniques: From Basics to Big Data With SAS Visual Analytics (Holland, 2015)	Purpose of visualization and basic charts	Data visualization is commonly used to make sense of aggregated variables and show their importance and relationship to each other to aid in decision making. The basic charts are line chart, bar chart, scatter plot, bubble plot, and pie chart (see Table 3.1).
A New Approach to Obtain Height Measurements from Video (Criminisi et al., 1999)	Calculates the height of a person using a reference object.	The height of a person can be calculated with the help of a known height of the reference object.

Identity Concealment when Uploading Pictures of Patients in a Tele-Medicine System (Raduban et al., n.d.)	Background of system above this research	GetBetter Telemedicine System is funded by WHO-TDR. It is cloud based web service bridging the communication between doctors to assist nurses in marginalized communities. Its recent development consists of tablet based offline system which can be connected to the online subsystem.
Embodied Conversational Agent System for Public Health Monitoring of Filipino Children (Lacsamana et al., 2016)	Thesis which serves as basis for this research	The ECA system can perform both monitoring and consultation activities for children however it can only collect and save data without ever displaying it.
Visualizing Health (Bennett, 2014)	Provide samples of visualizing health related information	Different types of visualization are needed to convey the risks or health condition of the patient.

Chapter 3

Theoretical Framework

3.1 Telemedicine

Telemedicine is utilizing ICT to render medical services from a distance. The World Health Organization (WHO) defines telemedicine as an open and constantly evolving science incorporating new advancements in technology, and responding and adapting to the changing health needs and contexts of societies. Recognizing that there is no one definitive definition of *telemedicine*, the World Health Organization has adopted the following broad description:

> "The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities" (WHO, 1997).

Meaning that as long as the medical service provides clinical support, overcomes geographical barriers, involves the use of ICT, and improves health outcomes, it can be considered as telemedicine. It can be as simple as online video conferencing or as complex as a 24/7 monitoring system of the vital signs of a patient.

Telemedicine applications are classified into two basic types according to the information transmission timing and the interaction between the individuals involved-—-be it health professional-to-health professional or health professional-to-patient (Craig & Patterson, 2005). Asynchronous or store-and-forward telemedicine involves the exchange of pre-recorded data between two or more individuals at different times. In contrast, synchronous or real-time telemedicine requires the immediate exchange of information having the involved individuals simultaneously present. In both synchronous and asynchronous telemedicine, relevant information transmitted can be in various forms of media such as text, audio, video, or still images. These two basic approaches in telemedicine are already applied to a wide array of services in diverse settings such as teledermatology, telepathology, and teleradiology.

Telemedicine enhances access, quality, efficiency, and cost-effectiveness thus reducing the variability of diagnoses as well as improving clinical management and health care services delivery worldwide. Traditionally underserved communities—-those in remote or rural areas with few health services and staff—is where telemedicine holds most potential by overcoming the distance and time barriers between healthcare providers and patients. However, despite its great potential, telemedicine applications achieved varying levels of success. In both industrialized and developing countries, consistent employment of telemedicine in the health care system to deliver routine services has yet to be achieved, and only few pilot projects were able to sustain themselves once initial seed funding was cut off. Some challenges hindering the consistent employment of telemedicine projects includes complex human and cultural factors, shortage of studies concerning telemedicine, legal considerations, and technological challenges.

3.2 Image Processing

Image processing is a method to perform one or more operations on an image, in order to get an enhanced image or to extract some useful information from it.

3.2.1 Edge Detection

Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extractions (MathWords, n.d.).

Edge detection uses an approach where the intensity variations occur in the image points is declared as the edge. It is a series of actions used to identify the points in an image where clear and defined changes occur in the intensity. This series of action is necessary to extract the image related information e.g. image sharpening, enhancement and object location present in the image (Dharampal & Mutneja, 2015).

Figure 3.1: Edge Detection using Canny Algorithm(MathWords, n.d.)

Canny Edge Detector

The Canny edge detector was developed way back in 1986 by John F. Canny. It is still widely used today and one of the default edge detectors in image processing (Rosebrock, 2015).

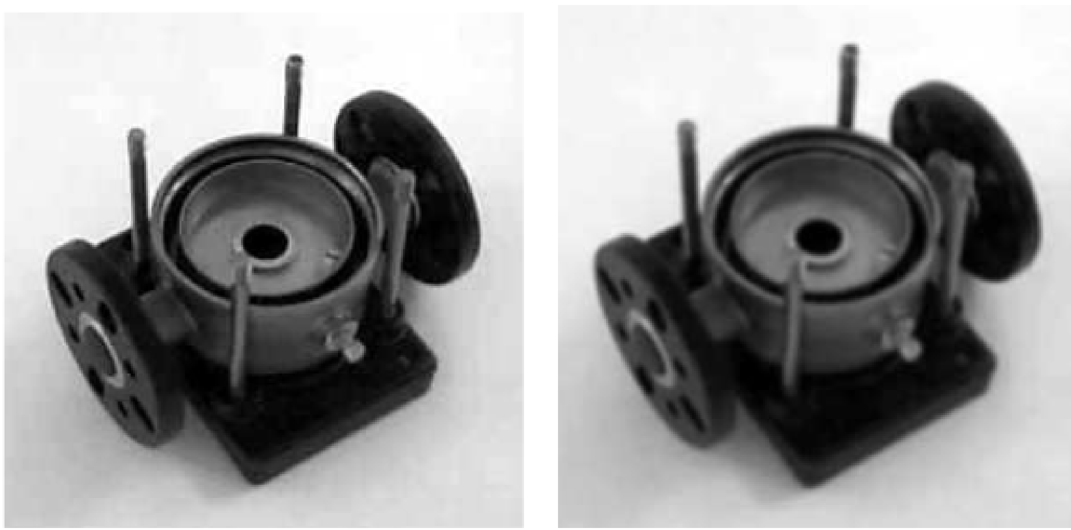
The Canny edge detection algorithm can be broken down into 5 steps:

Step 1: Smooth the image using a Gaussian filter to remove high frequency noise.

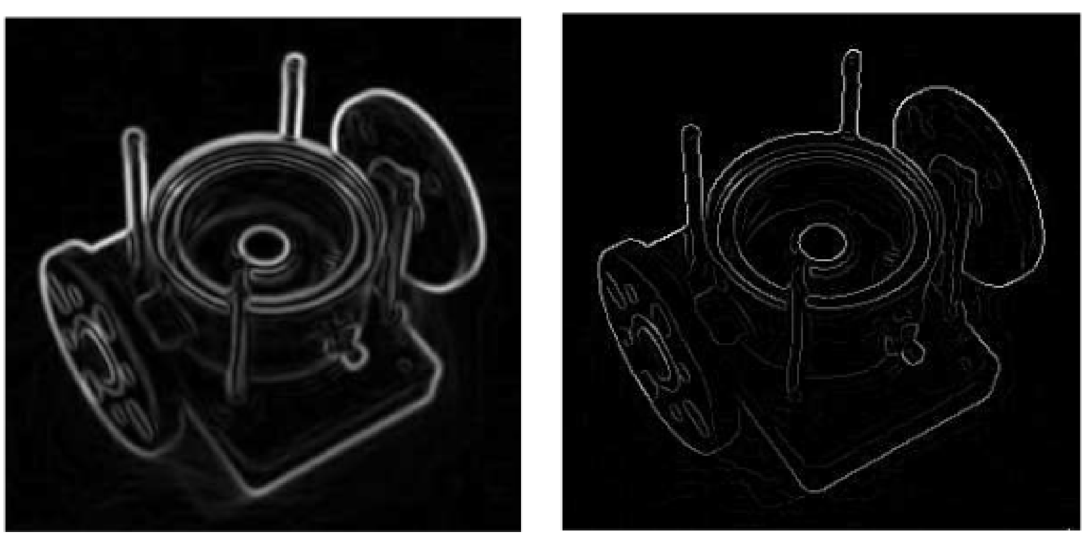
Step 2: Compute the gradient intensity representations of the image.

Step 3: Apply non-maximum suppression to remove “false” responses to edge detection.

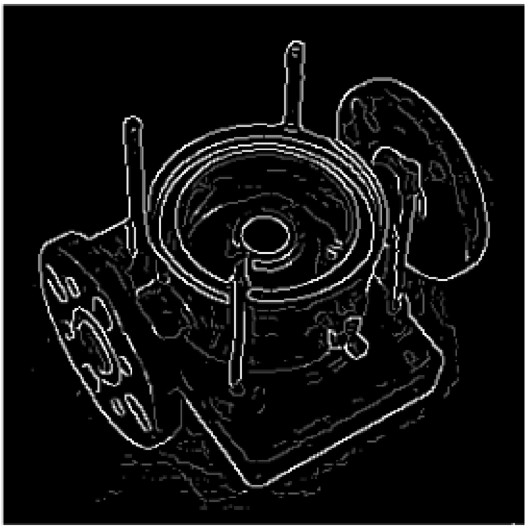
Step 4: Apply thresholding using a lower and upper boundary on the gradient values.



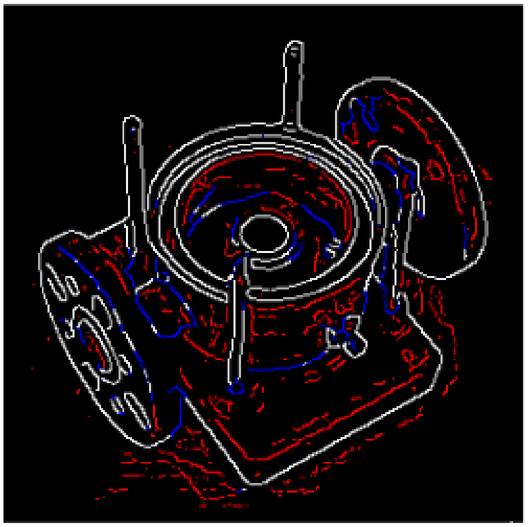
(a) Original Image (b) Smoothed Image



(a) Gradient Magnitudes (b) Edges after non-maximum suppression



(a) Double thresholding



(b) Edge tracking by hysteresis

Step 5: Track edges using hysteresis by suppressing weak edges that are not connected to strong edges.

Step 6: Compute the gradient intensity representations of the image.

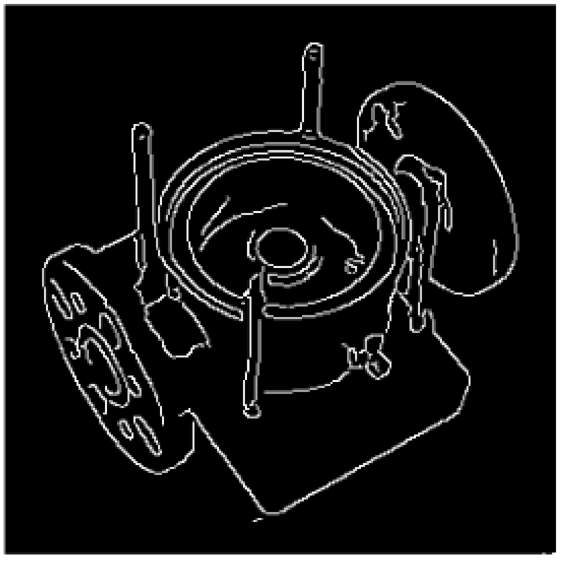


Figure 3.5: Final Image Output

3.2.2 Measuring size of objects with OpenCV

To measure the size of objects, the first step is to determine the pixels per metric ratio which describes the number of pixels that can "fit" into a given number real world measurements such as inches, millimeters, and meters.

Pixels per metric is defined by the simple formula of:

$$pixelspermetric = objectPixelWidth/knownWidth \tag{3.1}$$

This can be computed by using a reference object with two important properties:

- The reference object should have known dimensions (such as width or height) in terms of a measurable unit (inches, millimeters, etc.).
- The reference object should be easy to find, either in terms of location of the object or in its appearance.

Provided that both of these properties can be met, one can utilize the reference object to calibrate the pixelspermetric variable, and from there, compute the size of other objects in an image. (Rosebrock, 2016)

3.3 Data Visualization

Data visualization involves the creation and study of the visualization of data or equated to visual communication. Data visualization conveys more easily the patterns, trends, and correlations between data which would be hard to spot in raw tabular data (FusionCharts, 2017).

Data visualization has two goals: (1) explain data to solve specific problems, (2) explore large datasets for better understanding. Explanatory data visualization, mostly business related charts, usually directs the viewer along a defined path. In contrast, exploratory data visualization offers the viewer many dimensions to a data set or compares multiple data sets with each other inviting the viewer to explore the visual, ask questions along the way, and find answers to those questions.

3.3.1 Data Visualization Principles

In big data terminology, the term 'massive parallel processing' (MPP) refers to breaking down data into small units and processing each unit in parallel. Similarly, this is also how our eyes and brain process visual information; capture new information, break it into chunks and find meaning to those chunks.

Preattentive Attributes

Preattentive attributes is a term referring to the basic building blocks of the visualization process coined by Colin Ware, the Director of the Data Visualization Research Lab at the University of New Hampshire. These attributes immediately catch attention and can be perceived in less than 10 milliseconds even before we make a conscious effort to notice them. These attributes come into play when analyzing any visualization. Out of the attributes shown in Figure 3.6, only position and length can used to perceive quantitative data while other attributes are useful for perceiving other types of data such as categorical, or relational data.

If preattentive attributes are considered the alphabet in visual language, then analytical patterns are the words formed using them. Therefore in seeking out patterns in a visualization, preattentive attributes are first identified then combined into analytical patterns. Some basic analytical patterns are shown in Figure 3.7.

Gestalt's Principles

Gestalt principles describe how individual elements are organized into groups in the mind. These principles are used in highlighting important patterns and downplay other patterns. Figure 3.8 illustrates the Gestalt's principles relevant for data visualization.

3.3.2 Charts

When visualizing data in a chart, it is important to know and understand what chart is appropriate according to the message to be conveyed which can be shown

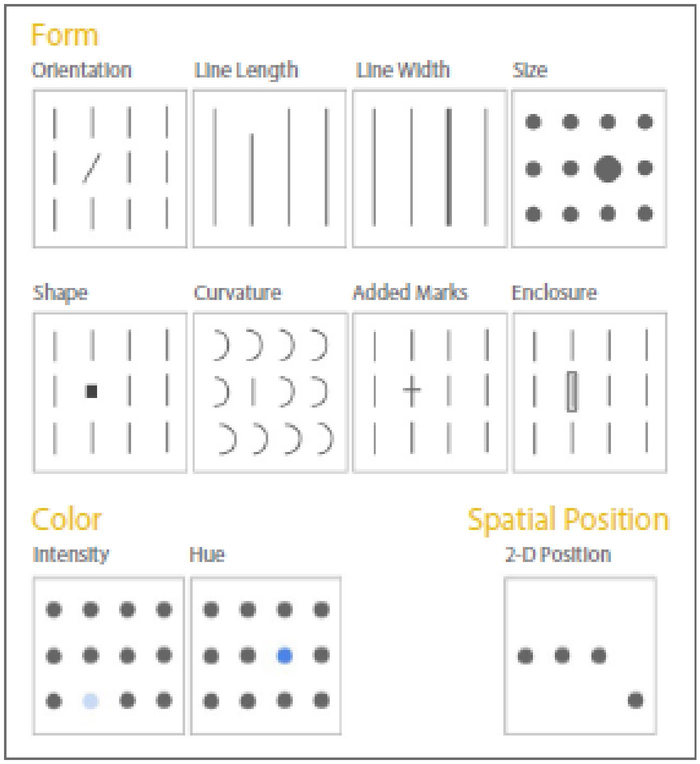


Figure 3.6: Preattentive Attributes

in the chart title and supported with the visual chart. In most cases, charts are used to show comparisons specifically comparison of an item over other items, data over time, relative comparisons (comparison of a part from a whole), data relationships, frequency, and identifying outliers or unusual situations (Scott, n.d.).

According to FusionCharts (2017), the basic chart types and their basic description are as follows. Sample charts for each chart type is shown in Figure 3.9 while the summary can be found in Table 3.1.

Line Chart

Line Charts are often used to track changes or trends over time and comparing multiple items over the same time period because they show the relationship of one variable to another. By stacking lines, it can be used to compare the trend or individual values for several variables (see Figure 3.9a).

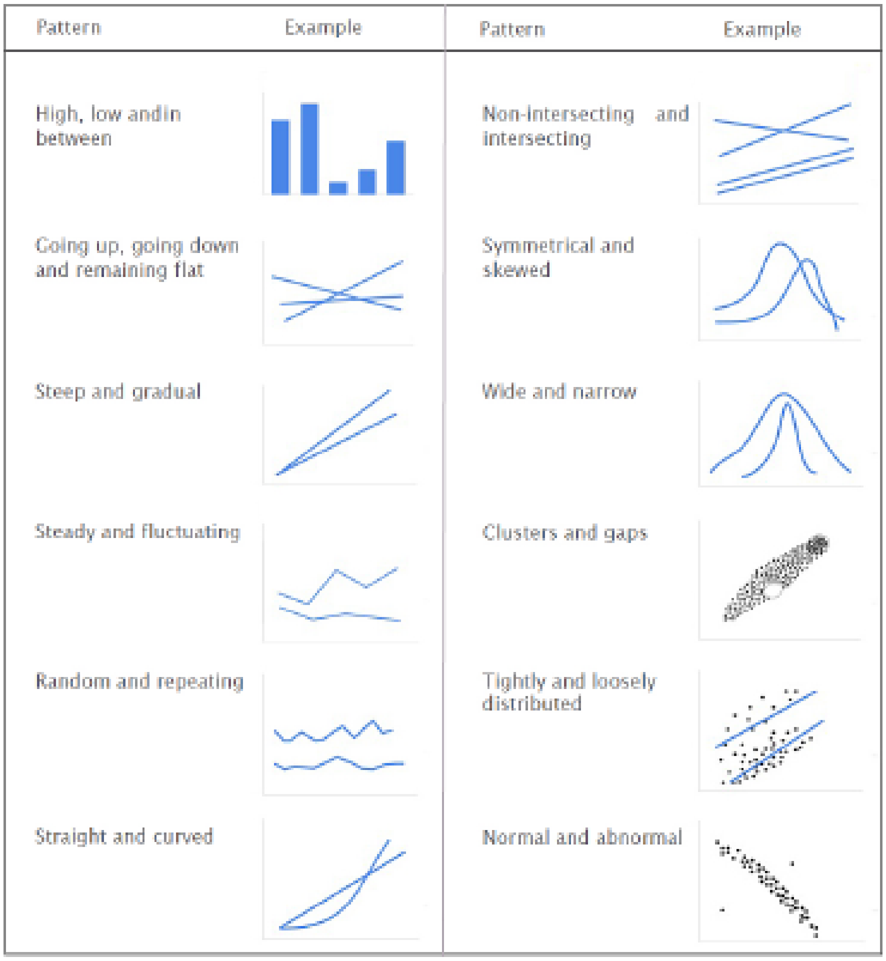


Figure 3.7: Analytical Patterns

Bar Chart

Bar charts are commonly used to compare the quantities of different categories or groups. The quantity of each category is represented using a bar (or column) which can be either vertical or horizontal with the length or height of each bar representing the quantity. Another form of a bar chart is called the progressive bar chart or waterfall chart which is used to show how the initial value of a measure increases or decreases during a series of operations or transactions (see Figure 3.9b).

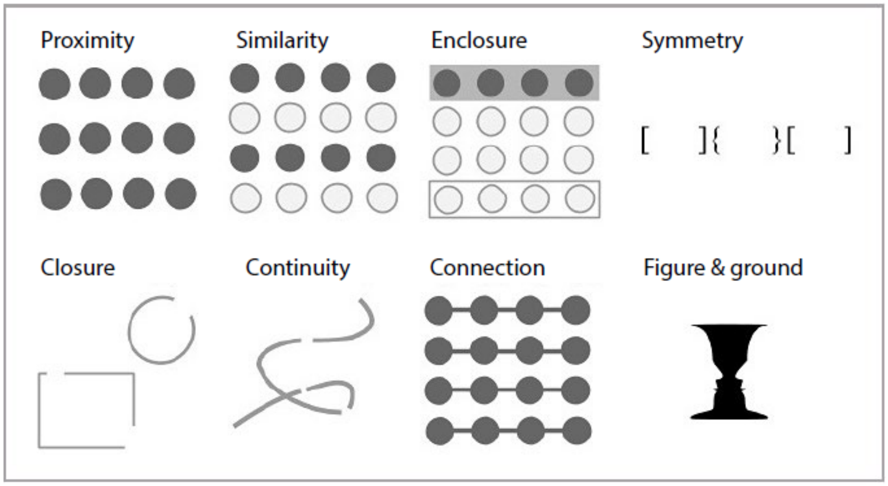


Figure 3.8: Gestalt's Principles

Scatter Chart

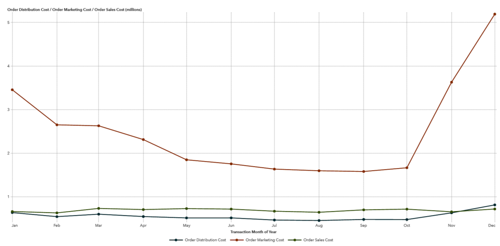
Scatter plots (or X-Y plot) are useful for examining the relationship or correlations between X and Y variables. These variables are correlated if they have a dependency on or somehow influence each other. A typical example would be the relationship between "profit" and "revenue." This relationship might be that as revenue increases, profit also increases (a positive correlation). For these type of cases, a scatter plot is a good way to visualize these relationships in data (see Figure 3.9c).

Bubble Chart

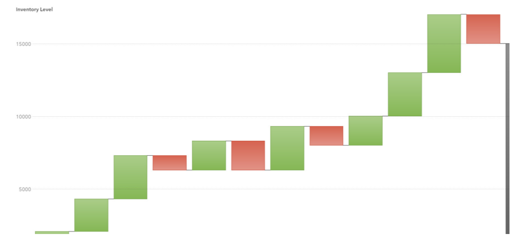
Bubble plots are useful for displaying sets of data with dozens to hundreds of values or when the values differ by several orders of magnitude. The color of the bubbles can be used to represent an additional measure while the animation of the bubbles can be used to display changes in the data over time (see Figure 3.9d).

Pie Chart

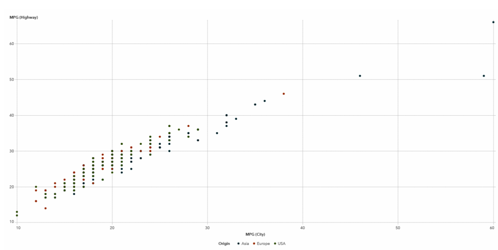
Pie charts (or donut charts) are mostly used to compare the parts of a whole. The size of each slice represent the size of their contribution to the whole. However,



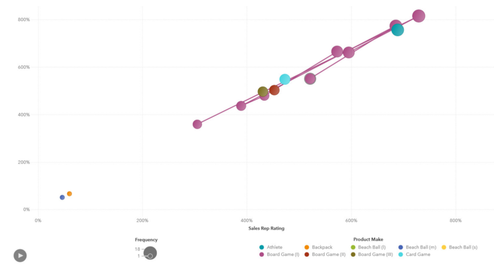
(a) Line Chart



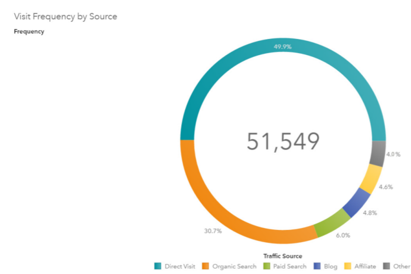
(b) Bar Chart



(c) Scatter Plot



(d) Bubble Plot



(e) Pie Chart

Figure 3.9: Basic Charts (FusionCharts, 2017)

it can also be difficult to interpret because it is difficult for the human eye to estimate the areas and compare visual angles as well as comparing slices of the pie or donut that are similar in size but not located next to each other (see Figure 3.9e).

Table 3.1: Comparison of Basic Charts

Chart Type	Description
Line Chart	Plots continuous data connected with a line Used in identifying trends Allows any number of data series
Bar Chart	Displays each data point as a column or bar where the height or length corresponds to the value

	Often used in comparing discrete items Allows any number of data series and can be stacked
Scatter Plot	Plots data points as an X-Y graph Shows the relationship between 2 variables Data values are discretized
Bubble Plot	X-Y chart represented with bubbles Shows the relationship between 3 variables
Pie Chart	Plots data points as a slice of a pie Shows relative proportions or contribution to a whole Allows only 1 data series and should only have few data points Data points must be positive

3.4 Medical Record

Medical record is the systematic documentation of an individual patient's medical history or care across time within one particular health care provider's jurisdiction. It can be dissected into five (5) primary components, including the medical history (often known as the **history and physical**, or **H&P**), laboratory and diagnostic test results, the problem list, clinical notes, and treatment notes (Spooner & Pesaturo, n.d.).

The medical history can be further divided into subcomponents namely patient demographics, chief complaint (CC), history of present illness (HPI), past medical history (PMH), family history (FH), social history (SH), allergies, medication history, review of systems (ROS), and physical examination (PE). Patient demographics includes the patient's name, birth date, address, phone number, gender, race, and marital status. Chief complaint is the primary reason the patient is presenting for care; it includes the symptoms the patient is currently experiencing. History of present illness expands upon the the CC, describing the patient's symptoms in detail as well as documenting related information regarding previous treatment for the CC. Past medical history includes a list of past and current medical conditions. Family history includes descriptions of the age, status, and presence or absence of chronic medical conditions in the patient's parents, siblings, and children. Social history includes a large amount of information regarding the patient's lifestyle and personal characteristics such as the patient's use of alcohol, tobacco and illicit drug use as well as descriptions of the patient's dietary habits, exercise routine and etcetera. Allergies include any history of allergic reactions a patient had to any medications, food, vaccines, stings, and contrast media as well as hypersensitivity reactions. Review of systems provides information regarding the subjective symptoms the patient is experiencing; conducted from head-to-toe order, positive and negative responses are documented overall and for each organ system. Physical examination is similar to the ROS but contains objective information from the practitioner's examination of the patient.

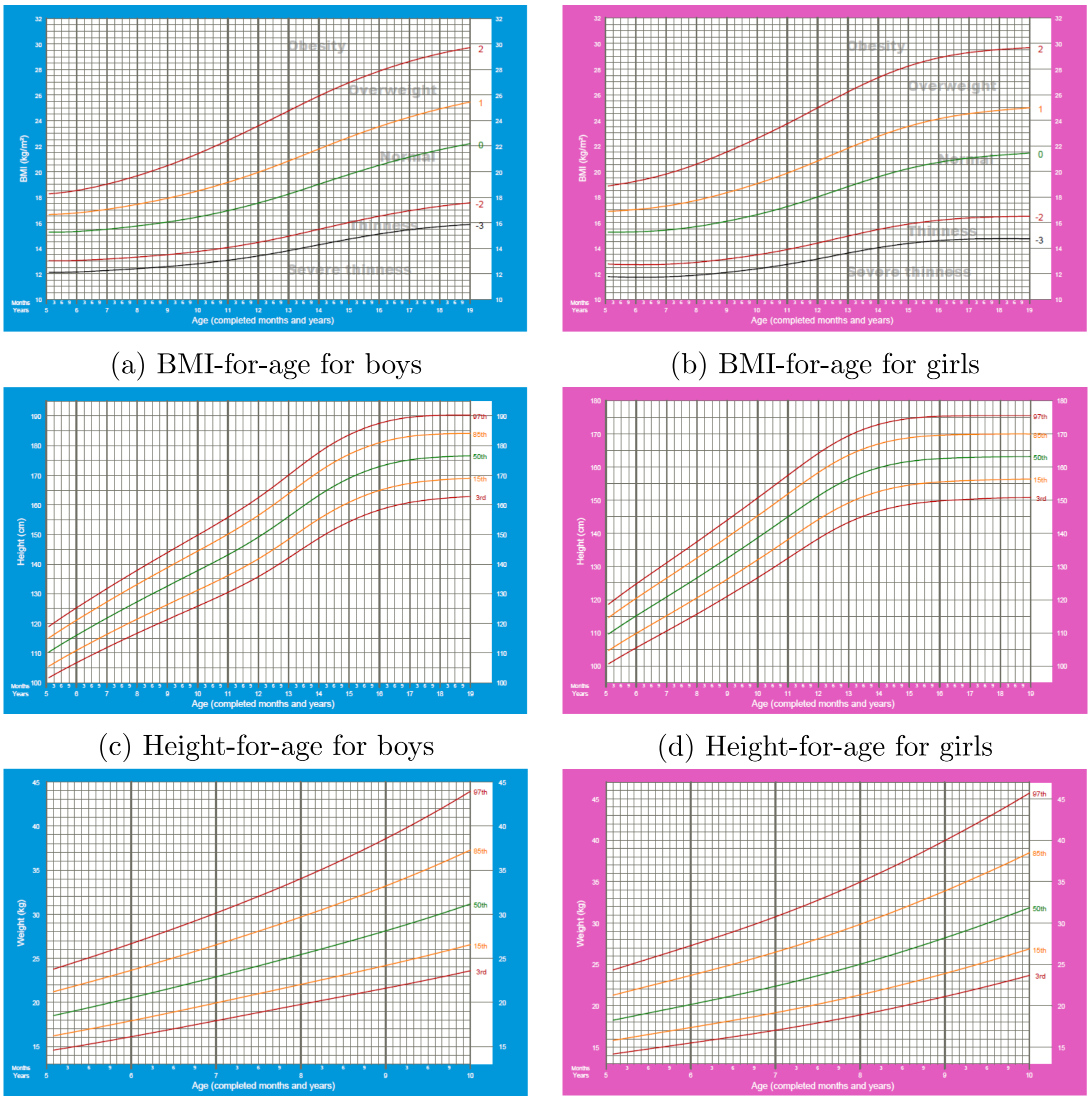
Depending on the condition and medical history of a patient as well as the length of time the patient has been in the care of the health care provider, the number and types of tests and details recorded may vary. A standard medical examination form given to undergraduate students in the yearly periodic check ups in De La Salle University for the academic year 2017 to 2018 can be seen in Appendix D.1. The yearly check up is composed of several tests performed at separate stations. The form is given and filled up by the nurses in each station for each test and then encoded in a computer before the dental check up and lung x-ray.

3.5 Growth Chart

A growth chart depicts the growth pattern of a child through measurable quantitative data such as height, weight and BMI. Alternatively, a growth reference chart depicts the common growth pattern of children and is used as a basis to evaluate the degree to which physiological needs of children for growth and development are fulfilled.

Pediatricians and health professionals involved in childcare assess the growth pattern of children to determine whether child nutrition is adequate or not. Hence, growth charts are essential items in the pediatric toolkit. The evaluation of child growth trajectories can affect the decision to implement health programs to improve child nutrition (Turck et al., 2013).

In year 2007, the World Health Organization (WHO) released growth reference charts that depict the growth pattern of children. The reference charts for height and BMI are for children at ages 5 to 19 years old while the weight reference charts are only for children at ages 5 to 10 years old (see Figure 3.10). However, the growth pattern of a child may still have a marked difference from the standard set due to final height, age for pubertal development, and prevalence of overweight and obesity.



(a) BMI-for-age for boys

(b) BMI-for-age for girls

(c) Height-for-age for boys

(d) Height-for-age for girls

(e) Weight-for-age for boys

(f) Weight-for-age for girls

Figure 3.10: Growth reference charts for children (WHO, 2007)

3.6 Data Synchronization

The Data synchronization is necessary for the consolidation of data the GeeBee application collects. The supposed work flow on how GeeBee collects the data is for the user to select a school for the data collection session the user will conduct. Ideally, the user can conduct as much monitoring and consultation as the device can handle. After every session, is the recommended time synchronizations should take place but its possible to sync at a much later date if needed.

With this restrictions in mind, the synchronization should be as much intuitive and easy to use. The way to synchronize is fairly easy, the user has to just press a button in the settings menu. Now, the way this is done is through setting a column flag in all the rows of the tables of the data synced. These tables include: *schools*, *patients*, *records* and *HPI*. All these aforementioned tables has a column named *synced* of type integer that only has 1 for synced and 0 for un-synced with a default value of 0.

Internally, once the user presses *'Sync Data'* in the application, the application queries the its database for the relevant tables that has un-synced values, then puts all the rows in respective array lists of each objects and converts each array list to a JSON representation. Once all the converting, the application prepares a volley POST request to the cloud server that hosts the database and the apache server. All the types of data to be uploaded (schools, patients, records, HPI) gets handled differently, therefore each type gets its own request i.e. uploading schools has its own request. The basic structure of the request includes a *request* and the *JSON* string to parse. The server does not just assume the data it receives as new data, there are checks in place per each table to ensure data integrity. Before inserting the received data, the server checks if the data received already exists by checking the union of the rows that is sure to be unique. For example in the patients, the columns, *firstName*, *lastName*, *birthday* and *schoolId* are all used to check whether a row with the same data already exists. Once all the data has been synced and inserted to the remote database, the server then sends a response of acknowledgement that the syncing is successful on its end. With the success signal from the server, we go back to the application that sent the requests the first place and set all the rows to synced. This way, if somehow the flags on the local database does not filter out the already synced, there is a fail safe on the server.

3.7 Regression

Regression is a statistical measure that tries to determine how strong the relationship is between a dependent variable (also known as Y) and one or more independent variables (also known as X). There are two (2) types of regression: linear and multiple linear regression. In predicting the dependent variable Y, linear regression uses only one (1) independent variable X, while multiple regression uses two (2) or more independent variables X. See equations 3.2 and 3.3 for the general forms (*Regression*, 2015).

$$linear : Y = a + bX + u \tag{3.2}$$

$$multiple : Y = a + b1X1 + b2X2 + b3X3 + ... + btXt + u \tag{3.3}$$

Where Y is the dependent variable, the variable to be predicted; X is the independent variable, the variable used in trying to predict Y; a is the intercept; b is the slope; u is the regression residual.

Regression is used in the image processing module to construct the weight formula. The dependent variable is the calculated weight while the independent variables are the front width, side width and actual height of the child.

Regression can be performed in Excel using Data Analysis which can be seen under the Data tab. There are different types of Analysis Tools available which will include Regression. Once Regression is selected, input the necessary fields such as the independent variables and the dependent variable. Excel will then generate a Summary Output containing the Regression Statistics and Coefficients. Coefficients contain the intercept and independent variables which will help construct the formula (*Regression in Excel*, n.d.). A sample screenshot of Summary Output can be seen in Figure 3.11.

11	SUMMARY OUTPUT	
12		
13	*Regression Statistics*	
14	Multiple R	0.981
15	R Square	0.962
16	Adjusted R Square	0.943
17	Standard Error	310.524
18	Observations	7
19		

(a) Regression Statistics

26		*Coefficients*
27	Intercept	8536.214
28	Price	-835.722
29	Advertising	0.592

(b) Coefficients

Figure 3.11: Screenshot of Regression Summary Output in Excel

Chapter 4

Improvement of the Public Health Monitoring System of Filipino Children

4.1 System Overview

Under the GetBetter Telemedicine System in the Philippines lies the Embodied Conversational Agent System which focuses on public health monitoring of Filipino children (Lacsamana et al., 2016). It aims to fulfill the need for children to undergo routine wellness checks with a doctor in communities that may not have accessible, affordable, or quality health care. In this subsystem, there already exists a data gathering software entitled GeeBee. GeeBee is an android application designed for Android tablets that accommodates the data gathering phase for both health monitoring and consultation.

Under the health monitoring module lies a Body Mass Index (BMI) test which requires the numerical input of the height and weight of children however it cannot be performed without the use of measuring tools. In response, this research developed an alternative way for the collection of the height and weight. By utilizing the built-in camera of the tablet, the GeeBeeCapture calculates the height and weight through image processing and returns the calculated values to GeeBee. The calculated height and weight may not be exact however the approximate will be enough to determine the BMI of the patient.

GeeBeeView is a mobile application developed to display the data collected by GeeBee from the previous research. It allows both medical professionals, authorities, and researchers to view both the health conditions of children over time and charts of aggregated health conditions of children with a demographic of school and creation of record. Cloud computing was applied to both GeeBee and GeeBeeView so that there will be a one-way sharing of data. GeeBee collects data offline; however, if there is an internet connection, the user can choose to upload the recorded data to the cloud directory. GeeBeeView downloads the recorded data from the cloud directory and displays it. GeeBeeView was developed to work offline but requires data that has to be downloaded from the cloud directory.

Sharing of data between GeeBee and GeeBeeView will only be done through the use of uploading and downloading from the cloud. The purpose of GeeBeeView is to show the downloaded data to the doctors or medical experts who are not physically present in the rural areas. In this way, doctors are able to check on patients and know the status of their health even if they are remotely far from each other. It is not required that both applications have internet connection all the time. Internet connection is only required for uploading and downloading purposes.

4.2 System Objectives

4.2.1 General Objective

To improve the public health monitoring system of Filipino children by utilizing image processing to provide an additional alternative way to perform the BMI test, interpret the collected data through data visualization techniques, and creating a cloud repository wherein data can be stored and accessed.

4.2.2 Specific Objectives

1. To calculate an estimate height and weight using image processing.

2. To upload gathered school, patient, consultation and monitoring records of GeeBee to the cloud repository.

3. To access and download the school, patient, consultation and monitoring records collected by GeeBee in a separate software.

4. To restrict access to registered user accounts only.

5. To generate a visualization of the collected patient, monitoring and consultation records.

6. To manipulate generated the generated visualizations with filters for age, gender and grade level.

4.3 System Scope and Limitations

The system should be able to calculate an estimated height and weight of the child using image processing. It should be able to do this calculation using only the resources provided by an Android tablet meaning that it will reduce the need to for external measuring tools. The quality of the image to be processed is dependent on the camera specifications of the device. During the photo session, the tablet must be held straight and parallel to the ground while the subject whose image will be taken must stand straight and must not be wearing loose garments which may affect the silhouette taken from the image. To calculate the height, a full body shot in the front view will be taken while in calculation of the weight, the subject should turn 90 degrees clockwise or counter clockwise relative to the view shown in the camera meaning a full body shot in side view will be taken. Failure to follow these instructions will make accuracy and precision suffer. To protect the privacy of the children whose picture is to be taken for BMI testing using the image processing module, the picture will be preprocessed and censor the child's face using the censoring tool created by Raduban et al.. The addition of this image processing module will not replace the original numerical input of height and weight in GeeBee rather only provide an alternative option in case external measuring tools are unavailable.

The system should be able to upload the data gathered by GeeBee to a cloud database wherein the data visualization module, GeeBeeView, will also be able to access and download the data. This cloud database will only be an external repository thus allowing both GeeBee and GeeBeeView to store data in their local database allowing them to operate without internet connection. As cloud database access needs internet connection, this function can only be used when the Android tablet has a stable internet connection. For both GeeBee and GeeBeeView, the system will not automatically upload and download of data as soon as it detect internet connection but uploads and downloads a dataset only when the user choses to do so.

The system should be able to generate a visualization of the collected data in GeeBeeView. The visualization may either be the health information of a child as an individual or a group of children. The visualization should be interactive allowing the user to change the chart, the attributes to be displayed as well as filtering data. The visualization is not limited to a dataset at a time allowing the user to visualize the data from two or more datasets.

4.4 Architectural Design

The improved Public Health Monitoring System consists of four major components: the data collection application (GeeBee), the data visualization application (GeeBeeView), the image processing application (GeeBeeCapture), and the cloud hosted database. The GeeBee application already existed prior to this research developed by Lacsamana et al. (2016). Some minor improvements were done to it wherein one is connecting its local database to the cloud for uploading while accessing the other applications from it is another. The GeeBeeView application was created in this research consists of the data visualization module while also being connected to the cloud database for downloading. The image processing software developed to calculate height and weight using image processing as an alternative for manual measuring. The cloud hosted database is nothing more than a storage space in the cloud so that sharing data is more efficient.

In Figure 4.1, the modules with the dotted lines are the ones that will be developed in this research while the solid lines are the modules finished by the previous thesis by Lacsamana et al..

4.4.1 GeeBee

Though GeeBee has been connected to the cloud database and has a few added functionalities, it still retains the its previous system architecture. It has three existing modules namely the ECA module, the consultation module, and monitoring module. Please refer to the document of Lacsamana et al. for elaboration.

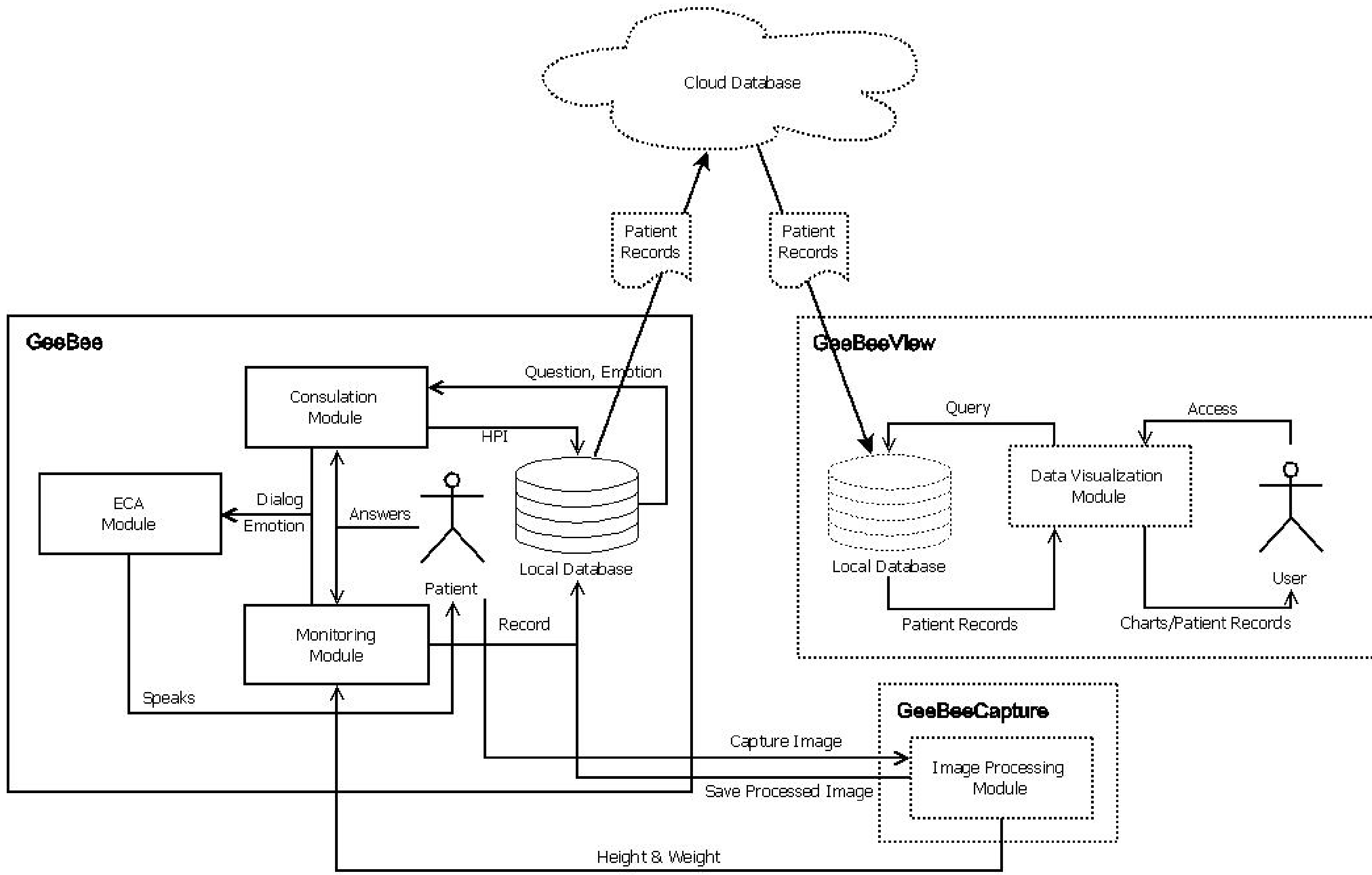
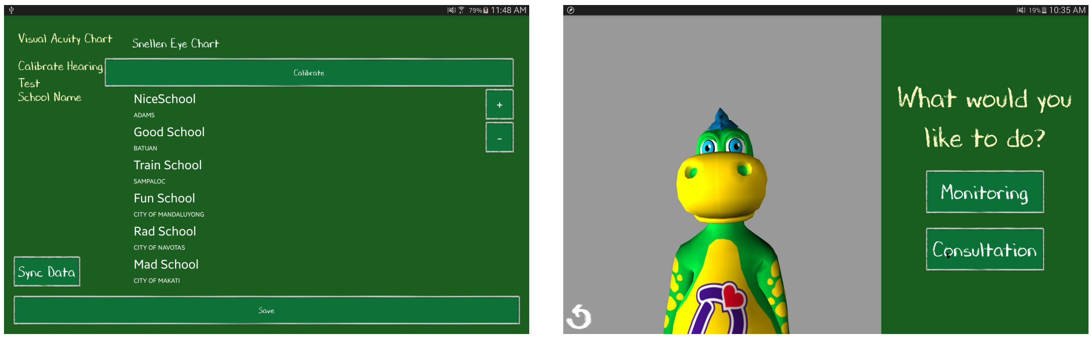


Figure 4.1: System Architecture of the Public Health Monitoring System

Some sample screens can be found on Figure 4.2.



(a) GeeBee Settings

(b) GeeBee Activities

Figure 4.2: GeeBee Sample Screens

In Figure 4.3, the process flow for GeeBee is shown. To upload the collected school, patient, monitoring and consultation records by GeeBee to the cloud repository, click the upper right gear button on the screen to access settings. In the settings screen, click the sync data button to upload the records not yet uploaded. To successfully upload the records, internet connection must be stable or it will fail otherwise, internet connection is not required. From the settings, it is also possible to add and remove schools. Whenever a school is removed, related information such as patient records and monitoring and consultation records related to the school or patient is also deleted in the local database.

4.4.2 GeeBeeView

The data visualization application, GeeBeeView, is a mobile application developed to be functional without internet connection thus it contains a local database from where it queries data to be charted. Its local database can be connected to the cloud database to download patient records and related data which it can display. It has two major data visualization functions which are to visualize aggregated health conditions of patients and to visualize the health condition change over time of a single patient. The visualization for both functionalities were charted using MPAdroidChart which is an outsourced API developed by Philipp Jahoda.

In Figure 4.4, the process flow for GeeBeeView is shown. Upon opening the application, it will try to download the latest dataset list and update the displayed list if internet connection is available otherwise it will only show an error and

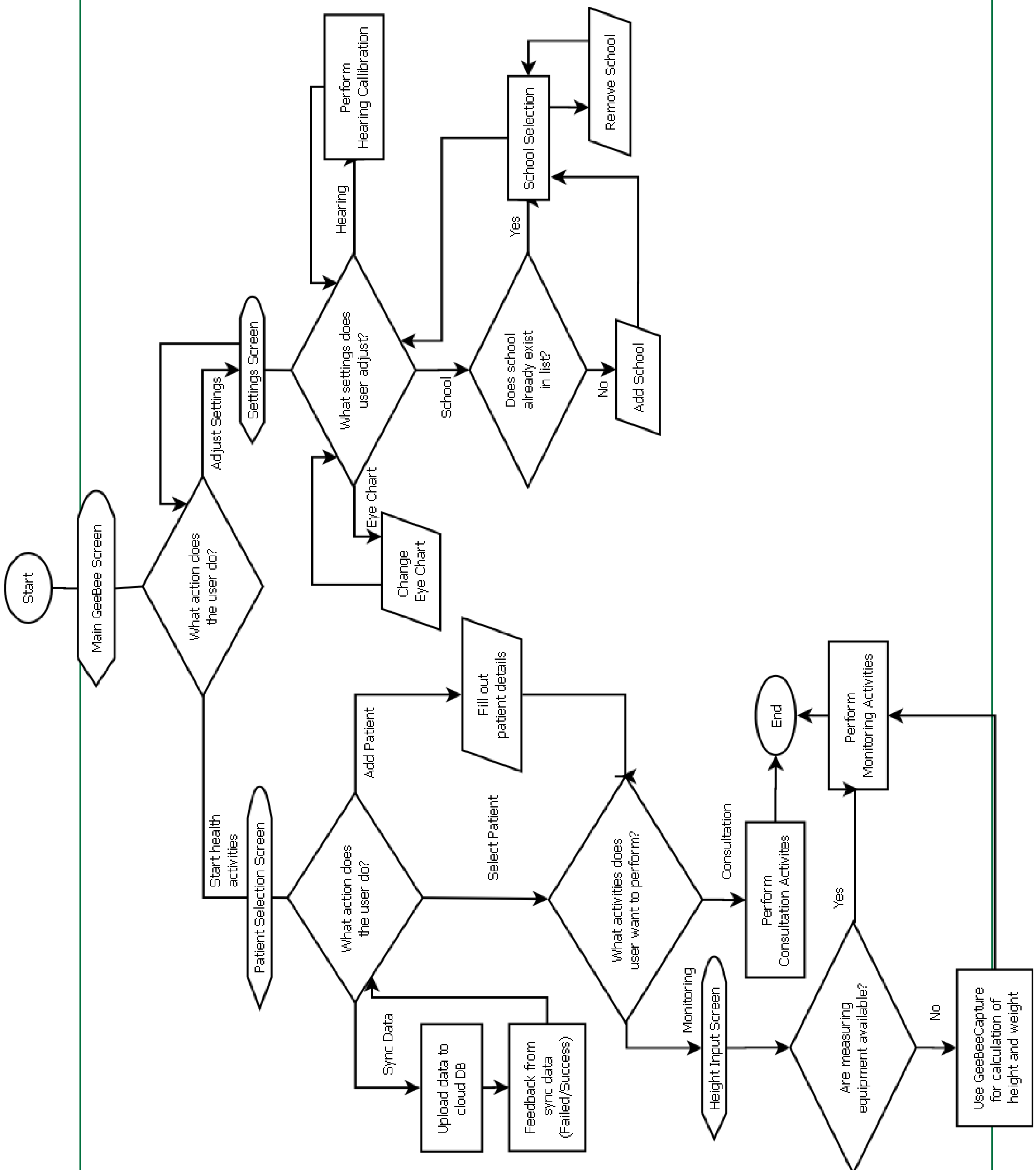


Figure 4.3: Process Flow for GeeBee

display the saved list. From the list of datasets, the user can either download or view a dataset. If the dataset was already downloaded, it can be immediately viewed however if not, the dataset must be downloaded and to download requires internet connection. If the dataset was previously downloaded once it can be viewed without internet connection. Aside from period of downloading the dataset list and downloading datasets, internet connection is not needed. When viewing the dataset, it will automatically display an aggregated data visualization of the monitoring tests results of patients within the dataset. This visualization can only display the result of one test at a time, but be altered by changing the health test and chart type displayed. In addition to that, it is also possible to add filters to only display the results of the subset with the selected age, gender, and grade level. From there, it is also possible to view the consultation list from that dataset and the patient list. From the consultation list, it is possible to select one consultation record to be displayed and from there switch out with another consultation record from the same patient at a different date. From the patient list, after selecting a patient, the patient's transcript of health will be displayed. The transcript of health is composed of a visualization of the monitoring tests results one test at a time over time and the raw results per check up. From the transcript of health it is also possible to view the consultation and immunization records of the patient.

4.4.3 GeeBeeCapture

GeeBeeCapture takes images and computes for the height and weight of the child with a ruler as the reference object. The module uses OpenCV for implementation. It is a standalone application and is separate from the GeeBee application. It is connected to the camera of the device and receives two images as its input: one image in the front view, and the other in the side view. It converts the images as a silhouette first. Afterwards, it computes an estimated height and weight as a numerical value which will be passed as an input to the Monitoring Module without changing the process flow.

In Figure 4.5, the process flow for GeeBeeCapture is shown. When the user selects Monitoring module in the GeeBee application, the height of the child is asked. There is a "Use GeeBeeCapture" button which will open the GeeBeeCapture application. The user will be asked to set the picture through the use of opening the camera or loading the image from the gallery. Once the image is taken or loaded, it should be displayed on the screen. The images for both front view and side view must be loaded to be able to compute for the height and weight

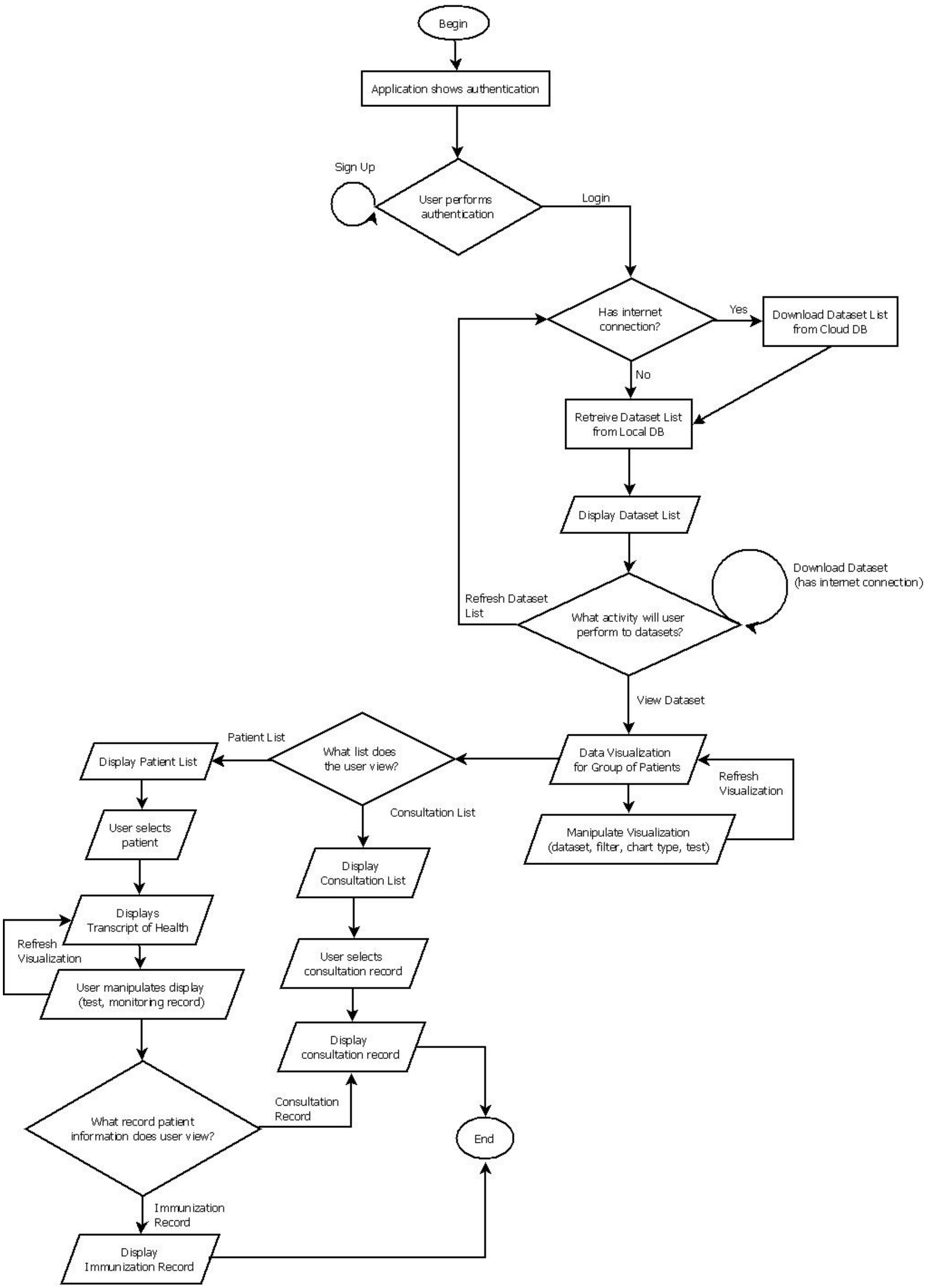


Figure 4.4: Process Flow for GeeBeeView

of the child. Once the two images are loaded, the user then clicks on the "compute and save" button which will calculate the estimated height and weight of the child and save the silhouette. The calculated height and weight should be displayed on the screen. Once done with GeeBeeCapture, the user can choose to go back to the GeeBee application by clicking the "Finish. Back to GeeBee Application" button. If the application is able to generate values for the height and weight, the user will be redirected to the GeeBee application. The height, weight and silhouette will be passed as well and will be stored in the GeeBee database. If there were no values calculated for the height and weight, then the user must simply repeat the taking or loading of the images.

The original raw images of the children which were previously captured are automatically deleted for confidentiality. This is also to prevent misuse since its purpose is to simply provide an alternative way of measuring the height and weight of the child if external measuring tools are unavailable and to not use the image of the child for other purposes.

The height and weight of the child is calculated with the help of a ruler as a reference object. The ruler has a length of 30.48 cm and should be black in color to be easily seen from the white background. It is vertically attached at the background to the right of the child and the child should be far enough for from the ruler for both objects to be distinguished. The height is calculated by using the front view of the child. The calculation steps are as follows:

Step 1: Process the image using Canny Edge Detection Algorithm (see Figure 4.7)

Step 2: Crop the image to the center to remove any unnecessary noise

Step 3: Find the reference object which is assumed to be the right most object. Additionally, image detection algorithm only searches at the center to find the object.

Step 4: Initialize pixels per metric value using the following equation below. ObjectPixelHeight is taken using the boundingboxHeight.

$$pixelsPerMetric = objectPixelHeight/knownHeight \tag{4.1}$$

Step 5: Draw a bounding box on found reference object (see Figure 4.8).

Step 6: Find the topmost contour which is assumed to be at least the head of the subject.

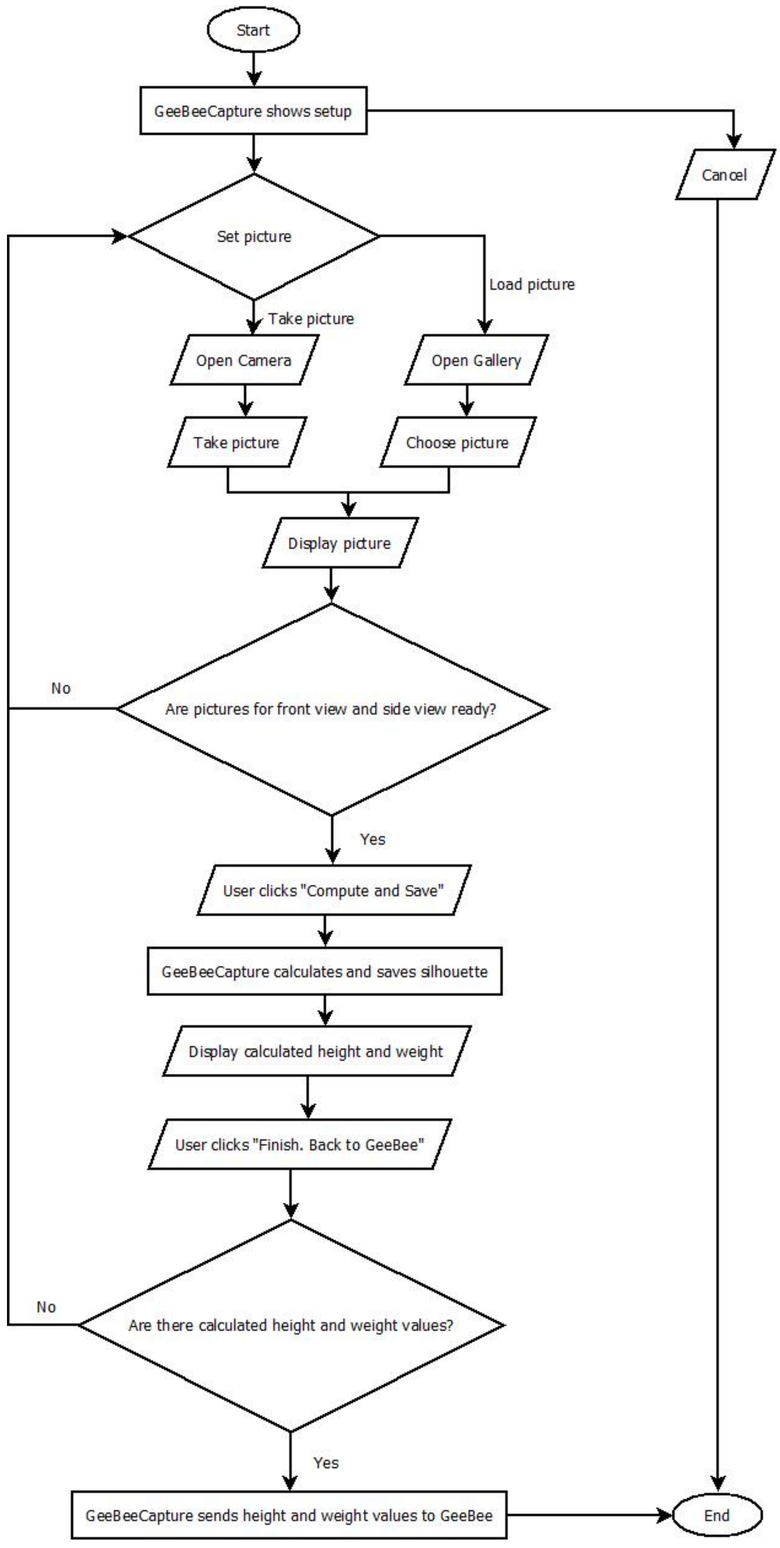


Figure 4.5: Process Flow for GeeBeeCapture

Figure 4.6: Original Image

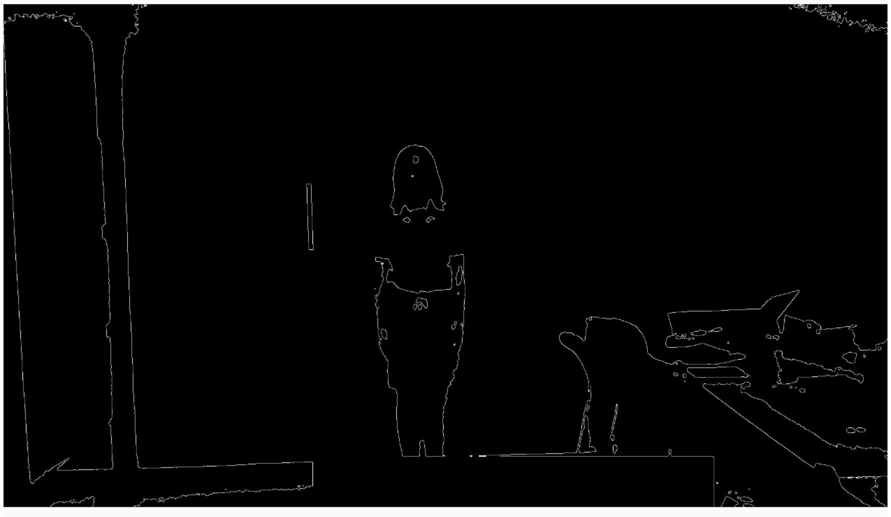


Figure 4.7: Image after Canny Detection Algorithm

Step 7: Draw a bounding box on found subject.

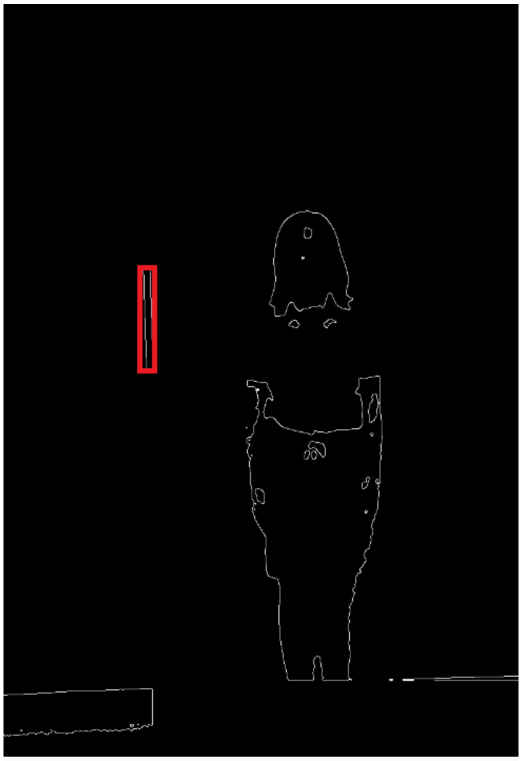


Figure 4.8: Detected reference object and enclosed in red bounding box

Step 8: Initialize top point using top left coordinate of bounding box (see Figure 4.9.

Step 9: Find the bottom most contour which is assumed the point where the wall and ground intersects.

Step 10: Draw a bounding box on found subject.

Step 11: initialize bottom point using the bottom right coordinate of bounding box.

Step 12: compute for the subject height using the equation:

$$subjectHeight = (topPoint - bottomPoint)/pixelsPerMetric \quad (4.2)$$

Getting the values for the width is the same for the height but the width of the bounding box is used. The weight is calculated using the values from the computed

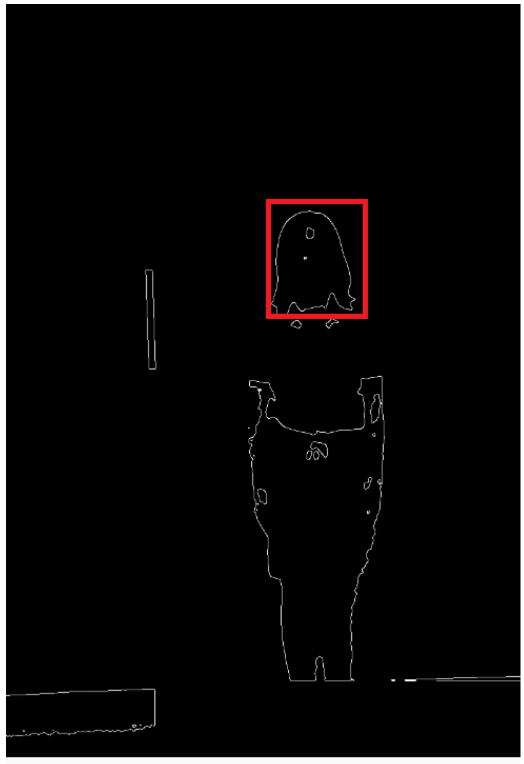


Figure 4.9: Detected top most object and enclosed in red bounding box

width of the child in front view and side view and computed height of the child. Regression was done using Excel's Data Analysis which can be found under the Data tab. To enable Data Analysis in Excel, the add-in Analysis ToolPak must be active. This can be set in the Excel Options. The following steps are done in Excel to construct the formula.

Step 1: Load the dataset.

Step 2: Click on Data Analysis under Data tab.

Step 3: Select Regression.

Step 4: Under the Input Y Range field, select the cells containing the independent variable. In this case, the front width, side width and actual or calculated height.

Step 5: Under the Input X Range field, select the cells containing the dependent variable. In this case, the actual weight.

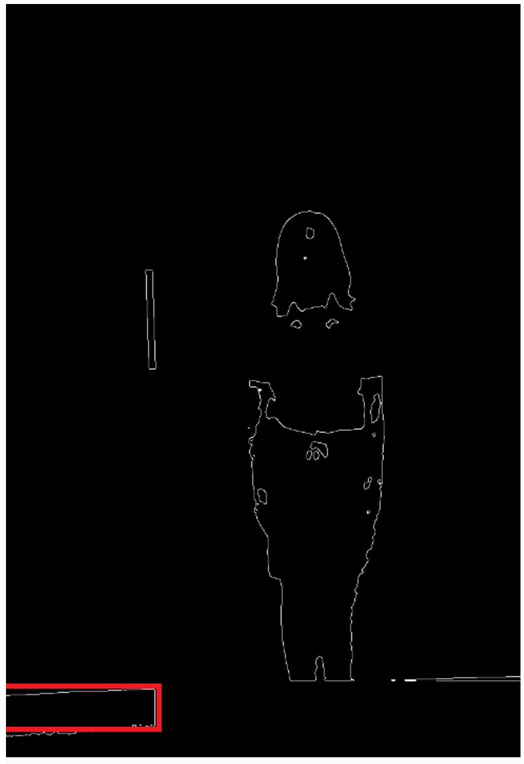


Figure 4.10: Detected bottom line in red bounding box

Step 6: Check the desired output option. In this case, a new worksheet ply. This will display the result in another sheet in the same excel file.

Step 7: Click ok.

The dataset that was used were composed of thirty (30) children which were gathered in the data collection. Data Analysis was performed twice, one using the front width, side width and actual height while the other using front width, side width and computed height. Equation 4.3 is modeled from the computed front width, side width and actual height of the children while Equation 4.4 is modeled from the computed front width, side width and computed height of the children.

$$weight = front_{width} \times -0.4556 + side_{width} \times 0.0728 + height \times 0.3102 \quad (4.3)$$

$$weight = front_{width} \times -0.306 + side_{width} \times 0.0721 + height \times 0.2606 \quad (4.4)$$

4.4.4 Cloud Database

The cloud database allows the storage and retrieval of the data gathered for this system into a cloud database serving as a repository wherein the different applications that are part of the system can access the data. It will by no means alter or change the data itself. The cloud database is connected to both the GeeBee and GeeBeeView applications. The cloud computing module for GeeBee uses only a straightforward process of uploading the data in the local database to the cloud database at the press of a simple press of a button where the data from the local database is evaluated and checked if it was already uploaded to the main remote cloud database. The consultation and monitoring module is not modified from the original GeeBee application and is still connected to the local database which enables the application to still work offline. The data from the local database will only be uploaded to cloud whenever the tablet is connected to the Internet with the user's consent. The cloud computing module for GeeBeeView allows access to the cloud repository and manually choose the dataset which it will download and copy to its local database at the start of the application workflow. The data visualization is connected to the local database and only visualizes data from its local copy allowing it to work offline but it requires the user to download the dataset first before it will be able to visualize any data.

Cloud Hosted Database

The cloud hosted database system follows the typical flow of a database server. The database engine is stored in a server computer the database is hosted to the Internet using an interface. The interface then communicates with connected clients to the server and queries and updates with requests by the clients. A simple visualization of this flow can be seen in Figure 4.11.

The database uses a SQLite database engine as SQLite is be easier to manage for use in Android devices and enough to meet all requirements in managing the database. The relational structure of the database is based mainly on the preexisting application: GeeBee, the proponents will not alter the database but with the exception with adding columns to relevant tables for checking if the row was synced or not(i.e. a 'synced' column). For serving the database to the Internet, PHP and MySQL is used to interface with the android application and the SQLite Database.

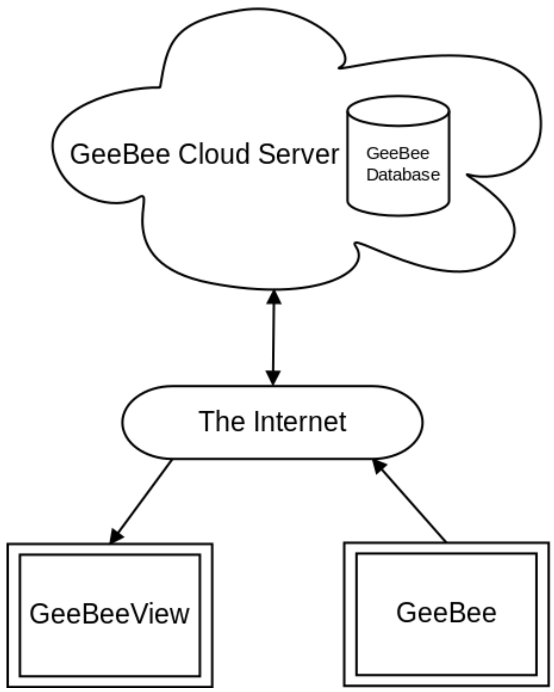


Figure 4.11: A Basic Database to Client Flow

The type of Cloud Computing service this research uses is an *Iaas* type. There is a provided cloud droplet to be used by the proponents. The droplet is the term used by the Cloud Computing service company called *DigitalOcean* to describe a portion of their hardware systems for personal or commercial use. The droplet runs Ubuntu, a Linux based operating system, with in it. The proponents will host the database in the droplet for access of the different data this research will be using.

Local Database

The database which is used for both GeeBee and GeeBeeView. All existing data structures are patterned after the patient information and record database from GeeBee is shown in Figure 4.12. The tables in the patient record and information are described in Table 4.1.

Table 4.1: Names and Descriptions of Tables for Patient Information and Record (Lacsamana et al., 2016)

Table	Description
Province	The list of the names and provinces of the Philippines with an assigned province ID.
Municipality	The list of the names of municipalities pf the Philippines with an assigned municipality ID and the corresponding province ID as well as the region ID from which is part of.
School	The list of the names of schools of the Philippines with an assigned school ID and the corresponding municipality ID where it is situated.
Patient	The patient identification information such as patient name, birthday, gender, school, dominant hand and remarks. It will also have an assigned patient ID and the corresponding school ID that the patient is attending.
Record	The records of each patient on every monitoring session with an assigned record ID, date of creation, remarks with the medical information stored from the tests performed. The medical information stored includes the patient ID of the patient, vaccination records, patient picture, height, weight, visual acuity, color vision, evaluation of gross and fine motor skills.
HPI	The HPIs generated by the system during consultation sessions with an assigned HPI ID, date of creation, and the corresponding patient ID whom the record belongs to.

Additional tables not present in the GeeBee database and only found in the GeeBee View database for the guidelines of normal growth of children and sectioning of patient information are found in Table 4.2.

Table 4.2: Additional Tables in GeeBee View

Table	Description
Dataset	The list of the sections based on the school and date created for the division of collected data with the assigned dataset ID, school ID, date of creation of the record to be sectioned, and status which signifies if the set of records were downloaded or not yet.
Ideal Growth Value	The ideal growth values declared by WHO using age and gender as basis. It has an assigned growth ID, the specific medical information whose ideal growth is recorded, gender, year, month, and the values of the ideal growth from 3 standard deviation as well as the median.

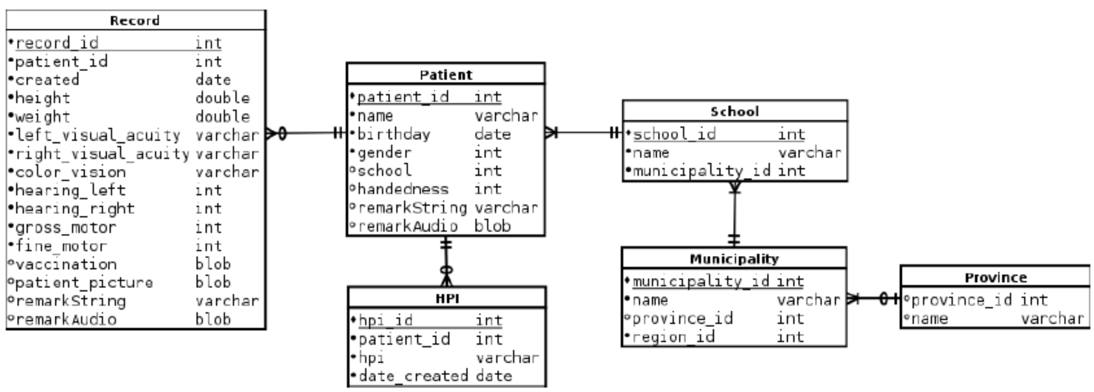


Figure 4.12: Entity Relationship Diagram (ERD) of Patient Information and Record from GeeBee

4.5 System Functions

4.5.1 GeeBee

The original GeeBee already had functionalities prior to this research which are divided in six (6) major functions namely the ECA, the user list, activity selection, monitoring module, consultation module, and application settings. The ECA possessing the ability for both verbal and non-verbal communication. The addition and selection of a patient. The activity selection wherein the user can branch to either the monitoring or consultation module. The monitoring module containing six (6) submodules for routine check-up specifically general monitoring, visual acuity test, color vision test, hearing test, gross motor test, and fine motor test. The consultation module containing the expert system and HPI generation. Finally, the application settings where calibration and other details are set.

The newly developed functions in GeeBee are only limited to data handling going to the remote cloud database. The selection, addition and removal of schools from the local database is also a part of the newly added functionalities so that in order to determine what school the user is currently recording data for. The main function added to the GeeBee Application in lieu of databases is the feature to sync data to the remote cloud database seamlessly with just a press of a button.

School Selection

School selection from the previous version of the GeeBee was only limited to a defined set of schools that the user cannot add or remove. With the new modified functionalities, it is now possible to not just select schools but also to add and remove schools to be used for the consultation and records. Adding these features is relevant to this research as this would add modularity and aid in streamlining the process of consultation using the application. The user would not have to request to add new schools from database managers. A screenshot of where one can access the school selection section is shown on 4.13.

Uploading/Syncing Data

The ability for the GeeBee application to upload and syncronize with the remote database is one of the main objectives of this study. Before, all data collected by the application all resided in the particular devices local storage and has no way of getting to the remote database. Now, with just a button, the user can leave the device to upload all the data all by itself. The button to initiate the process of syncing is shown on 4.14.

4.5.2 GeeBeeView

GeeBeeView is a mobile application for displaying collected data of GeeBee. Its functions are mostly about the display of data and does not insert to the database

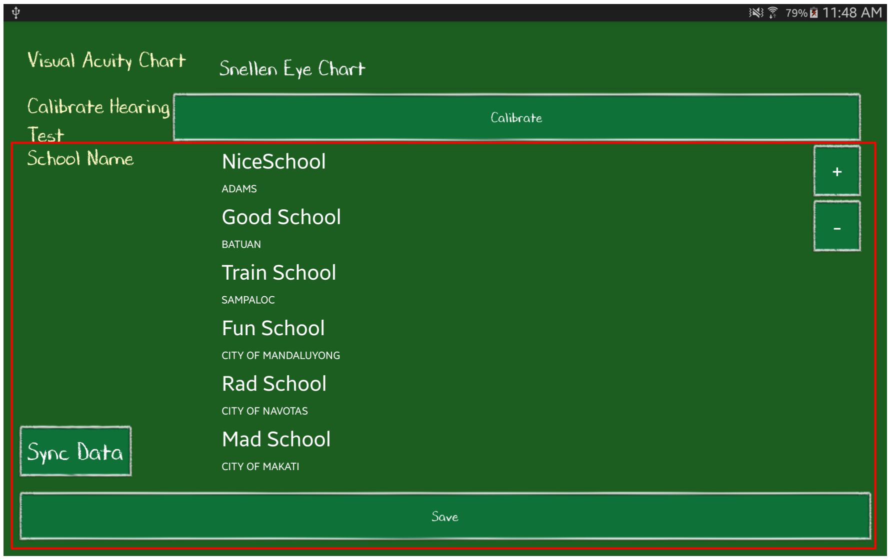


Figure 4.13: GeeBee Select School

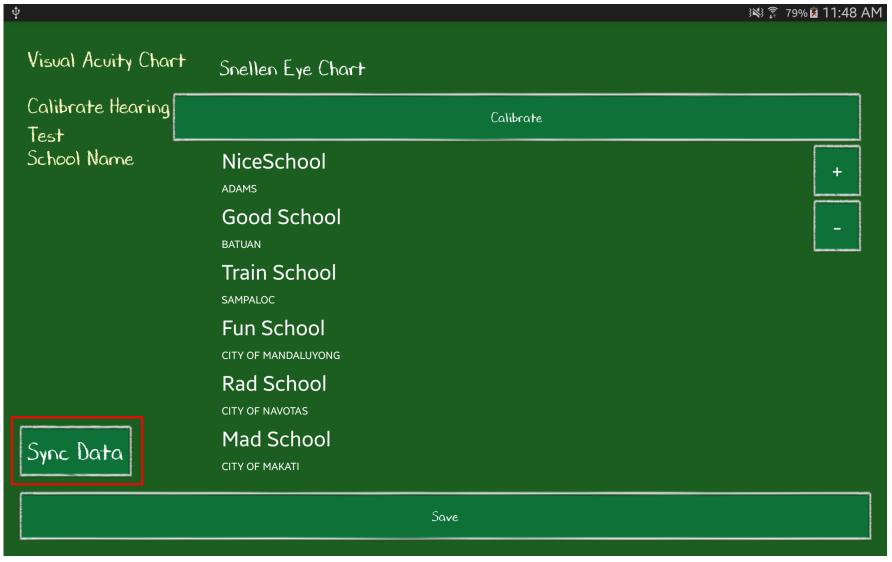


Figure 4.14: GeeBee Sync

except for the user authentication.

Authentication

Before the software enables the user to be able to view data from the software, the user must be first authenticated with a valid GeeBee account (see Figure 4.15). Even if the user can sign up in this screen, the system manager must first authorize access.

Figure 4.15: GeeBeeView Authentication

Dataset List

After authentication, the user will be shown a dataset list (see Figure 4.16). Each dataset pertains to a collection of data from patients which are grouped based on which school they belong to and the date wherein their record was created.

The datasets must be downloaded from the cloud database first and copied to the local database. Once copied, the dataset is ready for viewing.

Data Visualization of Aggregated Results

After the user selected a dataset for viewing, a data visualization of the aggregated health condition of the group of patients is generated. The default chart generated

Figure 4.16: GeeBeeView Dataset List

is a pie chart of the BMI classification of the patients. It is possible for the user to view the consultation list or patient list from here.

The visualization displayed is interactive and adjusts based on the selected source dataset/s, filter/s, chart, comparison set, and result of a health test. From the visualization of only one dataset, it can added on with another dataset with no limit. These additional datasets may be removed until only the original one is left. The contents of the datasets may also be filtered according to age and gender which can be added and removed. The chart may also be changed from the default pie chart to either a bar, scatter, or bubble chart. The health test result viewed may also be changed from the default BMI classification to visual acuity (left or right), color vision, hearing (left or right), gross motor, and fine motor (dominant, non-dominant, and hold). The comparison set is only available if the chart type is either pie or bar. It allows comparison of the dataset/s in the dataset list with a larger set which can be either the national profile, region, province, or municipality wherein the initial dataset resides in.

Consultation List

The consultation list is a list of consultations recorded from the consultation module in GeeBee. This list contains all the consultations recorded from only

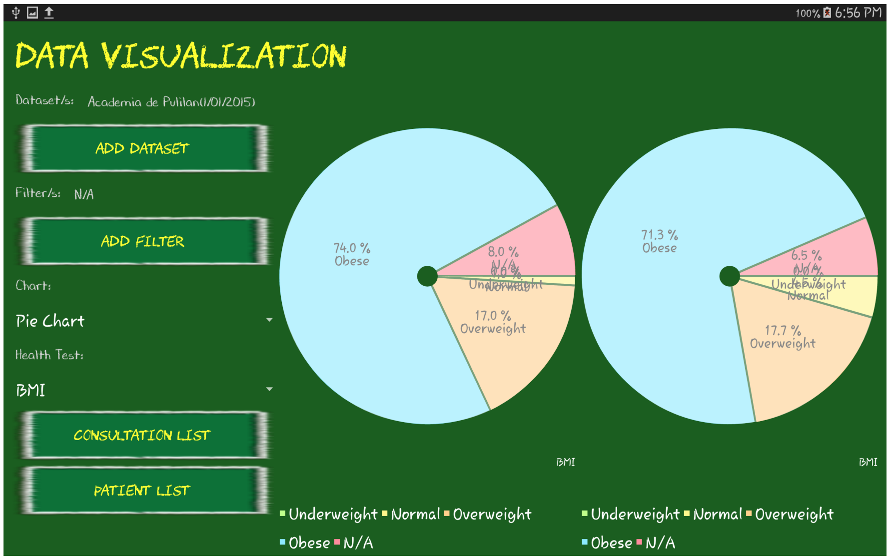


Figure 4.17: GeeBeeView Data Visualization of Aggregated Results

one school which was originally selected in the data visualization of aggregated patients. It displays the name and date of consultation.

Figure 4.18: GeeBeeView Consultation List

Consultation Record

To view a consultation, the user can click the view button from the consultation list. It will display the generated HPI of a patient detailing the symptoms experienced.

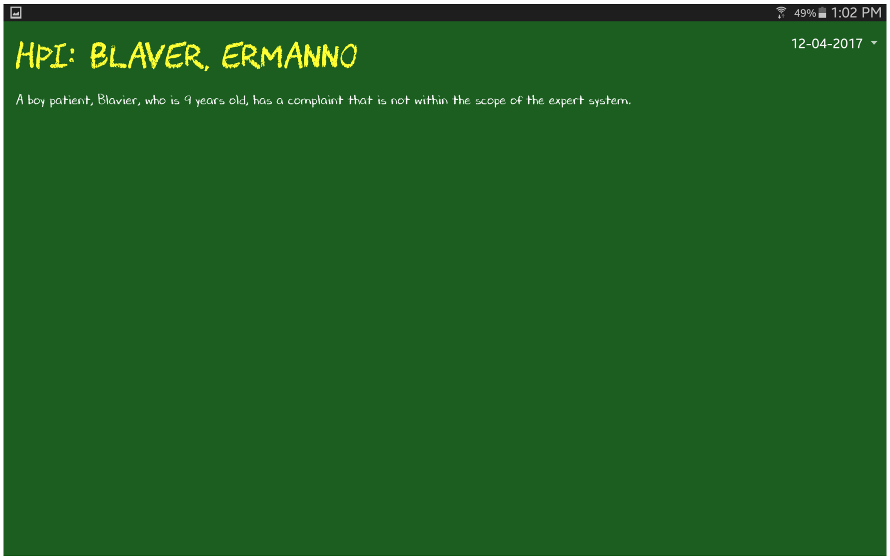


Figure 4.19: GeeBeeView Consultation Record

Patient List

The patient list is a list of patients who went through the general monitoring module which are included in the specified dataset. This patient list is arranged in chronological order displaying the name, gender and age of the patient when the record was created.

Transcript of Health

To view patient information, click the view record button next to the age of the patient whose record will be displayed. Patient information includes the patient details, record details, and visualization on change over time of health condition. The patient details include the name, birthday, gender, dominant hand, last

Figure 4.20: GeeBeeView Patient List

checkup date, remarks, and patient picture. The record details refer to check-up results which includes the height, weight, visual acuity of left and right eye, color vision, hearing of left and right ear, gross motor, fine motor of dominant and non-dominant hand, and remarks. The default record details displayed is on the latest dated record but can be swapped with previous records using the drop-down option located above the record details.

The visualization of change over time is a line chart having the age of the patient on the x-axis and the condition on the y-axis. Similar to the aggregated visualization, this visualization can only display the result of one test at a time. The light blue line with white circle at the plotted points is the health test results of the patient. In addition to that another lines are added for comparing the patient results to others. The nave blue line pertains to either the average or mode of health test result of patients with the same age as the patient. In cases of the visualization of the BMI, height and weight of the patient, aside from the patient line and the average line, there are additional lines to serve as guidelines to compare the growth of the child for what is considered ideal by WHO. These guidelines cover only the idea growth of patients in ages 5 to 19 years old. For BMI, there are five (5) guidelines, the area between the highest red line pertain to obese, the area between the red line and yellow pertains to overweight, the area between the yellow and lowest red line pertain to the normal, the area between the lowest red line and the black line is for thinness, and the area below the black line is pertains to severe thinness. For height and weight, there are 5 guidelines, the green line is the most ideal growth curve, the area between the two yellow lines which are 1 standard deviation from the ideal should cover 68% of the patients, the area between the two red lines which are 2 standard deviation from the ideal should cover 95% of patients. These guidelines can serve as a basis to check abnormality on the growth curve of the child.

From here the user can view either the consultation records or the immunization records of the patient.

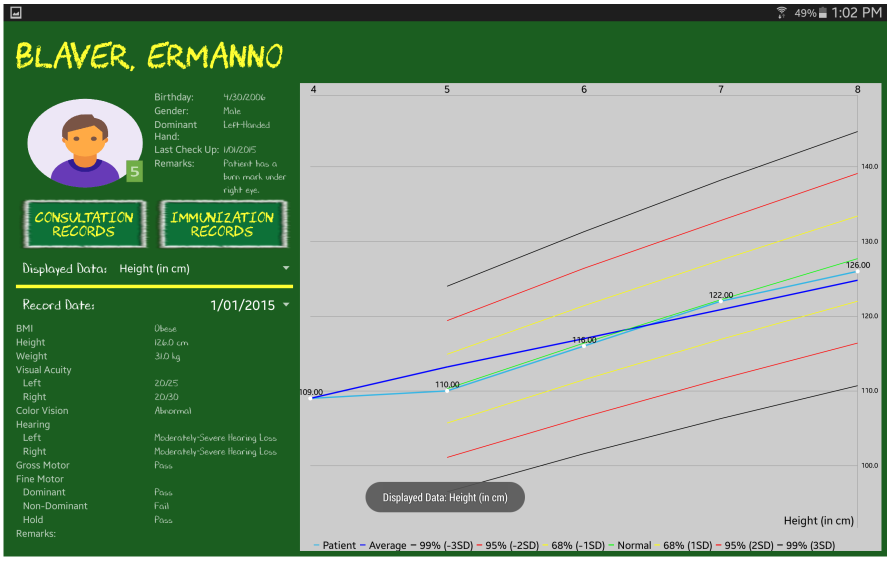


Figure 4.21: GeeBeeView Transcript of Health

Immunization Record

The immunization record can be viewed by clicking the view immunization record button from the view patient screen. The immunization record to be viewed by default is the latest one however it is possible to switch out with previous records by using the dropdown option on the upper right of the screen.

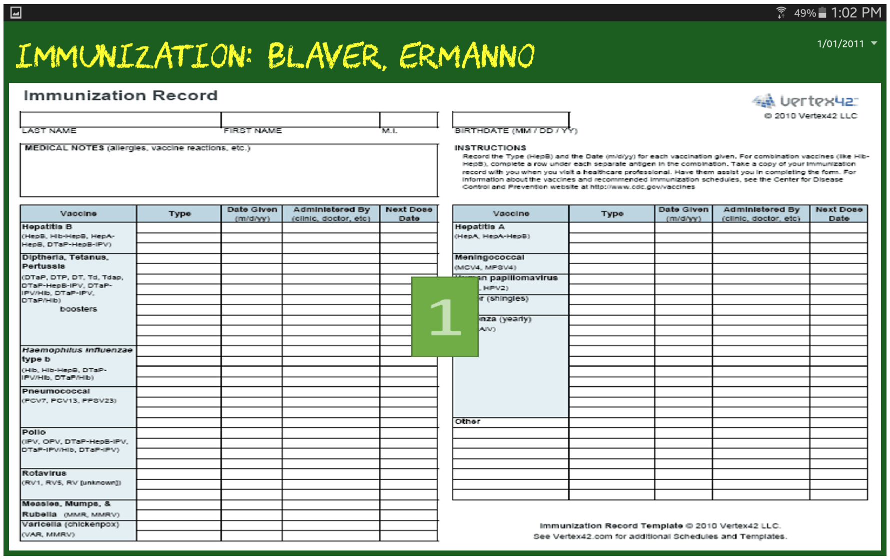


Figure 4.22: GeeBeeView Immunization Record

4.5.3 GeeBeeCapture

GeeBeeCapture is a mobile application that is integrated to GeeBee as an alternative way to measure the height and weight of children. The starting screen of the application can be seen in Figure 4.23. GeeBeeCapture calculates the height and weight by image conversion and retention then image computation.

Image Calibration

The Image Calibration function will be responsible in removing the background of the image in order to retain only the subject and the reference object to be calculated in the other function.

Image Conversion and Retention

The Image Conversion function turns the original image into a silhouette that is saved into the system and also reprocesses the image to be used for calculation.

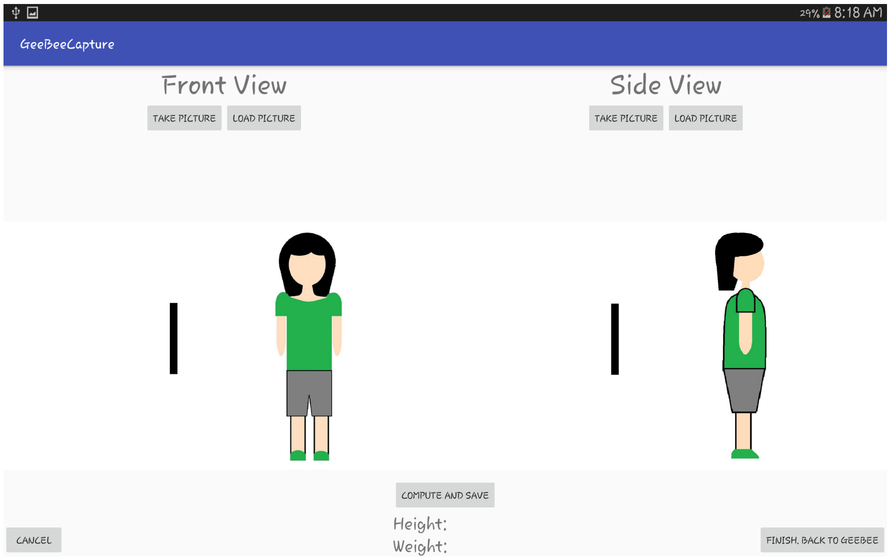


Figure 4.23: Start Screen

Image Computation

The Image Computation function computes for the height and weight of the child and then categorizes the weight group. The calculated data is passed to the Monitoring Module of GeeBee.

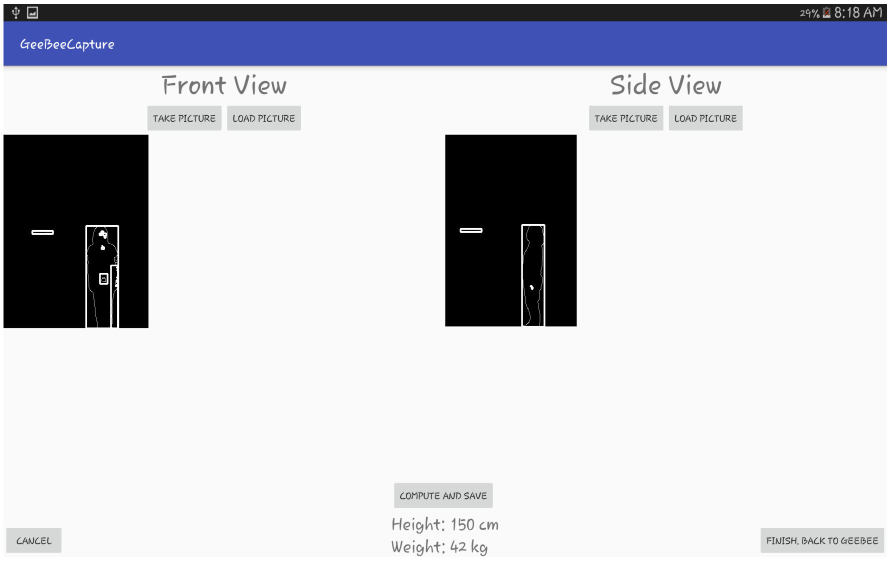


Figure 4.24: After Calculation

4.6 Physical Environment and Resources

The Public Health Monitoring System of Filipino Children is an improved version of the previous thesis by Lacsamana et al. with an additional image processing application for automatic calculation of height and weight, and a data visualization devise for displaying the collected data. It is an asynchronous telemedicine system composed of three mobile applications designed for Android tablets.

GeeBee is a data collection software that can perform the basic health monitoring and consultation activities for children wherein the collected data is uploaded. The target users are children aged 6 to 14 years old and may extend to the assistants who will guide or help them for said activities. Its system requirements include an operating system of Android 4.1 or higher and permissions for the usage of camera, microphone, storage, network communication, and battery. The tablet hardware components are working camera, speakers and microphone while accessories include earphones or headphones and stylus and a screen with at least 800 DPI to view the proper layout. A requirement not always needed is internet connection. It is unneeded for going through the monitoring and consultation activities however it is needed for uploading the data to the dedicated cloud database.

GeeBeeCapture is an image processing software that can calculate the height and weight of children as an alternative for manual measuring and return these values to GeeBee. The target users are the same as GeeBee. Its system requirements include an operating system of Android 4.4 or higher and permissions for the usage of camera and storage. The tablet hardware component required is only a working camera.

GeeBeeView is a data visualization software that can download and display the data collected by GeeBee. The target users are doctors or medical personnel who can give a diagnosis and further instructions to maintain or improve the health condition of the children and may also extend to authorities who plans for the health care of children. Its system requirements include an operating system of Android 4.4 or higher and permissions for storage and network communication. It does not have specific hardware components however it for proper viewing of the layout and visualization it requires a screen with at least 800 DPI. Similar to GeeBee, it also needs Internet connection for downloading the data from the cloud database however it does not need it to display and visualize the downloaded data.

GeeBee Specification Requirements	
Specification	Requirement
Processor	ARM Devices Only
RAM	At least 1 GB
Storage	1 GB
Internet Connection	Optional for Data Uploading
Screen Size	At least 800 DPI
Android Version	At least Jellybean 4.1 (API 16)
Stylus	Yes
Microphone	Yes
Camera	Yes
Headphones or earphones	Recommended

GeeBeeCapture Specification Requirements	
Specification	Requirement
Android Version	At least KitKat 4.4 (API 19)
Camera	Yes

GeeBeeView Specification Requirements	
Specification	Requirement
Storage	At least 1 GB
Internet Connection	Optional for Data Downloading
Screen Size	At least 800 DPI
Android Version	At least KitKat 4.4 (API 19)

Chapter 5

Design and Implementation Issues

5.1 GeeBee

5.1.1 Application Processor Architecture

One big hurdle in the GeeBee application is its possibility to be emulated into android emulators. This hurdle is due to the fact that android emulators have a CPU architecture of x86 for faster and seamless emulation of a device because the architecture of the host PC and virtual device shares the same instructions set. The problem with the emulators is that it cannot install applications that are not x86 compatible. Unfortunately, in the case of the GeeBee application, it is compiled in an ARM architecture due to the fact that the creators of the application only has library (.so) files that are for just ARM devices. This poses a problem because the ARM *apk* compiled merits the use of an ARM emulator which is impractically slow because the instruction sets are translated in real time to a compatible language in the host machine.

5.1.2 Uploading

Uploading data to the remote cloud database requires the cooperation of both the application and the cloud server mentioned in this research. Once the user prompts the app to sync data, the app queries the local SQLite database in the application for rows that are not synced. The tables queried are only specific as not all data within the application will be synced as there exists static tables in the database such as the different municipalities, regions and provinces. The ones that do have the sync attribute are as follows: *tbl_school*, *tbl_record*, *tbl_patients* and *tbl_hpi*, these tables are dynamic and is subject to change with the applications usage. These tables are also the important bits that has to be stored in to the remote database. During the querying of the tables that has a *synced* attribute, there is a general SQL query to run for SQLite to return the rows that need to be synced.

Listing 5.1: SQL Query for unsynced patients.

```
SELECT * FROM tbl_patient WHERE synced = 0;
```

The code in 5.1 is the SQL query used to get all the rows in *tbl_patients*. This is the general form of the SQL queries used in getting rows from tables that has the *synced* attribute.The same logic is the same with the other tables: *tbl_school*, *tbl_record*, *tbl_patients* and *tbl_hpi*.

After retrieving all the unsynced rows, the results then get instantiated to be their corresponding objects . Once instantiated the objects are collected in to Array Lists of their respective types, the application then creates post requests to a server. The POST request for inserting data to the remote database consists of a body that is *x-www-form-urlencoded* with keys named '*request*' and '*json_upload*'. The key '*request*' should have values *upload-patient*, *upload-school*, *upload-record* and *upload-hpi*. While the other key; *json_upload* should have the whole entirety of a JSON object in an Array in string encoding. Depending on what the value of the key *request* is, the server will know what array of object of the JSON it will be parsing. For example, if the *request* value would be 'upload-school' the corresponding *json_upload* value should be a JSON representation of an array of school. Following the school example, the server would just decode the string and would iterate each and every school. In each iteration, the server would do the inserting using the SQL statement:

Listing 5.2: SQL Statement for inserting a school.

```
INSERT INTO tbl_school(name, citymunCode)
```

```
2         SELECT * FROM ( SELECT ? as name,? as citymunCode)
3         AS tmp
4         WHERE NOT EXISTS (
5                 SELECT name, citymunCode FROM tbl_school
6                 WHERE name = ? AND citymunCode = ?
7         );
```

The SQL statement from Listing 5.2 is a general insert statement for schools and all the other relevant data to be accepted by the server such as HPI, patients, and records. Breaking down the statement in Listing 5.2, in line 1 is the main insert statement inserting to columns of 'name' and 'cityMunCode'. Line 2 inserts the values '?' from the sub-query with the values of '?' supplied from the decoded JSON object from the application. At line 4 - 7, is a 'safety net' for inserting new data. In the application level, after the application sends the un-synced data, it awaits for a 'SUCCESS' response back of the server to acknowledged that the server has received and processed the new data, in the event of the success response, the application then sets all the synced columns of the relevant tables to 1 meaning that that row is synced and will no longer be uploaded at anytime. This is the first line of defense for data integrity within the remote database. If this fails however, there is a check in the server level for data that could be a duplicate. In the event of a duplicate row, the server would know because of the SQL statements from lines 4 - 7 in the Listing 5.2. With that in place, it only inserts when the unique values of the *new* data does not exist in the same row in anywhere in the table, thus ensuring data integrity.

Finally, once all that is complete when all the relevant data POST requests are all responded with SUCCESS messages back to the application, the application will set all the synced columns of all the rows that were uploaded to the remote to 1, denoting that they are already synced. acheiving this can be done by invoking the update method of an SQLiteDatabase as shown on Listing 5.3.

Listing 5.3: Update to synced schools.

```
getBetterDb.update("tbl_school", values, "synced=0", null);
```

5.2 GeeBeeView

Since GeeBeeView only displays the data collected by GeeBee, the data structure was already defined. In this section, the term data refers to the school details, patient details, monitoring records and consultation records.

5.2.1 Dataset

When downloading the collected data to GeeBeeView, copying the entire contents of the cloud database is not efficient not to mention takes too much storage space. Therefore to section the data, the idea of separating them by datasets defined by the school and date was created. Among the data collected by GeeBee, the most numerous is the monitoring records. Therefore, the data was sectioned by the school and creation date of monitoring records. When downloading each dataset, all related information such as consultation records and patient information are also downloaded.

5.2.2 MPAndroidChart

MPAndroidChart is an open source charting library that is available for use in the android architecture developed by PhilJay (Philipp Jahoda). It offers a wide variety of 8 core charts and on top of that is capable of combining charts to create a more meaningful representation of the data one would want to show. It also offers smooth fluid like chart rendering and pinch to zoom scaling capabilities. It is also interactive so a user of an application created with it can understand the data better. As an added bonus the open source API also offers color customizations and animations for better chart experience.

This charting library was chosen for the data visualization module instead of Google Chart API despite its popularity is because MPAndroidChart can chart even offline only requiring the library jar file to be added.

5.2.3 Local Database

As stated in chapter 4, GeeBeeView displays the data collected by GeeBee through downloading the data, uploaded by GeeBee, stored in the cloud repository. This local database makes it possible for the application to store the data downloaded. Once the data is stored in the local database, GeeBeeView can display the data repeatedly even offline.

For example, GeeBeeView was installed in a tablet. While in an internet connected facility, dataset A was downloaded. After relocating in another place without internet connection, dataset A can still be displayed.

Though it may seem more advantageous to just have GeeBee and GeeBeeView share and access the same database to reduce the need for internet connection there are also some disadvantages to that arrangement such as GeeBeeView cannot display data not collected by GeeBee using the same tablet. On the other hand, although seemingly disadvantageous at first, the arrangement that GeeBeeView relies on internet connection for downloading datasets to display them; it can display the datasets not collected by the GeeBee installed on the same tablet. Another advantage would be that it does not require the installation of GeeBee at all and works as an independent application. This arrangement is the most effective if the doctor or medical personnel who will be giving the diagnosis or viewing the data for consultation is not physically available on site or if the tablet cannot be easily transported between the data collection site and the location of the doctor.

The database structure is the similar to the local database of GeeBee except for a few added tables for additional information used in visualization.

5.2.4 Ideal Growth Value Table

The contents of the Ideal Growth Value table in the database (shown in Table 5.1) is the encoded values of the growth reference charts mentioned in Chapter 3. This table contains values for the standard height (in cm) and BMI values of children for ages 5 to 19 years old and differs depending on gender while the weight (in kg) values are only for children ages 5 to 10 years old. The original table of growth reference charts values contain a set of values for each year and succeeding months starting the 5th birthday until the 19th birthday. However since the changes between one succeeding month to another is very minimal, it was decided to only include the yearly change.

Table 5.1: Ideal Growth Value table contents

ID	Record Column	Sex	Year	Mon	–3SD	–2SD	–1SD	Median	1SD	2SD	3SD
1	height	M	5	1	96.5	101.1	105.7	110.3	114.9	119.4	124.0
2	height	M	6	1	101.6	106.5	111.5	116.4	121.4	126.4	131.3
...	...	...	...	...	...	...	...	...	...	...	...
15	height	M	19	0	154.6	161.9	169.2	176.5	183.8	191.1	198.4
16	height	F	5	1	95.3	100.1	104.8	109.6	114.4	119.1	123.9
17	height	F	6	1	100.2	105.3	110.5	115.6	120.8	125.9	131.1
...	...	...	...	...	...	...	...	...	...	...	...
30	height	F	19	0	143.5	150.1	156.6	163.2	169.7	176.2	182.8
31	weight	M	5	1	12.7	14.4	16.3	18.5	21.1	24.2	27.8
32	weight	M	6	1	14.2	16.0	18.2	20.7	23.7	27.4	31.9
...	...	...	...	...	...	...	...	...	...	...	...
36	weight	M	10	0	20.4	23.2	26.7	31.2	37.0	45.0	56.4
37	weight	F	5	1	12.4	14.0	15.9	18.3	21.2	24.8	29.5
38	weight	F	6	1	13.6	15.4	17.6	20.3	23.8	28.1	33.8
...	...	...	...	...	...	...	...	...	...	...	...
42	weight	F	10	0	20.3	23.3	27.0	31.9	38.2	46.9	59.2
43	bmi	M	5	1	12.1	13.0	14.1	15.3	16.6	18.3	20.2
44	bmi	M	6	1	12.1	13.0	14.1	15.3	16.8	18.6	20.8
...	...	...	...	...	...	...	...	...	...	...	...
57	bmi	M	19	0	15.9	17.6	19.6	22.2	25.4	29.7	35.5
58	bmi	F	5	1	11.8	12.7	13.9	15.2	16.9	18.9	21.3
59	bmi	F	6	1	11.7	12.7	13.9	15.3	17.0	19.3	22.2
...	...	...	...	...	...	...	...	...	...	...	...
72	bmi	F	19	0	14.7	16.5	18.7	21.4	25.0	29.7	36.2

5.2.5 Authentication

The authentication input needed for both sign up and login are only the username and password. In sign up, the username is inserted into the database as is however the password is encrypted using 128-bit Advance Encryption Standard (AES) encryption before insertion. In accordance, in login the password is decrypted before comparison to user input.

Once registered, the user is then given an access level which determines whether the user can proceed to view the dataset list. The original plan was to have a system administrator to elevate the access level per user to determine whether the user should be allowed access. However, since this system has no other way to access the cloud database aside from the tablet and directly going to the access point then manually changing the access level, the default access level allows access to the collected patient information.

5.2.6 Data Visualization of Aggregated Results

The data visualization of aggregated results is composed of two charts. The left chart is the one depicting the results of the dataset selected while the right chart is the one depicting the results of the profile specified by the user.

The charts available are pie chart, bar chart, scatter chart, and bubble chart. Since the monitoring record results have predictable results depending on each health test, the results can be divided into categories. Using a pie chart can emphasize the percentage distribution of the patients based on the results. In comparison, the bar chart can emphasize the actual distribution based on the count of the patients per category. Scatter charts are best in showing the relationship between two variables. Scatter charts are best in showing the relationship between three variables.

The health tests available are visual acuity (left and right eye), color vision, hearing (left and right ear), gross motor, and fine motor (dominant, non-dominant, and hold). The only possible results for each test as defined by GeeBee is shown in Table 5.2.

Table 5.2: Results of Monitoring Tests in GeeBee

Test	Possible Results
Visual Acuity	20/200, 20/100, 20/70, 20/50, 20/40, 20/30, 20/25, 20/20, 20/15, 20/10, 20/5
Color Vision	Normal, Abnormal
Hearing	Normal Hearing, Mild Hearing Loss, Moderate Hearing Loss, Moderately–Severe Hearing Loss, Severe Hearing Loss, Profound Hearing Loss

Gross Motor	Pass, Fail, N/A
Fine Motor	Pass, Fail
Fine Motor (Hold)	Hold, Not–Hold

To visualize the dataset, the dataset school and date are taken then used to query patient monitoring records which correspond to the school and date from the database and are added to a list which will be used to plot the chart. These monitoring records are composed of monitoring tests results which can be predicted using the possible results listed in Table 5.2 and other information. By default, the visualization is a pie chart showing BMI categories.

To plot a chart, a monitoring test is selected. Since the results of the each test can be predicted, once a test is selected each possible result is then counted and copied as entries to be plotted. Before becoming entries, the counted results are saved to reduce counting again when changing chart types. Each chart type has a specific type of entry needed so whenever there is a change of chart type the saved counted results only need to be copied to the required entry type.

To add datasets, the available (or downloaded) datasets are displayed. After the dataset to be added is selected, the dataset school and date are used to query the patient monitoring records. These monitoring records are then added to the list of monitoring records used as input for the charts. After that, the dataset school and date are added to the dataset list. When removing a dataset, the list is then emptied, then each dataset in the dataset is queried and added to the list of monitoring records. Whenever there is an addition or removal of dataset for the visualization, the list of monitoring records changes therefore, the chart entries are then cleared, patient monitoring results are counted per possible result depending on the test to be displayed, then added as entries before redrawing the chart.

The filter allows the user to chart only the specified subset. The filters available are for age, gender, and grade level. When adding filter/s, it can be either one by one or all at once since the display allows it however for each filter type only one filter can be applied at a time. For example, the filter for gender is that the patient must be female. If the the user attempts to add filter that gender must be male, the gender filter is immediately replaced and only the filter that gender must be male will remain. If the user attempts to add filters for age and/or grade level, they will be added as filter/s and the gender filter will remain unless removed.

The filter is applied by using a temporary list of monitoring results, removing the patient records not fit for the given criteria by the filter. The monitoring records list displayed is then cleared before adding the contents of the temporary list to it. After the list is updated, the values are recounted before the chart is redrawn and the filter/s applied are added to the filter list. When removing a filter, the monitoring records list is cleared, then the all records based on the dataset list is added before filtering the list again based on the filters left.

5.2.7 Transcript of Health

The transcript of health displays both the visualization of the monitoring tests results of the patient and changes over time and the raw results. Similar to the visualization of aggregated results, the visualization of one patient over time can only display the results of one test at a time. In comparison, the raw results of all tests involved in a monitoring activity is displayed all at once at a specified date. This raw results can be switched with an older or newer one by the use of the dropdown menu specifying the date the monitoring activity was conducted.

The visualization for the height, weight and BMI have guidelines which can be used by the doctor or medical personnel to use as additional guide to determine if the growth of the patient is sufficient. These lines are described in Section 3.5 as growth charts and plotted using the points recorded in the Ideal Growth Value Table from the database. The labels are added according to growth reference charts in 3.10. Aside from guidelines from the growth reference charts from WHO, there is also an added guideline using the monitoring records collected in the local database. This added guideline uses the monitoring records of other patients in the same age as the patient to plot an average results line showing the average results of patients who were born at the same year and underwent the monitoring activity at the same year.

The visualization for transcript of health was planned to also change into different chart types similar to the visualization of aggregated results. However since the most important part of this view is to display the actual monitoring results and changes over time, the visualization was settled with only one type which is a line chart which emphasizes the change over time the most.

5.2.8 Consultation

Aside from monitoring activities, GeeBee also provides consultation activities and this is reflected in GeeBeeView as consultation or HPI records. The HPI records generated by GeeBee does not provide diverse information like monitoring records but only generates a string which contains the list of symptoms that the patient was experiencing. Thus, the display of consultation records only has the name of patient, date of consultation and the consultation string which generally only lists the symptoms experienced.

5.3 Image Processing Module

5.3.1 OpenCV

OpenCV or Open Source Computer Vision Library is an open source library for computer vision, image processing and machine learning that is free for academic or commercial use. It can be coded in Java, Python, C or C++ and supports devices such as Windows, MacOS, Linux, Android or iOS (*OpenCV*, 2017). [1]

It is being used for a very wide range of applications which include:

- Street view image stitching
- Automated inspection and surveillance
- Robot and driver-less car navigation and control
- Medical image analysis
- Video/image search and retrieval
- Movies - 3D structure from motion
- Interactive art installations

[1] OpenCV is the currently leading open source library that has more than 47 thousand user community and an estimated number of downloads exceeding 14 million.

5.3.2 Standalone

The initial plan of using image processing did not include using a reference object to calculate the height and weight of the child. Another problem encountered is about the extraction of the silhouette of the child. Different background colors add too much noise in trying to extract the subject and reference object. Most image processing projects encountered used python as the programming language. This is why the module was coded with python first, and later on to JAVA, which was needed for the development of android application.

5.3.3 Data Gathering

In the data gathering process for the test data for the image processing module, the plan was to solicit five (5) participants from each BMI category namely malnourished, underweight, normal, overweight, obese, and super obese. However from the thirty (30) participants from grade 1 to 2 students from the affiliated school were mostly underweight.

5.4 Cloud Computing Module

There were only two main problems witnessed by the proponents from the Cloud Computing standpoint. One is handling of the cloud droplet's credentials. During the first few weeks of development accessing the droplet was delayed due to forgotten passwords and login credentials with the main system and MySQL login from past users. The other problem encountered with the cloud module is that it is not accessible in strict networks with strict firewalls and proxies thus hindering the proponents sometimes on developing with anything to use with the cloud computing module inside of the school campuses.

Chapter 6

Results and Observations

The entire system was tested as per the requirements defined by the objectives of the research. The tests performed were based on the overall requirements and functionality of the system.

6.1 GeeBee

GeeBee is the application that gathers data from schools through its consultation and monitoring. However those are not the features developed by this research. The features developed by this research for GeeBee are the uploading or syncing or data and a minor modification of adding the ability to select the host school the current user session the user is going to gather data from.

6.1.1 School Selection

School selection should allow the user to add, delete and select a school to use for their current session.

Table 6.1: Test Results for School Selection

Test Case No.	Test Description	Test Steps	Expected Output	Actual Output
1	Add School from settings	From the main screen, open settings by pressing gear button on the upper right corner, tap plus (+) button and fill up details. Then tap "Add".	Addition of school is confirmed via toast message.	Toast message shows "School Added"
2	Remove School from List	From the main screen, open settings by pressing gear button on the upper right corner. Select a school to remove, tap minus (-) button.	Selected school will be removed from list with toast feedback.	Toast message shows "School Removed"
3	Select School from school list.	From the main screen, open settings by pressing gear button on the upper right corner then select a school to use, then press save button at the bottom.	Toast will confirm selection and selected school will be saved.	Toast shows "SCHOOL-NAME-HERE Selected"

6.1.2 Uploading / Sync

After performing the monitoring and consultation activities, it is vital to upload the data collected for viewing because GeeBee by itself does not have any functions for displaying the data collected.

Table 6.2: Test Results for Uploading or Syncing Data

Test Case No.	Test Description	Test Steps	Expected Output	Actual Output
4	Sync / Upload to remote database with Internet connection.	From the main screen, tap "Let's go" and then tap "Sync Data" near the bottom right.	Uploading data is confirmed via toast message.	Toast Says "Data Synced"
5	Sync / Upload to remote database without Internet connection.	From the main screen, tap "Let's go" and then tap "Sync Data" near the bottom right.	Uploading data fails.	Toast Says "No Internet Connection"

6.2 GeeBeeView

GeeBeeView is the mobile application responsible for displaying the collected data by GeeBee. Its functionalities can be divided into five parts namely authentication, dataset list, data visualization by group, consultation, and patient details.

GeeBeeView was tested using a Samsung Tablet Note 10.1 with the internet connection turned off except when downloading datasets. Since the scope of the research does not extend to the effectiveness of the visualizations, the tests included in this section only involves functionality tests.

6.2.1 Authentication

The function allows users to sign up and login to gain access to the patient information that the application will display. It also serves as a security defense so that all users must first have a username and password.

The current authentication method does not effectively protect non-authorized users from viewing the collected patient records since the it only requires the user to register a username and password allowing the user to immediately open the application.

Table 6.3: Test Results for Authentication

Test Case No.	Test Description	Test Steps	Expected Output	Actual Output
1	Sign Up	Fill up the username and password textbox, then press the “sign up” button.	The registration is confirmed via toast message.	Entered “qwerty” as username and “uiop” as password. Confirmed success by toast message.
2	Login	Fill up the username and password textbox, then press the “login” button.	The dataset list is displayed.	Entered “qwerty” as username and “uiop” as password. Dataset list is displayed.

6.2.2 Dataset List

The dataset list allows users to refresh the list and view or download a dataset. This is the next view after the successful login. As default, the application tries to download the latest dataset list from the cloud database however if there is no internet connection, the list will come from the local database. The dataset list will display the school name, date created, and an action button. If the dataset has not yet been downloaded, the text on the button will be “download” and otherwise “view.”

Upon opening the dataset list, the application tries to download the latest dataset list if internet connection is available and shows an error message if not.

The downloading of patient records related to the dataset selected is not efficient however it is effective. Whenever a dataset is downloaded, all the patients from the school affiliated is first downloaded, then the consultations before the monitoring records which are recorded on the date of the dataset.

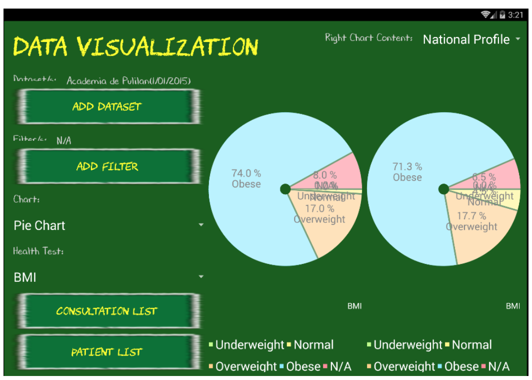
Table 6.4: Test Results for Dataset List

Test Case No.	Test Description	Test Steps	Expected Output	Actual Output
3	Refresh List	Click the "refresh" button.	The dataset list displayed will be updated to the latest one.	Dataset list was updated.
4	Download Dataset	Click the "download" button of the selected dataset.	The dataset will be downloaded and the action button text will change to "view."	Click the "download" button for the dataset "Knights and Angels Montessori School" on "05-05-2015." It downloads and after downloading the button text was changed to "view."
5	View Dataset	Click the "view" button of the selected dataset.	The data visualization activity is started and contents of the selected dataset is visualized.	Click the "view" button for the button for the dataset "Knights and Angels Montessori School" on "05-05-2011." The data visualization activity started.

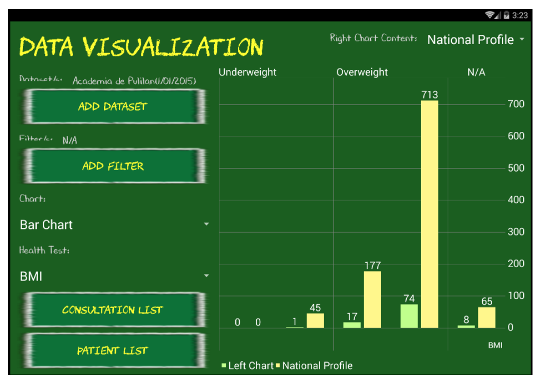
6.2.3 Data Visualization for Aggregated Results

The data visualization for aggregated results allows the user to have an interactive visualization of the aggregated health test results of patients whose monitoring records are part of the the dataset/s loaded to be visualized. The default chart is a pie chart displaying the distribution of the patients into different BMI categories.

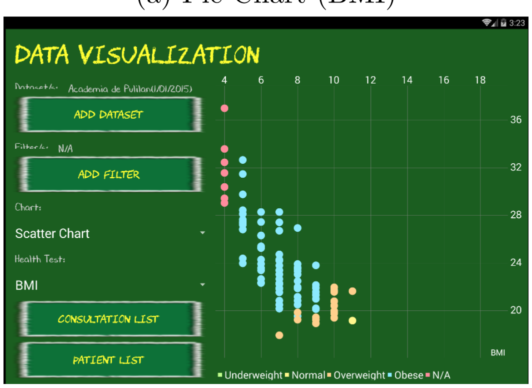
The visualization can only display the results of one monitoring test and one chart type at a time. When adding datasets, the added datasets are combined to the original dataset and treated as one source; therefore, it is impossible to compare two datasets. Even if many datasets are added, when viewing the patient list, only patients affiliated to the original dataset is displayed. When applying filters, only monitoring records which fulfill the condition of the filters added are counted and visualized.



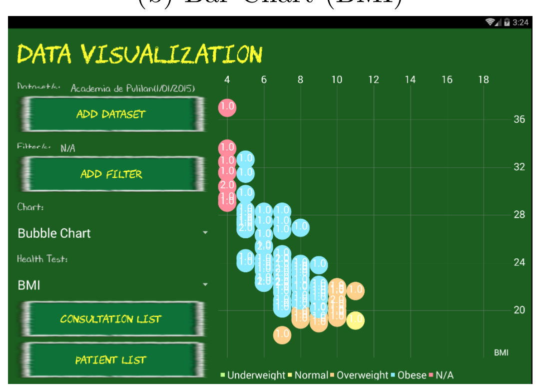
(a) Pie Chart (BMI)



(b) Bar Chart (BMI)



(c) Scatter Plot (BMI)



(d) Bubble Plot (BMI)

Figure 6.1: Data Visualization for Aggregated Results

Here are some sample screens of what visualization for aggregated data in Figure 6.1 using a GenyMotion tablet emulator with 320 DPI. These screens all depict the same dataset (input) and health test (BMI). For both the pie chart and the bar chart, the chart on the left displays the contents of the datasets within the list on the left part of the screen while the chart on the right displays the contents of the spinner on the upper right corner of the screen. For this example, the contents of the right chart is from the "Academia De Pulilan" on "1/01/2015" dataset while the contents of the right chart is the "National Profile" on the year of the dataset which is "2015" meaning it is the compilation of all results currently available at the local database recorded on the year 2015. In Figure 6.1a, the pie chart emphasizes the relative proportion of the number of patients belonging in each BMI category. In Figure 6.1b, the bar chart emphasizes the actual quantitative difference between the number of patients belonging each BMI category. Though in pie and bubble chart it is possible to compare the contents of two datasets namely the contents of the dataset list and a larger set (National Profile), in scatter and bubble plots only the contents of the dataset list is plotted. In Figure 6.1c, the scatter plot depicts the actual BMI of each patient with their respective ages using the color as the indicator for the category they belong in. In Figure 6.1d, the bubble plot depicts a very similar visualization as the scatter plot however, the number of patients in each plotted dot (BMI at age) is indicated to know if there is more than one patient in the plotted dot.

Table 6.5: Test Results for Data Visualization for Group of Patients

Test Case No.	Test Description	Test Steps	Expected Output	Actual Output
6	Add Dataset	Click the “Add Dataset” button. Select a dataset from the dropdown list that will appear in a dialog. Click the “Add” button in the dialog.	The dataset selected will be added to the dataset list on the upper left corner and the visualization will be refreshed to accommodate the additional data.	Added the dataset for “Academia de Pulian” on “01-01-2011.” The dataset was added to the dataset list and the chart adjusted.

7	Remove Dataset	Click on the "X" next to the dataset to be removed.	Both the dataset list and visualization should reflect the removal of the dataset.	Removed the dataset of "Academia de Pulian" on "01-01-2011." The dataset was removed from the dataset list and the chart adjusted.
8	Add Filter	Click the "Add Filter" button to open the filter dialog. To add age filter, select an equator from the dropdown selection, then fill the edit text next to it. To add gender filter, select a gender from the dropdown. Click the "Add" button on the filter dialog.	The filter list below the dataset list should show the filter added and the visualization will refresh to accommodate the filter.	Added filters, "age ¡ 6" and "gender = Male." The filters were added to the filter list and the chart adjusted.
9	Remove Filter	Click on the "X" next to the filter to be removed.	The filter list and the visualization should reflect the removal of the filter.	Removed filter "gender = Male." The filter was removed from filter list and the chart adjusted.

10	Change Chart Type	Select a chart type from the dropdown next to the “Chart Type:” label.	The visualization should change to the chart selected retaining the health test.	Selected the chart type “Bar Chart.” The pie chart became a bar chart.
11	Change Displayed Data	Select a health test from the dropdown next to the “Displayed Data:” label.	The visualization should change to the health test selected retaining the chart type.	Selected the test “Hearing Right.” The chart reflected the change.
12	Change Comparison Set	Select a comparison set to be compared with the set listed in the dataset list.	The visualized comparison set should change according to the selected larger set.	The default comparison set is ”National Profile.” Select the ”Province” from the dropdown menu from the upper right corner of the screen. The visualization reflected the change.
13	View Consultation List	Click the “View Consultation List” button.	The consultation list should be displayed.	Consultation list consisting of “Blaver, Ermanno” on “12-04-2017” and “Claffey, Tadd” on “10-13-2017” was displayed. Both consultation records belong to the selected school.

14	View Patient List	Click the "View Patient List" button.	All the patients whose data is visualized should be listed.	Only the patients from the initial dataset is listed.

6.2.4 Consultation

The consultation list allows the user to view the list of consultation records related to the dataset selected. The consultation list displays the patient name, the consultation date and a view button.

The consultation list is not very informative since it does not specify which cases (or probable illness) are commonly encountered; however this problem lies in GeeBee itself since the generated HPI or consultation record does not specify it. The display itself can be more informative if the consultation record is divided in more parts wherein certain symptoms or information can be emphasized. Since when downloading datasets, all consultation records from the affiliated school is downloaded, the consultation records available for viewing does not need conform to the dataset date but must be uploaded at the time when downloading the dataset.

6.2.5 Transcript of Health

The transcript of health function allows the user to view various records of the student. The information shown can be divided into three parts namely the patient details, record details, and visualization. The default visualization is a line chart depicting the height of the patient over time.

Similar to the data visualization of aggregated results, the transcript of health can only visualize one monitoring test at a time. The visualizations for height and BMI has guidelines for standard growth of children ages 5 to 19 years old while the guidelines for weight is only for children ages 5 to 10 years old which are from the growth reference charts released by WHO. To complement that, an additional guideline is shown. This guideline is based on the available data from the database and is the standard set by the patients from the Philippines.

Table 6.6: Test Results for Consultation

Test Case No.	Test Description	Test Steps	Expected Output	Actual Output
15	View Consultation	Click the "view" button of the selected consultation record.	The name and consultation details should be displayed.	Selected the consultation record of "Blaver, Ermanno" on "12-04-2017." The name and consultation details were displayed.
16	View Other Consultation of Same Patient	On the upper right of consultation activity, select a consultation date.	The consultation details on the date selected should be displayed.	Selected the date "12-01-2016." The consultation details were replaced with the consultation recorded on that date.

Table 6.7: Test Results for Transcript of Health

Test Case No.	Test Description	Test Steps	Expected Output	Actual Output
17	View Patient	Click the "view" button of the selected patient.	Patient information and other details should be displayed.	Clicked the "view" button of "Bethel, Siuox." The patient information was displayed.
18	Change Displayed Data	Select a health test from the dropdown next to the "Displayed Data:" label.	The visualization should change to the health test selected.	Selected the test for "Weight." The chart reflected the change.

19	Swap Patient Record Displayed	Select a record date from the dropdown next to the "Record Date:" label.	The record details displayed should be updated and correspond to the record details collected on the date selected.	Selected the record date "01-01-2011." The record displayed reflected the change.
20	View Consultation List	Click the "View Consultation" button.	The latest consultation details of the patient should be displayed.	The consultation on "12-04-2017" of the patient was displayed. It was the latest one.
21	View Immunization	Click the "View Immunization" button.	The latest immunization record of the patient should be displayed.	The immunization record on "01-01-2011" was displayed. It was the earliest one.
22	Swap Immunization Record Displayed	Select a record date from the dropdown on the upper right corner of the screen.	The immunization record on collected on that date should be displayed.	Selected the record date "01-01-2015." The immunization record displayed reflected the change.

6.3 GeeBeeCapture

The GeeBee capture module allows the user to be able to take the picture of the subject and determine the height and weight of the subject.

Table 6.8: Test Results for GeeBeeCapture

Test Case No.	Test Description	Test Steps	Expected Output	Actual Output
1	Take Picture (Front View)	Click the “Take Picture” button on the left part of the screen. Take a picture with the camera. Select ”Ok” after taking the picture.	The picture taken should be displayed in the Front View layout or left part of the screen.	The picture taken was displayed in the Front View layout or left part of the screen.
2	Take Picture (Side View)	Click the “Take Picture” button on the right part of the screen. Take a picture with the camera. Select ”Ok” after taking the picture.	The picture taken should be displayed in the Side View layout or right part of the screen.	The picture taken was displayed in the Side View layout or right part of the screen.
3	Load Picture (Front View)	Click the “Load Picture” button on the left part of the screen. Choose a picture from the Gallery.	The picture selected should be displayed in the Front View layout or left part of the screen.	The picture displayed on the Front View layout or left part of the screen.
4	Load Picture (Side View)	Click the “Load Picture” button on the right part of the screen. Choose a picture from the Gallery.	The picture selected should be displayed in the Side View layout or right part of the screen.	The picture displayed on the Side View layout or right part of the screen.

5	Compute and Save	Click the "Compute and Save" button.	The height and weight of the child should be displayed below the "Compute and Save" button. The silhouette should be saved	The height and weight is displayed below the "Compute and Save" button.
6	Finish. Back to GeeBee Application	Click the "Finish. Back to GeeBee" button.	GeeBeeCapture should close and return the calculated height and weight to the GeeBee application.	GeeBeeCapture closed and returned to the GeeBee application.
7	Cancel	Click the "Cancel" button.	GeeBeeCapture should close and return to the input of height in the GeeBee application.	GeeBeeCapture closes and returns to the GeeBee application.

The group based the algorithm mentioned on Chapter 3, measuring size of objects with OpenCV and modified it accordingly to achieve the desired results as discussed in chapter 4. The following common problems was encountered during the development of the algorithm and testing:

- same color of subject's garments to the background which resulted to the bounding box not able to take up the whole subject's body for measurement
- too much background noise in the image that resulted to incorrect identification of subject and reference object
- full body shots make the subject appear to be "floating" which resulted to the computed height to be much higher than it actually is.

The group was able to address the issues based on set assumptions and thus the following modifications:

- the subject and reference object is assumed to be taking up relatively the center of the image, thus the image was cropped to the center.
- The tallest bounding box is assumed to be the subject and thus taking it's top left point pixel would be the subject's top of the head coordinate.
- the left most bounding box is assumed to be the reference object and thus its height in pixels would be extracted to get the pixels per metric variable.
- the most bottom bounding box is assumed to be where the wall and the floor meet and thus its top left coordinate would be the subject's bottom of the foot coordinate.

Four weights (Weight A, B, C and D) were calculated using the computed front width, computed side width and height. Weight A uses the first equation (Equation 4.3) to get the predicted weight using true height. Weight B uses the first equation to get the predicted weight but using the computed height. Weight C uses the second equation (Equation 4.4) to get the predicted weight using true height. Weight D uses the second equation to get the predicted weight but using the computed height. The following computations can be seen in Table 6.11. There are four errors computed (Error A, B, C and D). These four errors are their difference between the true weight and predicted weights A, B, C and D.

Calculating the results in Tables 6.10 and 6.11 on page 97 and page 98 respectively, the computed data are as follows:

Table 6.9: Summarized Results of Height and Weight

	RMSE	Total Accuracy	Standard Deviation
Height	1.48	98.88%	1.46
Weight A	2.37	92.26%	2.41
Weight B	2.43	91.20%	2.46
Weight C	2.41	92.01%	2.44
Weight D	2.35	92.05%	2.39

The corresponding height and weight results would mean that the calculations are fairly accurate having the RMSE relatively close to 0. As seen in Table 6.9, Weight A has an RMSE of 2.37, Weight B has an RMSE of 2.43, Weight C has an RMSE of 2.41 and Weight D has an RMSE of 2.35. Weight A and C are both calculated using actual heights and between them Weight A which uses

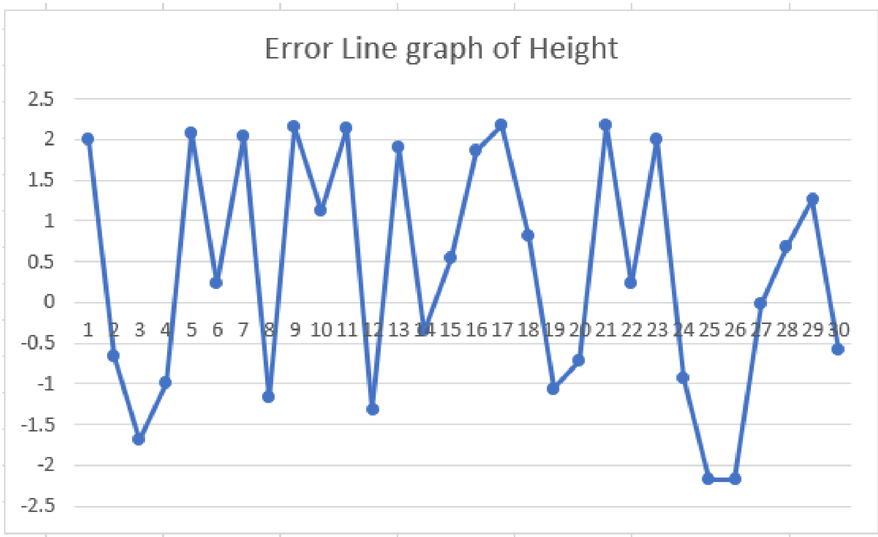


Figure 6.2: Line Graph for Height

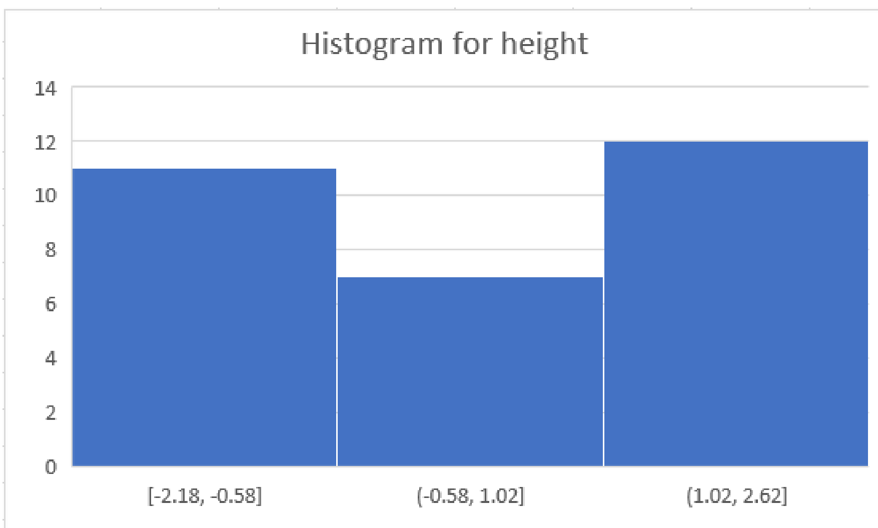


Figure 6.3: Histogram for Height

Equation 4.3 is better than Weight C which uses Equation 4.4 because it has a lower RMSE. Weight B and Weight D are both calculated using computed heights however opposite from the previous case, Weight D which uses Equation 4.4 has a lower RMSE than Weight B which uses Equation 4.3. In conclusion in terms of RMSE, when using actual height, equation 4.3 is better however when using computed height, equation 4.4 is better. Taking into consideration all the four

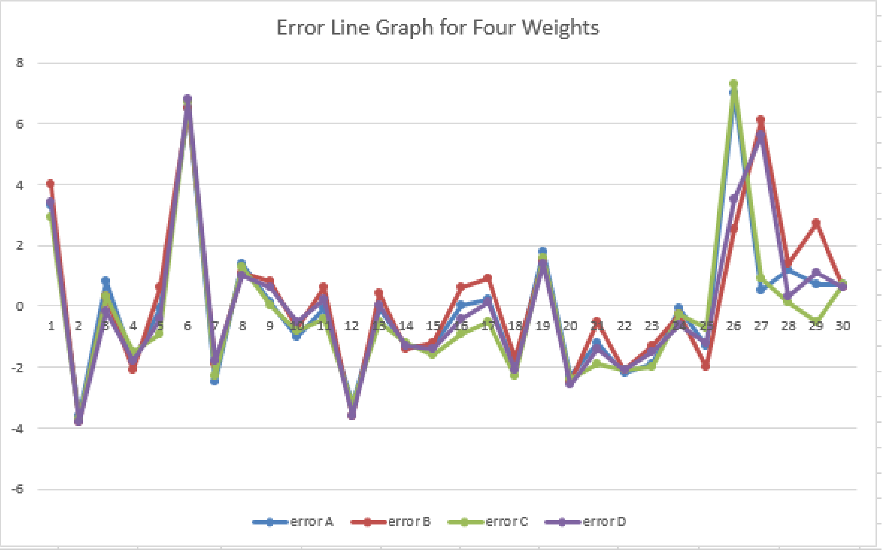


Figure 6.4: Line Graph for Four Weights

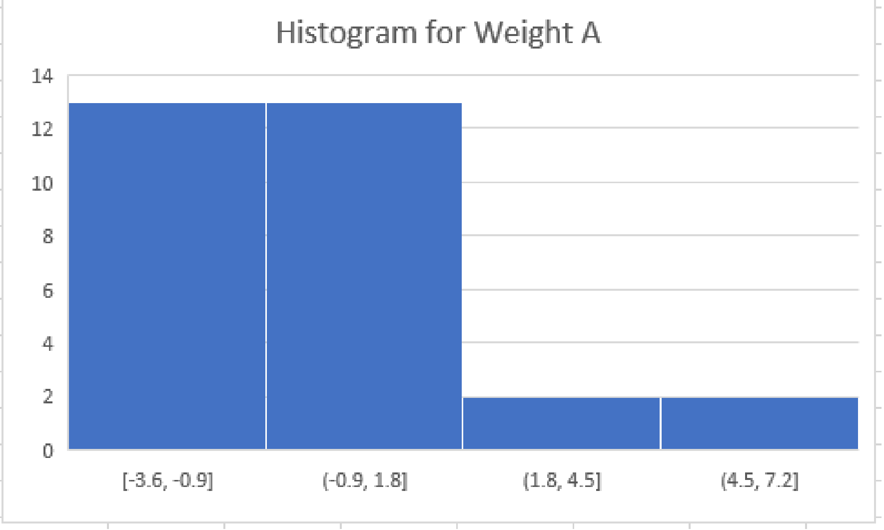


Figure 6.5: Histogram for Weight A

weights, Weight D, calculated using Equation 4.4 with computed height, gives the best calculation since it has the lowest RMSE. Therefore in the image processing module, Equation 4.4 is used in the software to calculate the weight of the child because disregarding whether it uses actual height or computed height, Weight D which uses Equation 4.4 still has the lowest RMSE.

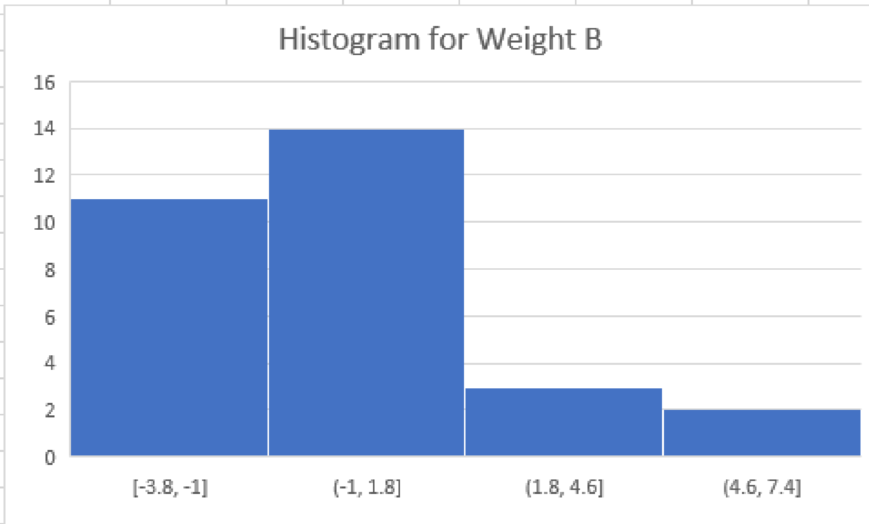


Figure 6.6: Histogram for Weight B

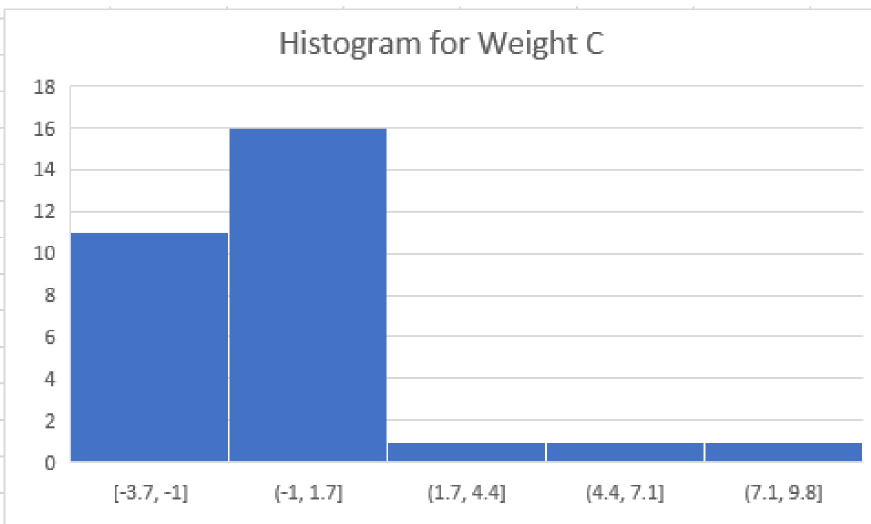


Figure 6.7: Histogram for Weight C

The individual accuracy for height is calculated by dividing the actual height over the computed height or vice versa and then averaging it to get the total accuracy. To get the individual accuracy for weights, divide actual weight over the computed weight or vice versa then get the average for the total accuracy. Accuracy represents how close the calculations to the actual height and weight. Weight A has an accuracy of 92.26%, Weight B has an accuracy of 92.26%, Weight

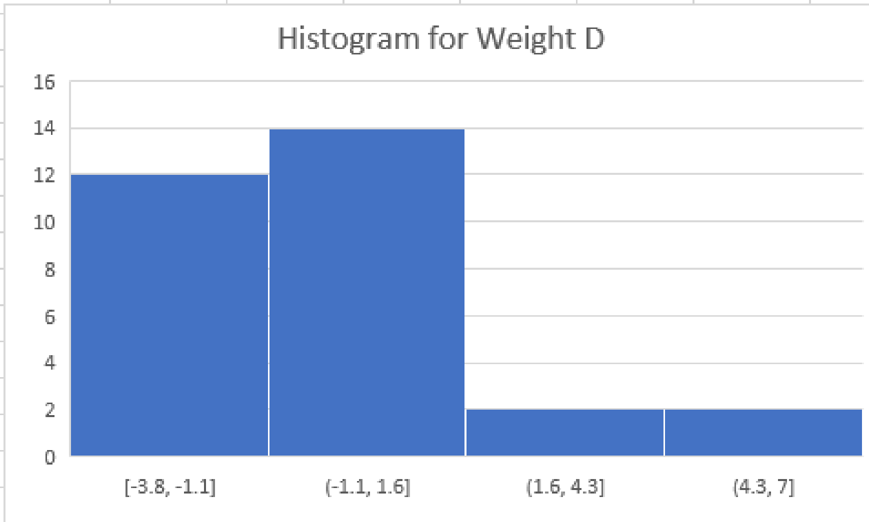


Figure 6.8: Histogram for Weight D

C has an accuracy of 92.01% and Weight D has an accuracy of 92.05%. Weight A is better than Weight C because it has a higher accuracy. Weight D which uses Equation 4.4 is better than Weight B because it has a higher accuracy. Equation 4.3 is better when using actual height but Equation 4.4 is better when using computed height. Amongst the four weights, Weight A has the highest accuracy. However, the image processing module uses Equation 4.4 because it uses computed height as input. Therefore, the second equation (Equation 4.4) is more appropriate because between Weight B and Weight D which both use computed height as input, Weight D has a better accuracy.

The Standard Deviation for Weight A is 2.41, Weight B is 2.46, Weight C is 2.44 and Weight D is 2.39. Between Weight A and Weight C, Weight A is better because it has a smaller standard deviation than Weight C. Between Weight B and Weight D, Weight D is better because it has a smaller standard deviation than Weight B. In terms of standard deviation, Equation 4.3 is better when using actual height while Equation 4.4 is better when using calculated height. Amongst the four weights, Weight A has the smallest standard deviation.

All of the computed samples are within the range of +-2.18 cm and -3.8 to 6.8 kilos for weight. In conclusion, whether in terms of RMSE, total accuracy and standard deviation, Equation 4.4 is better when using calculated height therefore it is the equation used for calculating weight in the image processing module.

Performance time wise, the overall algorithm does NOT have any nested for loops inside it, which would lead to relatively linear time for it to process. One can expect to get the results almost immediately after capturing the front and side images of the subject.

Table 6.10: Image Processing Results for Height (in cm) sorted

True Height	Computed Height	Error
119	121.18	-2.18
131.5	133.67	-2.17
111	112.7	-1.7
109.5	110.82	-1.32
114	115.17	-1.17
113	114.06	-1.06
111	112	-1
109	109.94	-0.94
111.5	112.22	-0.72
111.5	112.16	-0.66
131.5	132.08	-0.58
109	109.35	-0.35
113.5	113.51	-0.01
124	123.77	0.23
112.5	112.27	0.23
116	115.46	0.54
111	110.32	0.68
106.5	105.68	0.82
111	109.87	1.13
104	102.73	1.27
105	103.13	1.87
107	105.11	1.89
117	115	2
122	120	2
110.5	108.46	2.04
110	107.92	2.08
108.5	106.36	2.14
119	116.85	2.15
107	104.83	2.17
100	97.82	2.18

As seen in Figure 6.9, the program was able to calculate the height to near

Table 6.11: Image Processing Results for Weight (in kilos) sorted

Computed Front Width	Computed Side Width	True Height	Computed Height	True Weight	Weight A [a]	Weight B[b]	Weight C[c]	Weight D[d]	Error A	Error B	Error C	Error D
37.7	25.7	111.5	112.6	15.7	19.3	19.5	19.4	19.5	-3.6	-3.8	-3.7	-3.8
36.6	33.2	109.5	110.82	16.5	19.7	20.1	19.7	20.1	-3.2	-3.6	-3.2	-3.6
38.1	27.8	111.5	112.22	17	19.3	19.5	19.4	19.6	-2.3	-2.5	-2.4	-2.6
37.4	23.4	106.5	105.68	15.7	17.7	17.4	18	17.8	-2	-1.7	-2.3	-2.1
37.2	27.9	112.5	112.27	17.8	20	19.9	19.9	19.9	-2.2	-2.1	-2.1	-2.1
35.4	24	111	112	18.3	20.1	20.4	19.8	20.1	-1.8	-2.1	-1.5	-1.8
35.4	29.6	110.5	108.46	17.8	20.3	19.7	20.1	19.6	-2.5	-1.9	-2.3	-1.8
41.2	20.8	122	120	18.7	20.6	20	20.7	20.2	-1.9	-1.3	-2	-1.5
38.3	24.8	100	97.82	14.2	15.4	14.7	16.1	15.6	-1.2	-0.5	-1.9	-1.4
40	23.2	116	115.46	18.1	19.4	19.3	19.7	19.5	-1.3	-1.2	-1.6	-1.4
35.6	26.2	109	109.35	18.2	19.5	19.6	19.4	19.5	-1.3	-1.4	-1.2	-1.3
35.4	26.1	119	121.18	21.4	22.7	23.4	22.1	22.6	-1.3	-2	-0.7	-1.2
38.2	24	109	109.94	18.1	18.2	18.4	18.4	18.7	-0.1	-0.3	-0.3	-0.6
35.5	25.5	111	109.87	19.1	20.1	19.8	19.9	19.6	-1	-0.7	-0.8	-0.5
41.2	22.8	105	103.13	15.5	15.5	14.9	16.4	15.9	0	0.6	-0.9	-0.4
42.3	30.3	110	107.92	17	17.1	16.4	17.9	17.4	-0.1	0.6	-0.9	-0.4
40.6	26.6	111	112.7	18.7	17.9	18.4	18.4	18.9	0.8	0.3	0.3	-0.2
38.1	26.3	107	105.11	17.6	17.7	17.2	18.1	17.6	-0.1	0.4	-0.5	0
40.3	22.8	107	104.83	16.7	16.5	15.8	17.2	16.6	0.2	0.9	-0.5	0.1
38	23.9	108.5	106.36	18	18.1	17.4	18.4	17.8	-0.1	0.6	-0.4	0.2
43.8	24.3	111	110.32	17.4	16.2	16	17.3	17.1	1.2	1.4	0.1	0.3
40.3	26.1	119	116.85	20.6	20.5	19.8	20.6	20	0.1	0.8	0	0.6
43.7	36.9	131.5	132.08	24.3	23.6	23.7	23.6	23.7	0.7	0.6	0.7	0.6
38.6	26.1	114	115.17	21.1	19.7	20	19.8	20.1	1.4	1.1	1.3	1
44.5	29.3	109	102.73	16.4	15.7	13.7	16.9	15.3	0.7	2.7	-0.5	1.1
38.6	24	113	114.06	21	19.2	19.5	19.4	19.6	1.8	1.5	1.6	1.4
41.8	29.1	117	115	22.7	19.4	18.7	19.8	19.3	3.3	4	2.9	3.4
37.7	28.3	119	133.67	28.8	21.8	26.3	21.5	25.3	7	2.5	7.3	3.5
41.2	28.3	131.5	113.51	24.6	24.1	18.5	23.7	19	0.5	6.1	0.9	5.6
39.5	29.9	124	123.77	29.1	22.6	22.6	22.4	22.3	6.5	6.5	6.7	6.8

[a] Predicted weight from Equation 4.3 using actual height
[b] Predicted weight from Equation 4.3 using computed height
[c] Predicted weight from Equation 4.4 using actual height
[d] Predicted weight from Equation 4.4 using computed height

Figure 6.9: Best case figure for height (-0.01 error)

perfection was that it was able to get the bottom point correctly. going back to the figure, the front view capture of the subject has a near perfect angle evidence of the bottom line to not be slanted at all.

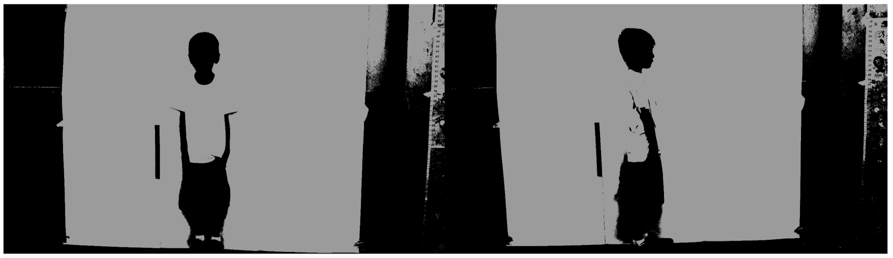


Figure 6.10: Worst case figure for height (+2.8 error)

Compared to the worst case scenario which in this case is Figure 6.10, both the front and side view of the subject is slanted as evidence of the bottom line of it. For the front view, its slanted to the right, while the side is to the left. This then results to the said error.

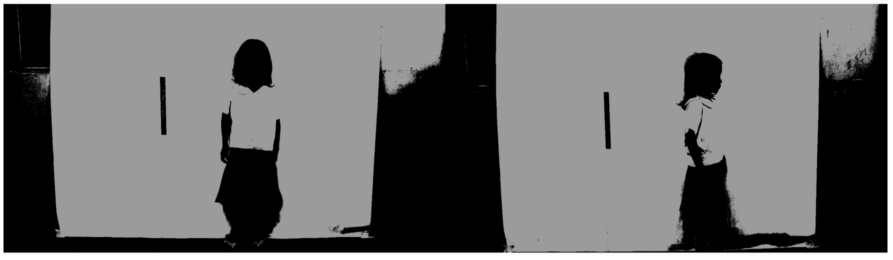


Figure 6.11: Worst case figure for weight (6.8 error)

As seen in Figure 6.11, the clothes of the child may have added some weight because the skirt makes her front width and side width wider. As compared to the best case seen in Figure 6.12 where there is no obstruction from clothes.

Figure 6.12: best case figure for weight (0 error)

Chapter 7

Conclusion and Recommendations

7.1 Conclusion

The improved public health monitoring system on the research is now composed of three mobile applications. GeeBee for data collection. GeeBeeCapture for measuring height and weight via image processing. GeeBeeView for displaying the collected data and applying data visualization.

GeeBeeCapture is an image processing mobile application that was designed to calculate the height and weight of children using their images as input. The original plan was to have it as an additional module to GeeBee however developing the image processing module while attached to GeeBee was difficult due to the processing power needed by the ECA. Therefore, it was developed to function independently. Despite that they are separate applications, GeeBeeCapture can be accessed from GeeBee as an alternative way to measure height and weight without disrupting the process flow. Going through the monitoring activities in GeeBee, when the height and weight is needed for input, GeeBeeCapture can be used then the calculated height and weight are returned to GeeBee. The images of the children are not censored when taken however they are immediately disposed of for confidentiality and to prevent misuse.

The image processing module developed is not capable of computing the height and weight of children accurately without the use of external tools which was the initial aim for this alternative however it not fulfilled in this research due to its setup requirement which is a white background with a ruler as reference object. As discussed in chapter 4, the algorithm developed assumes that on the right of the subject, there will be a ruler that serves as the reference object. From a sample of 30 students taken from Inchican Elementary school, the margin of error for the height is +-2.18 cm or +- 0.86 inches. The reason for the error is the angle of the image taken as discussed in the best and worst cases in chapter 6. Regardless, the group was able to achieve its goal and kept the margin of error to a reasonable measurement. For the calculated weight, the summary of calculated weights is shown in Table 6.9. Weight D had the lowest RMSE among the four weights. Weight A had the highest accuracy, however Weight D was use as the basis because its input has to be a computed height and Equation 4.4 can give a better accuracy than Equation 4.3 which uses an actual height. In terms of Standard Deviation, Weight D has the lowest among the four. Since Weight D uses the second equation or Equation 4.4, the image processing module uses this equation in calculating weight not only because it was modeled using computed height but also due to having the highest accuracy when using calculated height, lowest RMSE and standard deviation.

GeeBeeView is a data visualization mobile application that was designed to display the collected information of GeeBee. It was developed as a completely separate application from GeeBee so that it can function properly even without GeeBee. However this can also be a detriment in the sense that the data it can display must first be uploaded by GeeBee to the cloud database and downloaded to its local database.

The data visualization module of GeeBeeView is capable of presenting the individual health results of a single child and the aggregated results of a group of children. The visualization for a single child is a line graph emphasizing the changes of the child's health results over time. The visualization of the aggregated results of a group of children is interactive in the sense that it allows addition and removal of datasets and filters and changing of chart types. The visualization of aggregated results can be used to compare two sets particularly the contents of the dataset list and a larger set however, this is only applied for the pie and bar charts.

The cloud computing functionalities added to GeeBee and GeeBeeView was designed to cater to both applications in unison. Both applications with their local database counterparts are all integrated in their respective applications. Both communication with the remote server and their local databases are not necessarily two-way. In the case of GeeBee, the communication with the local database in the remote database are mostly exclusively upload to the remote database, while GeeBeeView is almost exclusively download only. Connections of the local database to a remote and enabling then to sync is necessary for storing the data in a centralized database to be able to safe keep, organize, and to make data accessible.

7.2 Recommendations

With the current stance of the database related functionalities, of both the GeeBee and GeeBeeView applications, the database algorithms used and presented only used minimal optimizations for uploading and downloading data. In the sense of uploading data, it includes uploading bytecodes and binary data from images and audio. Future researchers should opt to try compression of data as with the combination of both bulks of audio binary data, image binary data and text, it could prove to make uploading faster and easier also limiting data storage consumptions.

GeebeeCapture can be improved if it can accurately calculate the height and weight of its subject without the need for a reference object. The current application requires a ruler and a white background to calculate the height and weight. Furthermore, GeeBeeCapture can be improved if the clothes of the subject do not affect the calculated weight. There are times wherein the clothes extend and are included in the measurements of the width, which may affect the calculated weight.

The main problem for the algorithm discussed in finding the height is the angle of the picture. An image taken that is slightly slanted to the left would result to the calculated height to be smaller than the actual one, while slightly slanted to the right would result to bigger. Hence as seen in figure 7.1, a recommendation for this is during the image capture there is an added 'line guide' to tell the user if he the subject being taken is slanted or not.

Another problem is the presence of image noise that makes finding the subject and reference object difficult. This could be made easier if during image capture, there is a line that separates the subject and reference object in the middle, then simply an addition to the algorithm would be that the first big contour/bounding box at the right of the line is the subject and the first big contour/bounding box

Figure 7.1: Green line at the bottom is the guide during image capture to help the user in taking a good angled shot, in this figure the image is slightly slanted.

at the left would be the reference object.

Regarding the detriment of GeeBeeView needing the displayed data to be uploaded and downloaded, future researchers can combine the two applications in the sense that they can share a single database or copy the data collected to remove the need for internet connection and the risks accompanied by uploading medical information. However, this can also pose the problem of requiring GeeBee, with the heavy processing needed for the ECA, for viewing the data collected which is not needed. Aside from that, the option of only keeping the medical records to the local database will diminish the advantage of having an off-site specialized doctor for diagnosis for specific cases though the advantage of having non-medical personnel perform the collection of data and the on-site doctor performing the diagnosis still remains.

The visualization of GeeBeeView can still be improved by comparing the aggregated results of different datasets. The current implementation only combines the original dataset and the added dataset/s to be treated as one set in the vi-

Figure 7.2: green line at the center is the guide during image capture, to help in image detection

sualization. An added functionality can be switching to combining the added dataset/s and treating them as separate sets allowing the user to compare two or more datasets. Another improvement can be adding other chart types or combining them to fully utilize the capabilities of the MPAndroidChart API. Another recommendation is that before and after adding additional visualizations, it would be best to conduct a user survey or interview on which visualizations do the medical personnel expect and which are useful for giving insights.

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Appendix A

Research Ethics Documents

De La Salle University

DE LA SALLE UNIVERSITY
General Research Ethics Checklist

This checklist is to ensure that the research conducted by the faculty members and students of De La Salle University is carried out according to the guiding principles outlined in the Code of Research Ethics of the University. The investigator is advised to refer to the De La Salle University Code of Research Ethics and Guide to Responsible Conduct of Research before completing this checklist. Statements pertinent to ethical issues in research should be addressed below. The checklist will help the researchers and evaluators determine whether procedures should be undertaken during the course of the research to maintain ethical standards. The University's Guide to the Responsible Conduct of Research provides details on these appropriate procedures.

Details of the Research	
Students	Cardano, Marc Daniel T. Dy, Stephanie Joy D. Lim, Reanna Chelsey N. Pagtalunan, Dominic M.
Thesis Adviser	Azcarraga, Judith J.
Department	Software Technology Department, College of Computer Studies
Title of the Research	Image Processing and Data Visualization for a Cloud-based Public Health Monitoring System of Filipino Children
Term(s) and Academic year in which research is to be conducted	Term 1, A.Y. 2016-2017 to Term 1, A.Y. 2017-2018

This checklist must be completed AFTER the **De La Salle University Code of Ethics** ***has been read and BEFORE gathering data.***

Questions	**Yes**	**No**
1. Does your research involve human participants (this includes new data gathered or using pre-existing data)? If your answer is **yes**, please answer **Checklist A (Human Participants).**	✓	
2. Does your research involve animals (non-human subjects)? If your answer is **yes**, please answer **Checklist B (Animal Subjects).**		✓
3. Does your research involve Wildlife? If your answer is **yes**, please answer **Checklist C (Wildlife)**.		✓
4. Does your research involve microorganisms that are infectious, disease causing or harmful to health? If your answer is **yes**, please answer **Checklist D (Infectious Agents).**		✓
5. Does your research involve toxic/chemicals/ substances/materials? If your answer is **yes**, please answer **Checklist E (Toxic Agents).**		✓

Research with Ethical Issues to address:

If you have a YES answer to any of the above categories, you will be required to complete a detailed checklist for that particular category. A YES answer does not mean the disapproval of your research proposal. By providing you with a more detailed checklist, we ensure that the ethical concerns are identified so these can be addressed in adherence to the University Code of Ethics.

Declaration of Conflict of Interest

[X] I do not have a conflict of interest in any form (personal, financial, proprietary, or professional) with the sponsor/grant-giving organization, the study, the co-investigators/personnel, or the site.

[ ] I have a personal/family or professional interest in the results of the study (family members who are co-proponents or personnel in the study, membership in relevant professional associations/organizations).

Please describe the personal/family or professional interest: ______________________

____

[ ] I have propriety interest vested in this proposal (with the intent to apply for a patent, trademark, copyright, or license)

Please describe propriety interest: ______________________________

____

[ ] I have significant financial interest vested in this proposal (remuneration that exceeds P250,000.00 each year or equity interest in the form of stock, stock options or other ownership interests).

Please describe financial interest: ______________________________

____

Declaration

We certify that we have read and understand the De La Salle University Code for the Responsible Conduct of Research and will abide by the ethical principles in this document. We will submit a final report of the proposed study to the DLSU-Research Ethics Office. We will not commence with data collection until we receive an ethics review approval from the College Research Ethics Committee.

Marc Daniel Cardano T.

Stephanie Joy D. Dy

Reanna Chelsey N. Lim

Dominic M. Pagtalunan

Endorsement from thesis adviser to the thesis panel for proposal defense...

Judith J. Azcarraga

Date

Endorsement from thesis adviser to the thesis panel for final defense...

This is to certify that the research was conducted in a manner that adheres to ethical research standards. I am thus endorsing the group for final defense.

Judith J. Azcarraga

Date

De La Salle University	**Research Ethics Review Committee** Research Ethics Office, 3F Henry Sy Sr. Hall De La Salle University Manila 2401 Taft Avenue, Manila 1004, Philippines REO@dlsu.edu.ph (632) 524-4611 loc. 513	SOP No.: 2 Form No.: 2.03 Version No.: 1 Effectivity Date: July 2016

DE LA SALLE UNIVERSITY

Checklist A

Research Ethics Checklist for Investigations involving Human Participants

This checklist must be completed AFTER the De La Salle University Code of Research Ethics and Guide to Responsible Conduct of Research has been read and BEFORE gathering data. The University Code of Research Ethics is available at http://www.dlsu.edu.ph/offices/urco/forms/URCO-Code-of-Research-Ethics_August2011.pdf

NOTE: This checklist is completed after the research proponent fills out the General Checklist Form.

Only answer this Checklist if you answered YES on question 1 of the General Checklist.

Researcher Details				
Students	Cardano, Marc Daniel T. Dy, Stephanie Joy D. Lim, Reanna Chelsey N. Pagtalunan, Dominic M.			
Thesis Adviser	Azcarraga, Judith J.			
Department	Software Technology Department			
Title of the Research	Image Processing and Data Visualization for a Cloud-based Public Health Monitoring System of Filipino Children			
Term(s) and Academic year in which research is to be conducted	from:	Term 1, A.Y. 2016-2017	to:	Term 1, A.Y. 2017-2018

Provide a brief description of the data collection procedure to be undertaken in the research:

The research includes the collection of new data. The data collected will be used for the testing of the image processing tool which will require the height and weight by using specified measuring tools and a full body mug shot with the reference object of at least 30 human participants.

The following should be attached to the checklist:

- A copy of the informed consent form to be used in the study.
- A copy of the instrument/tool that will be administered to the participants.
- If applicable, a copy of the letter seeking permission to collect data from participants who are under the supervision of an agency, institution, department, or office.
- If applicable, a copy of the parental consent form for participants below 18 years old.

The following items refer to important ethical considerations in the conduct of research with human participants. Provide a check for the appropriate answer to each question.

Source of data *Please check all that apply:*			
	1. New data will be collected from human participants If you checked this item, how will the new data be gathered? Please check all that apply. **After answering this question, please proceed to page 3**		
			Experimental Procedures/Intervention/ Treatments
			Focus Group
			Personal Interviews
			Self-administered Questionnaire
			Researcher-administered Questionnaire
			Internet survey
			Observation
			Telephone survey
		✓	**Others, please specify:** **Height and weight of participant, and image data**
	2. Pre-existing data from human participants, i.e., from a dataset **If you checked this item, please proceed to page 7**		

If both options are checked (both new data and pre-existing data), **answer all of the questions in this document.**

ONLY ANSWER IF NEW DATA WILL BE COLLECTED (item 1 above)

Sampling Details	
Number of Participants/Subjects	**30 participants**
Location where the participants will be recruited/ where subjects will be obtained?	**Inchican Elementary School**
How long will the data collection take place?	**Two weeks or more, until the quota is met**

Who will perform the data collection?	**The proponents**
Location(s) where data collection will take place	**Inchican Elementary School**
What procedures will be employed to ensure voluntary consent from participants?	**Written consent form with participant signature**
Data Retention	
How long will data with participant identifiers be kept after the publication of the first paper from the project?	**2 Years**
How long will anonymized data be kept after the publication of the first paper from the project?	**4 Years**
Procedure for Informed Consent	
How will informed consent be recorded? (check all that applies) Reminder: please attach informed consent that will be used in the study	[X] Written Consent [ ] Audio-recorded Consent [ ] Online/Email recorded Consent [ ] Others, please specify:

If you will not obtain a recorded informed consent, answer the questions that follow:

Why does the waiver of informed consent not pose a threat to the welfare and rights of the participants? **N/A**

Why is recording an informed consent not practical for the proposed study? **N/A**

	Yes	No	Not Applicable
1. Will the research involve students who will be receiving course credits for their participation? **If YES, please attach a copy of the consent form and a summary of the debriefing process that will help**		✓	

participants understand how their participation in the research has provided a relevant learning experience to the crediting course.			
2. Does the study involve participants below 18 years old or those who are unable to give their informed consent? **If YES, please attach a copy of the parental consent form.**	✓		
3. Is there a possibility that the research can induce physical and/or psychological harm to the participants? Will they experience pain or some discomfort as a result from their participation in the research? **If YES, please attach an acceptable argument that outlines the benefits of doing the research and how they outweigh the cost of harming the participants.**		✓	
4. Will the participants be deliberately falsely informed or made unaware that they are being observed? Will they be misled in a way that they will possibly object to or show unease when told of the real purpose of the study? **If YES, please attach an acceptable argument that outlines the benefits of doing the research and how they outweigh the cost of harming the participants.**		✓	
5. Will the research involve the discussion of, or questions on, sensitive topics (e.g. sexual activity, substance abuse, or mental health)? **If YES, please make sure that the informed consent form explicitly states that sensitive questions will be posed and that you will safeguard the anonymity of the participants and ensure confidentiality. Please attach a copy of your informed consent form and your instrument.**		✓	
6. Will the research involve the administration of drugs, or other substances to the participants?		✓	

If YES, please attach an acceptable argument that outlines the benefits of doing the research and how they outweigh the cost of harming the participants. **Please also attach a description of the procedure that will ensure that the participants will be brought back to their physical and psychological states prior to their participation in the research.**			
7. Will biological samples (e.g. blood, saliva, urine) be obtained from the participants? **If YES, will this involve invasive procedures? Please attach a description of these procedures.**		✓	
8. Will genetic materials be obtained from the biological samples? **If YES, please attach a description of the procedures that will ensure confidentiality. Please attach the informed consent form.**		✓	
9. Will financial inducements (other than reasonable expenses, like transportation or meal allowances) be offered to the participants for their participation in their research? **If YES, the researcher(s) should be mindful of how the inducements can influence the participants' responses or behaviors during the research. Indicate the financial inducements offered to the participants:** ____		✓	
10. Is there a possibility for groups or communities to be harmed by the dissemination of the research findings? **If YES, please attach a description of procedures to ensure the anonymity and confidentiality of the research findings.**		✓	

De La Salle University	**Research Ethics Review Committee** Research Ethics Office, 3F Henry Sy Sr. Hall De La Salle University Manila 2401 Taft Avenue, Manila 1004, Philippines REO@dlsu.edu.ph (632) 524-4611 loc. 513	SOP No.: 2 Form No.: 2.03 Version No.: 1 Effectivity Date: July 2016

Answering YES to most of the above items will signal an ethical issue that needs to be addressed. Some actions that will allow adherence to research ethical principles are provided with each item. The researcher is advised to refer to the University's Guide to the Responsible Conduct of Research for the appropriate procedures to ensure adherence to ethical principles in the conduct of research.

Declaration

We certify that we have read and understand the De La Salle University Code for the Responsible Conduct of Research and will abide by the ethical principles in this document. We will submit a final report of the proposed study to the DLSU-Research Ethics Office. We will not commence with data collection until we receive an ethics review approval from the College Research Ethics Committee.

Marc Daniel T. Cardano

Stephanie Joy D. Dy

Reanna Chelsey N. Lim

Dominic M. Pagtalunan

Endorsement from thesis adviser to the thesis panel for proposal defense...

Judith J. Azcarraga

12/18/17

Date

Endorsement from thesis adviser to the thesis panel for final defense...

This is to certify that the research was conducted in a manner that adheres to ethical research standards. I am thus endorsing the group for final defense.

Judith J. Azcarraga

Date

GeeBee De La Salle University

Parental Consent to Participate in Study (Parent/Guardian)

Ang inyo pong anak ay malugod naming inaanyayahang makilahok sa pagkuha ng impormasyon tungkol sa inyong anak para sa aming sistema na *GeeBee.*

Ang sistemang GeeBee ay bahagi ng proyekto ng mga guro at estudyante ng De La Salle University (DLSU).

Kami po ay humihingi ng inyong pahintulot kung maaari po naming anyayahan ang inyong anak na makilahok sa pagkuha ng impormasyon sa kaniyang tangkad at timbang, pati na rin ang pagkuha ng kaniyang litrato habang siya ay nakatayo.

Ginagawa po namin ito upang malaman kung ang litrato ay makapagbibigay ng maayos na tantsa sa tangkad at timbang ng isang bata.

Kung kayo ay pumapayag na sumali ang inyong anak, kukunan po namin ang kaniyang tangkad gamit ang height ruler at timbang gamit ang weighing scale. Pagkatapos ay kukunan namin ang inyong anak ng apat (4) na litrato (may halimbawang litrato sa kabilang pahina). Aalalayan po namin ang inyong anak sa pagkuha ng impormasyon at litrato.

Sa pagkuha ng litrato ng bata, agad po namin tatakpan ang kanilang mata para hindi sila agad makilala.

Gagamitin po namin ang impormasyon upang masubukan namin kung ang sistema na nagkakategorya ng pangangatawan ng isang bata base sa tangkad at timbang sa pamamagitan lamang ng litrato at kung ang sistema naming ay tugma sa tunay na tangkad at timbang ng bata.

Ang lahat ng personal at pribadong impormasyon patungkol sa inyong anak na aming makukuha, ay tinitiyak na hindi makakalabas at mananatiling kompidensyal.

Malaya po kayong tumanggi kung ayaw ninyong makilahok ang inyong anak sa pagkalap ng impormasyon. Kung sakaling kayo ay pumayag ngunit ayaw ng inyong anak, hindi po namin itutuloy ang pagkalap ng impormasyon. Kung meron po kayong mensahe at kung ano pang mga ibang mungkahi, maaari ninyo akong tawagan o i-text sa 0999 801 9458 (Smart) o 0917 769 0248 (Globe), o kaya naman ay mag-e-mail stephanie_dy@dlsu.edu.ph o reanna_lim@dlsu.edu.ph.

Marc Cardano
Estudyante, College of Computer Studies
De La Salle University (DLSU)

Reanna Lim
Estudyante, College of Computer Studies
De La Salle University (DLSU)

Stephanie Dy
Estudyante, College of Computer Studies
De La Salle University (DLSU)

Dominic Pagtalunan
Estudyante, College of Computer Studies
De La Salle University (DLSU)

Kung kusa ninyong ilahok ang inyong anak sa pag-subok, pakisulat ang inyong pangalan na may pirma sa ibabaw at petsa:

Pangalan ng Magulang at Pirma : ______________________________ ***Petsa:*** ________________

Pangalan ng anak: ____

GeeBee De La Salle University

Informed Consent Form for Child Participant

Kayo po ay inaanyayahang makilahok sa pagkuha ng impormasyon para sa aming sistema na *GeeBee.*

Ang sistemang GeeBee ay bahagi ng proyekto ng mga guro at estudyante ng De La Salle University (DLSU).

Kung kayo ay papayag na gumamit ng aming sistema, malaki ang maitutulong nito sa ikagaganda at ikakaayos nito.

Kukunin ang inyong tangkad gamit ang height ruler at timbang gamit ang weighing scale. Pagkatapos ay kukunan namin kayo ng apat (4) na litrato kung saan kayo ay nakatayo. Dalawa (2) dito ay nakaharap kayo sa kamera at ang natitirang dalawa (2) ay nakatagilid kayo. Gagabayan namin kayo sa pagkuha ng inyong tangkad, timbang at litrato.

Ginagawa namin ito upang malaman kung ang litrato ay makapagbibigay ng maayos na tantsa sa tangkad at timbang ng isang bata.

Sa pagkuha ng litrato ay agad tatakpan ang iyong mga mata para hindi kayo agad makilala.

Ang lahat ng personal at pribadong impormasyon na makukuha namin sa inyo ay tinitiyak na hindi makakalabas at aming iingatang mabuti.

Maaari kayong tumanggi kung hindi niyo gustong sumali sa pagkuha ng impormasyon para sa aming sistema. Kung meron kayong mensahe at kung may ibang katanungan, maaari niyo akong tawagan o i-text sa 0999 801 9458 (Smart) o 0917 769 0248 (Globe).

Marc Cardano
Estudyante, College of Computer Studies
De La Salle University

Stephanie Dy
Estudyante, College of Computer Studies
De La Salle University

Reanna Lim
Estudyante, College of Computer Studies
De La Salle University

Dominic Pagtalunan
Estudyante, College of Computer Studies
De La Salle University

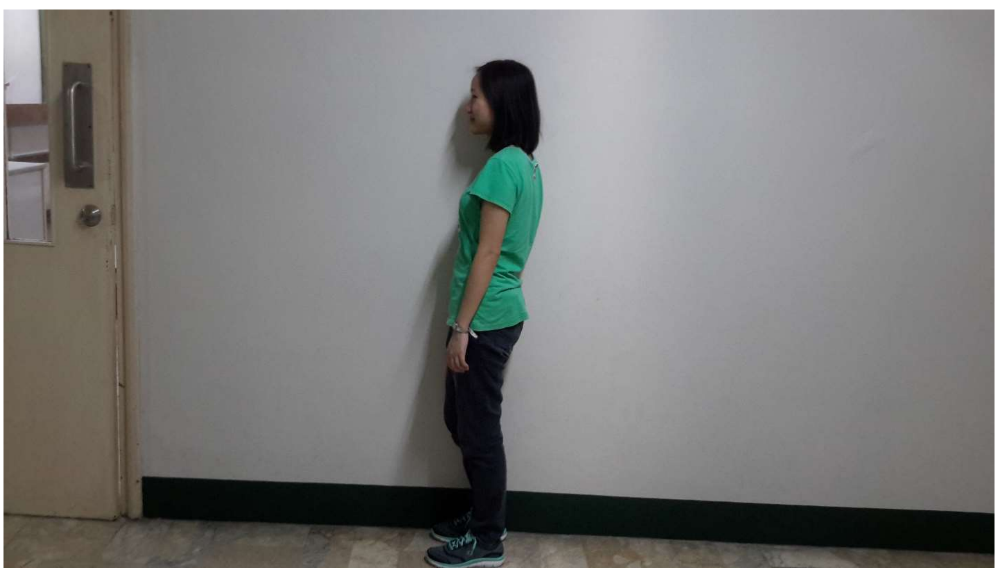
Kung kayo ay pumapayag na gamitin ang aming sistema,
Pakisulat ang inyong pangalan at section sa baba:

Pangalan: ____ *Section:* __________________

GeeBee

Sample Pictures

Front View (Censored)



Side View

De La Salle University

RESEARCH ETHICS CLEARANCE FORM
For Thesis

Names of student researcher/s :	*Cardano, Marc Daniel T.* *Dy, Stephanie Joy D.* *Lim, Reanna Chelsey N.* *Pagtalunan, Dominic M.*
College:	College of Computer Studies
Department:	Software Technology Department
Course:	BS Computer Science with specialization in Software Technology
Duration of project:	from: Term 2, A.Y. 2016 - 2017 to: Term 1, A.Y. 2017-2018

Ethical considerations

The ethical concerns raised are due to the collection of the height and weight as digital photograph of the human participants. Since the participants will be children from Grade 1 to Grade 4, their legal guardian signed the consent forms first. In regards to privacy, the children's names will not appear in the document and their photographs censored.

To the best of our knowledge, the ethical issues listed above have been addressed in the research.

Dr. Judith J. Azcarraga
Name and signature of adviser/mentor
Date: Dec. 18, 2017

Dr. Arnulfo P. Azcarraga
Name and signature of panelist
Date:

Mr. Neil Patrick A. Del Gallego
Name and signature of panelist
Date: Dec 18 2017

Appendix B

Similarity Report

De La Salle University

Final Paper

ORIGINALITY REPORT

8%	7%	2%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	samples.jbpub.com Internet Source	1%
2	www.pyimagesearch.com Internet Source	1%
3	www.sas.com Internet Source	1%
4	netcentric.dlsu.edu.ph Internet Source	1%
5	Submitted to Colorado Technical University Online Student Paper	<1%
6	www.iosrjournals.org Internet Source	<1%
7	www.fusioncharts.com Internet Source	<1%
8	www.omicsonline.org Internet Source	<1%
9	Submitted to De La Salle University - Manila	

	Student Paper		<1%
10	hingx.org Internet Source		<1%
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12	developer.nvidia.com Internet Source		<1%
13	Submitted to Aspen University Student Paper		<1%
14	www.slideshare.net Internet Source		<1%
15	Turck, Dominique, Kim F. Michaelsen, Raanan Shamir, Christian Braegger, Cristina Campoy, Virginie Colomb, Tamás Decsi, Magnus Domellöf, Mary Fewtrell, Sanja Kolacek, Walter Mihatsch, Luis A. Moreno, and Johannes van Goudoever. "World Health Organization 2006 Child Growth Standards and 2007 Growth Reference Charts : A Discussion Paper by the Committee on Nutrition of the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition", Journal of Pediatric Gastroenterology and Nutrition, 2013. Publication		<1%

16	Submitted to Swinburne University of Technology Student Paper	<1%
17	Alexander, . "Understanding Chart Types", Excel® Dashboards & Reports Alexander/Excel, 2011. Publication	<1%
18	Submitted to American Intercontinental University Online Student Paper	<1%
19	Submitted to National College of Ireland Student Paper	<1%
20	Submitted to Christ University Student Paper	<1%
21	Criminisi, Antonio, Andrew Zisserman, Luc J. Van Gool, Simon K. Bramble, and David Compton. "", Investigation and Forensic Science Technologies, 1999. Publication	<1%
22	Submitted to Bridgepoint Education Student Paper	<1%
23	support.sas.com Internet Source	<1%
24	mro.massey.ac.nz Internet Source	<1%

25	Submitted to Southern New Hampshire University - Distance Education Student Paper	<1%
26	Submitted to University of Liverpool Student Paper	<1%
27	dartforddirect.info Internet Source	<1%
28	mie-epi.com Internet Source	<1%
29	www.investopedia.com Internet Source	<1%
30	Submitted to Bocconi University Student Paper	<1%
31	ir.canterbury.ac.nz Internet Source	<1%
32	chenwen.cai.swufe.edu.cn Internet Source	<1%
33	Submitted to VIT University Student Paper	<1%
34	Submitted to University of Wales Institute, Cardiff Student Paper	<1%
35	opencv.org Internet Source	<1%

36	Submitted to Athens University of Economics and Business Student Paper	<1%
37	Submitted to AUT University Student Paper	<1%
38	Submitted to Far Eastern University Student Paper	<1%
39	Submitted to London School of Commerce Student Paper	<1%
40	ntl.bts.gov Internet Source	<1%
41	Submitted to Kaplan University Student Paper	<1%
42	Submitted to Pennsylvania State System of Higher Education Student Paper	<1%
43	www.ehow.com Internet Source	<1%
44	ebook.ecog-obesity.eu Internet Source	<1%
45	"Exploring Drivers' Route Choice Behaviors in Urban Road Network by Data Mining", CICTP 2015, 2015. Publication	<1%

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48	www.bdigital.unal.edu.co Internet Source	<1%
49	brage.bibsys.no Internet Source	<1%
50	www.hanc.info Internet Source	<1%
51	www.appropriatingtechnology.org Internet Source	<1%
52	eprints.maynoothuniversity.ie Internet Source	<1%
53	www.science.gov Internet Source	<1%
54	www.mnacrp.org Internet Source	<1%
55	munin.uit.no Internet Source	<1%
56	link.springer.com Internet Source	<1%
57	dalspace.library.dal.ca Internet Source	

		<1%
58	dspace.nwu.ac.za Internet Source	<1%
59	Hae-Min Moon. "Intelligent video surveillance system using two-factor human information", Telecommunication Systems, 07/02/2011 Publication	<1%
60	Moon, Jin Soo. "Reappraisal of Regional Growth Charts in the Era of WHO Growth Standards", Pediatric Gastroenterology Hepatology & Nutrition, 2013. Publication	<1%
61	Fong, . "Introduction", Telemedicine Technologies Information Technologies in Medicine and Telehealth, 2010. Publication	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		

Appendix C

Record of Contribution

De La Salle University

Departmental Record of Contribution

This form should be submitted along with the THSST-3 final deliverables. The contribution disclosed herein will formalize the contribution of each of the proponents and the adviser to the research. It is important that the proponents and the adviser agree with the figures and remarks imparted here, and it is expected that all has arrived to the same conclusion in good faith.

Title	Proponents	
Image-Based Height & Weight Calculation and Data Visualization for Public Health Monitoring System of Filipino Children	*Proponent 1 (P1)*	**Cardano, Marc Daniel T.**
	Proponent 2 (P2)	**Dy, Stephanie Joy D.**
	Proponent 3 (P3)	**Lim, Reanna Chelsey N.**
	Proponent 4 (P4)	**Pagtalunan, Dominic M.**
	Adviser (A)	
	Dr. Judith J. Azcarraga	

Key Event	*Contribution in % (N/A allowed except for total)*					Remarks
	P1	*P2*	*P3*	*P4*	*A*	
Idea conceptualization	15%	15%	15%	15%	40%	
Research formalization	22%	22%	22%	22%	12%	
Tool development	25%	25%	25%	25%	0%	
Overall contribution*	20.6%	20.6%	20.6%	20.6%	17.3%	

Marc Daniel T. Cardano
Proponent

Stephanie Joy D. Dy
Proponent

Reanna Chelsey N. Lim
Proponent

Dominic M. Pagtalunan
Proponent

Dr. Judith J. Azcarraga
Adviser

* this row must be filled

Appendix D

Other Appendices

De La Salle University

D.1 Medical Examination Form

Health Services Office

MEDICAL EXAMINATION FORM

DATE: ________________
SCHOOL YEAR: __________

ID NUMBER: ____________________ COLLEGE: ____________
LAST NAME: ____________________ FIRST NAME: _____________________ M.I._______
CONTACT#: _______________
CONTACT PERSON IN CASE OF EMERGENCY: _______________________ RELATIONSHIP: _____________
CONTACT#: ________________

AUTHORITY TO CONDUCT MEDICAL EXAMINATION

I, ________________________, ____years old accept and understand that I am required to undergo a physical examination and chest x-ray to determine my fitness and well-being as a student. I fully understand that the results will be held as confidential medical records and will be used by the University for my care and treatment. My health information cannot be released to third persons except with my consent or unless the disclosure of the information is required by law. I also accept and understand that the procedures are requirements for the next academic year enrolment. I acknowledge that my medical records will be retained by the University for a period of 5 years from examination or health visit.

____
Signature of Student

PHEX Consultation Details

Physical Exam (to be filled-out by a nurse/doctor)

Blood Type_______________
Blood Pressure____________
Resp. Rate_______________
Temperature______________
Pulse Rate________________
Height (in inches) __________
Weight (in pounds) ________
BMI (to be computed by the system) _____
BMI Category-system-generated_______
LMP (Female) ________
Right Vision__________
Left Vision ___________

☐ Corrective Lens

MROTC_____________
MPE________________

____
Assigned Nurse

____
Examining Physician

Medical History (updated)
1.______________________
2.______________________
3.______________________
4.______________________

Medications_______________
____
____

Social History
___ Smoking
___ Drinking
___ Exercising

Findings
Extremities
___ Left Handed
___ Right Handed

Diagnosis
____
____
____

Remarks/Recommendations
☐ Physically Fit
☐ For Clearance
____
____

Physical Findings	Abnormal Findings
EENT ___Normal	
Head and Neck ___Normal	
Breast ___Normal	
Lungs ___Normal	
Heart ___Normal	
Neurologic ___Normal	
Chest X-ray ___Normal	
Abdomen ___Normal	
Skin ___Normal	

2401 Taft Avenue, 1004 Manila, Philippines Tel: (632) 536-0252 | Trunk Line: (632) 524-4611 loc. 221

D.2 Resource Persons

Dr. Judith J. Azcarraga
Adviser
College of Computer Studies
De La Salle University-Manila
jay.azcarraga@delasalle.ph

Dr. Arnulfo P. Azcarraga
Principal Investigator
GetBetter Project
arnie.azcarraga@delasalle.ph

D.3 Personal Vitae

Mr. Marc Daniel T. Cardano
De La Salle University
09983413882
marc_cardano@dlsu.edu.ph

Ms. Stephanie Joy D. Dy
De La Salle University
09998019458
stephanie_dy@dlsu.edu.ph

Ms. Reanna Chelsey N. Lim
De La Salle University
09177690248
reanna_lim@dlsu.edu.ph

Mr. Dominic M. Pagtalunan
De La Salle University
09273140495
dominic_pagtalunan@dlsu.edu.ph