Universal Hand Analyzer

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Declaration

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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Confirmation by the Supervisor

The above candidate has carried out research for the M.Sc. in Information Technology Dissertation under my supervision.

Signature of the Supervisor: ……………………….
Date: ……………..…
Name of the Supervisor: Mr.B.H Sudantha

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Abstract

The human hand has a considerably large scope of variation in size, shape, and strength between and within individuals and nationalities. Characterizing hands into sizes to accurately account for the variations within a specific population would be a valuable contribution to glove manufacturers.

The research proposal for the “Analysis of wide number of Shapes and Sizes of Hands to Manufacture Gloves” explores an image processing based solution to challenges faced by glove manufacturing companies in creation of various glove sizes that specifically matches different types of hands.

This application would be capable of Scanning Hands, identify the sizes and models, productive analysis, Decision Making and it is integrated with SAP HANA/SAP BI. By feeding the collected data to the analytical engine which comes integrated to SAP HANA, the results are aggregated into comprehensible data outputs.

While 3D scanning technologies are still in early stages of development there is a major demand available. A cutting-edge solution that would comprehensively address the flaws in current systems and integrate the same with enterprise resource planning, would ultimately benefit the manufacturers to gain competitive advantage at the industrial level.

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Chapter 1

1. Introduction

1.1. Prolegomena

The world is comprised of approximately seven billion people and each individual is unique in various ways. Adjusting the workplace, tools, and personal protective equipment to accommodate humans is a key component of ergonomics. One aspect of ergonomics is anthropometry.

Midas Safety is a Multinational Company and it Manufactures Gloves for various Purposes, Regions and Countries all over the world. People around the world have different Shapes, sizes and skin types. So according to our CEO, “The Glove should be the second skin to your Hand”.

To achieve that goal, the organization has to manufacture various gloves to meet the usage requirements and sizes to meet each individual specific need. For that we need an extensive database which contains the sizes and shapes which matches people wise, country wise and region wise.

The document includes the research proposal for the “Analysis of wide number of Shapes and Sizes of Hands to Manufacture Gloves”. This application will be capable of Scanning Hands, identify the sizes and models, productive analysis, Decision Making and it is integrated with SAP HANA/SAP BI.

1.2. Background & Motivation

People around the world has hands with different sizes, models, skin types, according to the Countries, Male Female wise, Region wise, Age and etc. As a Gloves manufacturer, we need to address all of these matters and if fulfilled then the business can reach a successful level.

Currently we don’t possess that kind of database. We are using AUTOCAD software to draw the Models for Manufacturing. That is not a good Practice for Business. If we have a Database with all the needful requirements, we can manufacture the suitable and perfect gloves for customer needs.

Factor analysis was used to develop a more detailed description of the human hand to be used in the creation of glove sizes; currently gloves sizes are small, medium, and large. The created glove sizes provide glove designers with the ability to create a glove design that can provide fit to the majority of hand variations in both the male and female populations.

Our Company's Backend is SAP HANA and Users are using SAP BI reports. There is a huge requirement for above research data.

1.3. Problem definition

The human hand has a large amount of variation in size, shape, and strength between and within individuals and populations. Characterizing hands into sizes to accurately account for the variations within a specific population would be a valuable contribution to glove manufacturers.

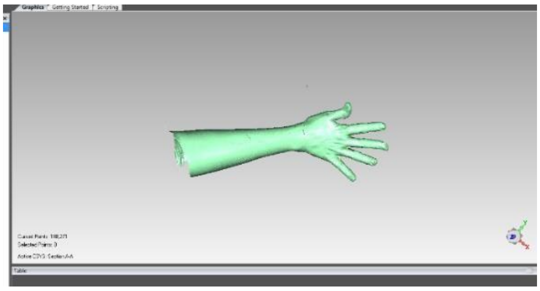
Currently hand sizes used in the manufacturing industry use static measurements of hand length, breadth, and circumference.

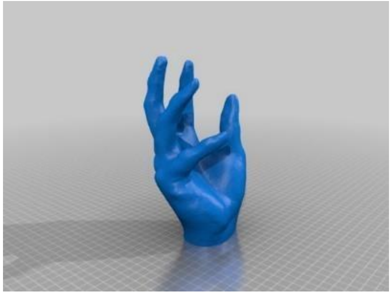
There is no application to recognize hand sizes and models Analysis in the field. We are using 3D scanner & thermos sensors to identify the scales & heats. We are going to highly integrated with SAP HANA & through that we are going to save the cost, time & more comfort product to our users. And also we can provide the data to fashion, Jewellery industries

1.4. Proposed Solution

The overall goal of this thesis is to develop different glove sizes using the database by Scan Hands of people who is in different ages, genders, countries, regions & professionals. To meet this goal, four specific objectives were developed.

The first objective was to reduce the number of variables in the database by classifying them into groups. The second objective was to develop a sizing system using the factor scores. The third objective of this research was to identify specific sizes using percentiles and cluster analysis. The last objective was to compare the developed sizing system with the research done by Kwon et al, (2009) Finally when a person wants to buy a glove, first we can scan his or her Hand, then the software identifies the suitable comfort size and the model of selected glove. And it displays how the glove looks after wearing through 3D view.





1.5. Aim and Objectives.

1. Review the literature related to the hand written recognition.
2. Select the most appropriate hand scanning method.
3. Develop a device for hand scanning.
4. Develop application for Factor Analysis in the Development of Hand Sizes for Glove Design
    1. Reduce the number of variables in the database by classifying them into groups
    2. Develop a sizing system using the factor scores
    3. Identify specific sizes using percentiles and cluster analysis
    4. Compare the developed sizing system with the research done by Kwon
5. Integrated with SAP HANA & SAP BI

1.6. Structure of Thesis

Chapter 1: Introduction chapter, brief description about production confirmation and its current issues and the solutions proposed are briefly outlined here

Chapter 2: A detailed explanation about problem domain and current system will be covered with in this chapter. A comparison about available solutions also included

Chapter 3: This Technology review chapter covers available technologies and tools that are considered for a development in this nature.

Chapter 4: My approach chapter is about the technologies and methodologies adapted to this system. It will give some detailed explanation about the selected technologies and methodologies I'm going to using in this development.

Chapter 5: This chapter is covering up the analysis and design stage of the development.

Starting from the current system study it will provides all the necessary artifacts up to GUI.

Chapter 6: Implementation information is included in this chapter. I will be discussing most of the critical and vital implementation methods.

Chapter 7: This evaluation chapter will cover software evaluation methods. With regard to the development it will discuss the evaluation methods and test cases for the evaluation.

Chapter 8: This chapter is for the conclusion and further enhancements to the system. There I will discuss the success of this development and the capabilities of further enhancements.

Chapter 2

2. Development and Challenges in Universal Hand Analyzer.

2.1. Introduction

During recent years several commercial sensors have been introduced to obtain three-dimensional acquisitions. Yet, most of them can only attain partial acquisitions and certain techniques are necessary to align several acquisitions of the same object to get a full reconstruction of it. Range image registration techniques are used in Computer Vision to attain the motion between sets of points.

It is based on the computation of the motion that best fits two (or more) sets of clouded points. This chapter presents an overview of the existing techniques, as well as a new classification of them. We have employed a set of representative techniques in this field and some comparative results are presented. The techniques presented in this chapter are discussed and compared taking into account their 3D registration performance.

2.2 Techniques to acquire the depth Information

Surface acquisition is one of the most important topics in visual perception. Without it, acquiring the third dimension is impossible. In order to attain this depth perception, various systems have attempted to imitate the human vision system. These methods are classified into what Woodham [Woodham, 1978] refers to as direct 13 14 Chapter 2. State-of-the-art in Surface Alignment methods and indirect methods. Direct methods are those that try to measure distance ranges directly, for example, pulsed laser based systems, where the depth information is the only information available.

Indirect methods are those that attempt to determine distance by measuring parameters calculated from images of the illuminated object. Several direct and indirect methods commonly refer to these techniques as shape from X, where X is one of a number of options resulting from the spread of such technologies in the last few years. Shape from X techniques can be divided into three main groups:

Techniques based on modifying the intrinsic camera parameters, i.e. depth from focus/defocus and depth from zooming, consisting of the acquisition of several images of the scene from the same point of view by changing the camera parameters. By using depth from focus/defocus, the camera parameters can be dynamically changed during the surface estimation process [Favaro and Soatto, 2002]. Depth from zooming involves the use of multiple images taken with a single camera coupled with a motorized zoom.

Techniques based on considering an additional source of light projected onto the scene, i.e. shape from photometric stereo and shape from structured light. Photometric stereo considers several radiance maps of the measuring surface captured by a single camera and a set of known light sources. The use of at least three radiance maps determines a single position and orientation for every imaged point [Solomon and Ikeuchi, 1996]. The structured light technique is based on the projection of a known pattern of light onto the measuring surface, such as points, lines, stripes or grids. 3D information of the scene is obtained by analyzing the deformations of the projected pattern when it is imaged by the camera [Salvi et al., 2004].

Techniques based on considering additional surface information, i.e. shape from shading, shape from texture and shape from geometric Constraints. Shape from shading uses the pattern of shading in a single image to infer the shape of the surface. Often, the parameter of the reflectance map is unknown. In this case we have to estimate the albedo and the illuminant direction. From the reflection map and by assuming local surface smoothness, we can estimation local surface normal, which can be integrated to give local surface shape [Gibbins, 1994]. The basic principle behind shape from texture is the distortion of the individual texels. Their variation across the image gives an estimation of the shape of the observed surface. Issue with Current excel based arrangement.

2.3 Midas Project (Pakistan Plant)

Beltexco Private Limited is located in Karachi, Pakistan. Which is a maintain under Midas family. They started same research one year back, they used Zscanner to scan the hands. Normally expert will take minimum 5 min to take scan a hand. After that it needs filter by using another software. It need a trained person to handle it.
Then use another software to take the measurement. so process is to long and can't keep hand more the once sec still. Because small movement of fingers effect to the scanned object.

Currently that project is not successful stage. Because of the time take to scan process and it need trained human resources and high cost. Need a special permission to take to travel between two countries.

2.3.1 About ZScanner™ 700

The 33rd International Conference and Exhibition on Computer Graphics and Interactive Techniques is, in its usual fashion, a bonanza of all things futuristic in both medicine and technology in general. From open-heart this exhibit profiles the most interesting ideas of tomorrow's medicine.

We begin with the **Z Corporation**, a Burlington, Mass Company, that unveiled the ZScanner™ 700, "the first handheld, self-positioning 3D scanner on the market that can digitize 3D surfaces in real time." Not specifically designed for clinical work (and not approved by the FDA), this laser-based device can nonetheless be used for medical education and, probably, for a whole range of pathology and forensic medicine applications. "Create highly detailed reproductions of complex organs and bone structures", company says. We also envision the use of this device for biomedical engineering.

2.3.2 How It Works

First of all we have to stick a special dot shaped paper which is mixed with a chemical on the hand. The distance between two paper dots should be minimum of 2 centimeters. Then we have to scan the whole hand using the ZScanner 700. The Zscanner 700 has an inbuilt software, which helps to get the Scanned Model.

2.3.2 Challenges

1. Not Portable
2. Paper Dots made with a special chemical costs high.
3. Special Paper Dots should be pasted on the Hand properly, or else it won't scan.
4. A fully trained person will also take at least 5 minutes to scan the hand.

5. People cannot keep their hand without moving for a long time.

2.4 Problem definition

Following are the issues that have been identified after analysis;

1. Keeping the hand still is a major issue during scanning. Even a subtle movement of the hand, the process has to be re-started.
2. Positing of the paper points should be done with care and this is a time consuming task.
3. Cost of operation is very high due to the paper used for positional marking is expensive.

2.5 Summary

With the technologies that are available today, we can come to a conclusion that the 3D scanning technologies are still in its infant stages, but are making considerable break trough's that are making the technology more feasible to operate in an industrial level. As of this stage, Midas has seen the benefits that can be obtained by using such a technology in its production lines and the competitive advantages that this technology will bring to the organization.

2.6 Summary of limitation

In terms of limitations, one of the biggest problems was finding research materials on the subject. This meant that I had very little reading material. so planning ahead was a bit difficult. To overcome this I read a lot of technical specification on devices that related to the subject and their usages.

Chapter 3

3. Technology Adopted for

3.1 Introduction

Through the earlier chapter a descriptive literature review has been conducted. Throughout that study, the possibilities, strengths, obstacles and weaknesses of the technologies used by the other researchers could appropriately be found. This chapter will illustrate the technology, concepts and theories in order to give a Clarification for the problem. Further, it will define analyses of technologies and justification or explain how it is used in this entire research.

3.2 Used Technology

Visual C #

C# (pronounced C sharp) is a programming language designed for building a wide range of enterprise applications that run on the .NET Framework. Visual C .NET enables developers to build solutions for the broadest range of clients, including Web applications, Microsoft Windows Forms-based applications, and thin- and smartclient devices. And, with an elegant, modern programming language, Visual C developers can leverage their existing C++ and Java skills and knowledge to be successful in the Microsoft .NET development environment.

.NET

ASP.net is a free web framework for building great web sites and web applications using html, css, and JavaScript. ASP.net supports three approaches to build web sites.

AForge.NET Framework

AForge.NET is an open source C# framework designed for developers and researchers in the fields of Computer Vision and Artificial Intelligence - image processing, neural networks, genetic algorithms, fuzzy logic, machine learning, robotics, etc.
The framework is comprised by the set of libraries and sample applications, which demonstrate their features:

- AForge.Imaging - library with image processing routines and filters;

- AForge.Vision - computer vision library;

Microsoft SQL Server

Microsoft SQL Server is a relational database management system developed by Microsoft. As a database server, it is a software product with the primary function of storing and retrieving data as requested by other software applications—which may run either on the same computer or on another computer across a network

Remote Function Call (RFC) in SAP

RFC is a mechanism that allows business applications to communicate and exchange information (in pre-defined formats) with other systems. RFC stands for 'Remote Function Call and RFC consists of two interfaces:

- calling interface for ABAP Programs
- calling interface for Non-SAP programs.

SAP ABAP

ABAP (Advanced Business Application Programming, originally Allgemeiner Berichts-Aufbereitungs-Prozessor, German for "general report creation processor") is a high-level programming language created by the German software company SAPSE.

3.3. Development tools

Microsoft Visual Studio

Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows, as well as web sites, web apps, web services and mobile apps. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, Windows Store and Microsoft Silverlight. It can produce both native code and managed code.

SQL Server Management Studio

SQL Server Management Studio (SSMS) is a software application first launched with Microsoft SQL Server 2005 that is used for configuring, managing, and administering all components within Microsoft SQL Server. The tool includes both script editors and graphical tools which work with objects and features of the server.

Chapter 4

4. Novel approach to Universal Hand Scanner.

4.1. Introduction

In the previous chapters the problem and a solution for it has been described. In this chapter, the approach of interfacing the problem with the solution will be described.
Before the start of the project, a lot of time and resources were spent on reading on past researches approaches to the subject. A lot of time was spent in reading and understanding the equipment that was available for such tasks.

4.2. Hypothesis.

When it comes to mass production of safety equipment for different regions, the only analysis that you can make is by using sales data after a product has been in the market for a certain amount of time. This sometimes creates problems such as dead stock, unavailability of products thereby creating either surplus or loss of profit to the vendors which in turn affect the manufacturer. Analysis of aftermarket sales data takes time and in the case of entering a new market, the vendor has very little data on releasing stock with the right size specification to the market.

With the analysis tools available today, if the correct data is obtained, accurate predictions can be carried out that will ease the market entry and reduce the dead stock levels in the market.

4.2.1 Data Collection

In terms of data collection, if a simple yet accurate system can be designed, it can be scaled to levels that will result in mass data gathering. This is an important part as the accuracy of the proposal depends entirely on the base data set. The more the accurate this data set is, the better the actual result is with the prediction.

Since raw un-relatable data is of little value, meta data also has to be collected alongside the actual physical data. This is the main part that will help in the organizing and grouping of the processed information that will make representation much more sensible.

4.2.2 Representation

Representation this information in mineable formats will be a key factor. Usage of dashboards to represent the data will make decision taking using the patterns found in the data much more easy since it's easily comprehended.

Storage of this information is also a key component. After researching into big data storage, it turns out that there are a lot of technologies and methodologies to choose from and ample solution provides who specialize in such cases.

Our main hypothesis is that by mass accumulation of hand sizes and analyzing with the region of origin, using SAP BI solutions, region specific gloves can be manufactured that will reduce the waste of materials and increase the conform level of the wearer. This will in turn increase the demand for the products developed by Midas.

4.3. Input to the system.

- Model of the hand
    - Person need to apply his hand on the scanned area. Which is reduce the noice detection & and other disturbance
- Geographic data;
    - Country
    - Region
    - Race
    - Weather Conditions
    - Age

Using html web form get the above information from the person who is going to scanned his hand. Those details is required to analysis the data accordingly

4.4. Output of the system.

- Cutting pattern of the glove by region
    - Identified S/M/L/XL size of the gloves sizes according to the countries and different regions and race .
    - Once we received a order from customer we can give our self feedback of the product.

- Material wastage details

- Because of exact sizes it save the unwanted materials

- Analysis of the sizes

4.5. Process

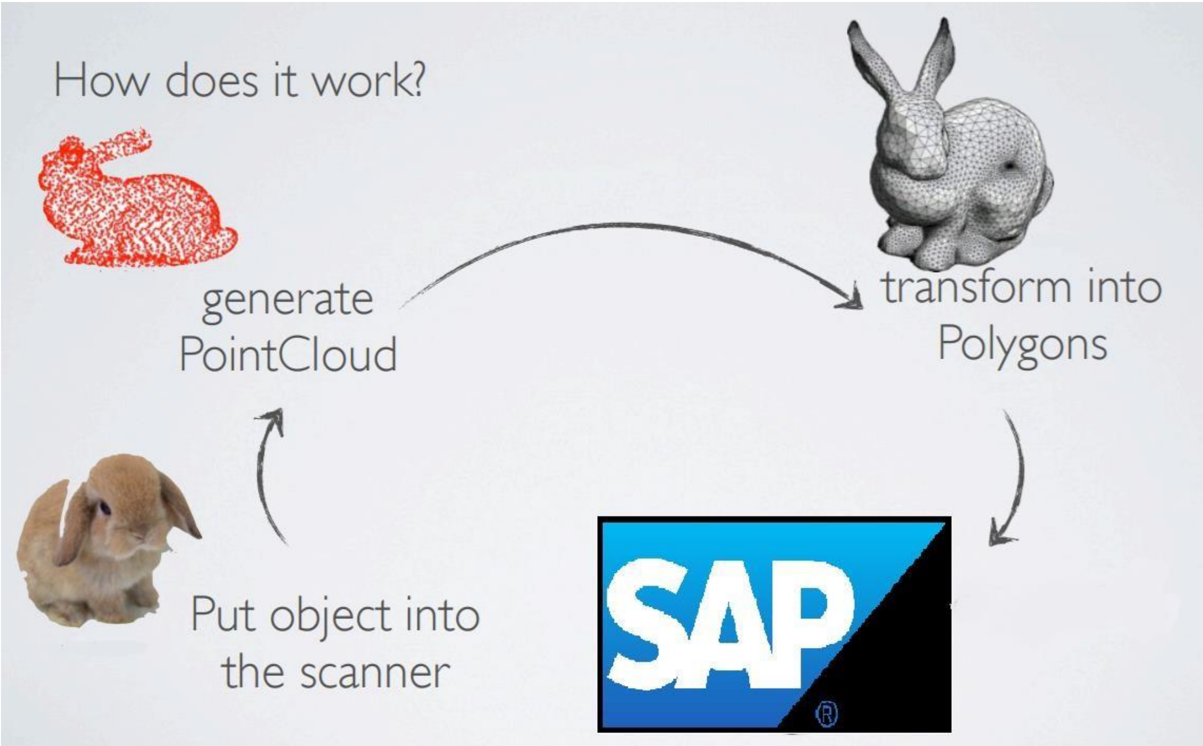


Figure 1: Obtaining hand characteristics

4.6. Users of System

- R&D Department – they can have multiple hand sizes all over the world . they are the team who decide the new gloves to the market.

- Production Planners – once new order received they can decide the sizes of the gloves Small / Median / Large scale. Then they can planed BOM in SAP. Save the cost

- Sales Managers – when they received a order they can justify the order with customers. Like this region this kind of employees hands sizes should be this.

4.7. Features

- Statistical models of designs. o Region based manufacturing patterns
- Summary (Decision making information)

4.8. Summary

Identification of the patterns of size spread in a region through gathered data and proposing manufacturing quantities to best match market movement which in turn reduces dead stocks and increase product movement to the end consumer seamless.

By identifying the inputs to the system and the outputs that are expected, we can determine the changes that are wanted in order to identify them. By incorporating current process into the life cycle, the necessary proposals of data handling can be brought in to obtain the desired outcome.

Chapter 5

5. Design of Universal Hand Scanner (Solution Design)

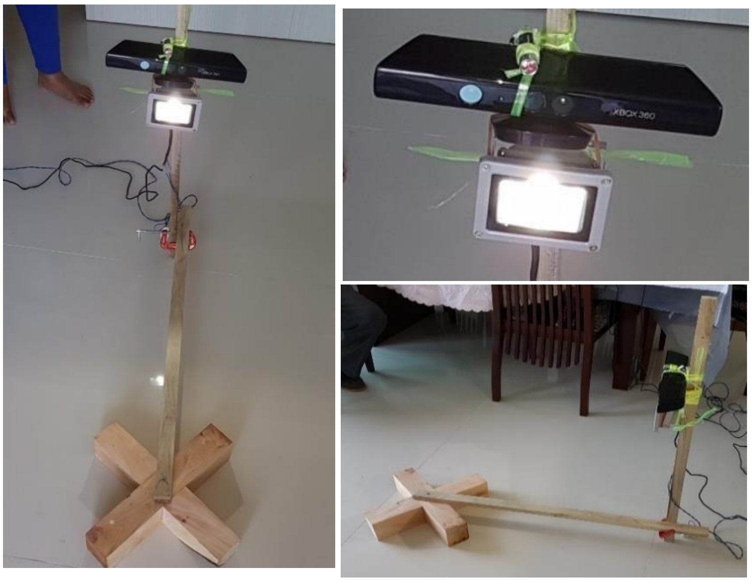
5.1. Introduction

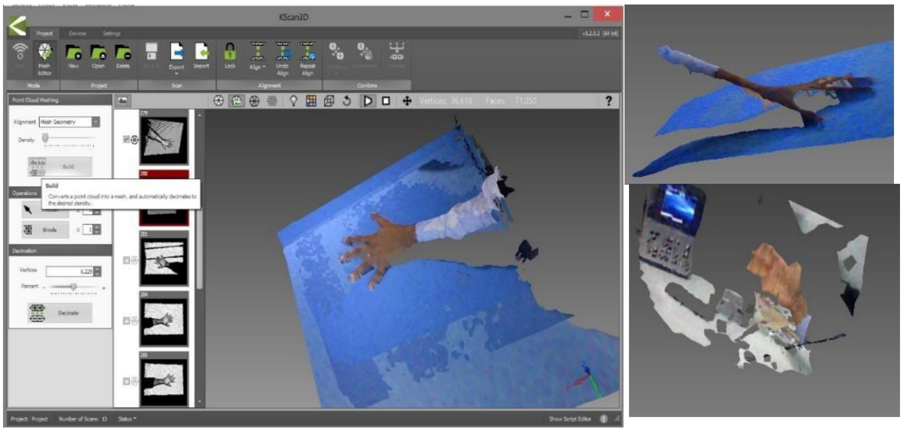
The following chapter illustrates the practical approach taken at implementing the solution to the problem.

5.2. Scan Model

5.2.1 Kinect - Long Distance

Kinect is Microsoft's motion sensor add-on for the Xbox 360 gaming console. The device provides a natural user interface (NUI) that allows users to interact intuitively and without any intermediary device, such as a controller & also can use as 3D scanner





Challenges

1. 1.fingures can’t ditected correctly(ducky hands)
2. small objects not correctly identified
3. can’t scan hand freely

5.2.2 Intel Realsense SR300 – Short Distance

Intel RealSense, formerly known as Intel Perceptual Computing, is a platform for implementing gesture-based human-computer interaction techniques. It consists of series of consumer grade 3D cameras together with an easy to use machine perception library that simplifies supporting the cameras for thirdparty software developers

5.2.3 Bundle Adjustments Technique

Given a set of images depicting a number of 3D points from different viewpoints, bundle adjustment can be defined as the problem of simultaneously refining the 3D coordinates describing the scene geometry, the parameters of the relative motion, and the optical characteristics of the camera(s) employed to acquire the images, according to an optimality criterion involving the corresponding image projections of all points.

Detect 3D coordinates Using images and First identified the main key points in particular image and then it will match with rest images points. It need lot of CPU usage , memory & Time consuming , No need any special sensor

5.2.4 Identified the sizes

By feeding the collected data to the analytical engine which comes integrated to SAP HANA, we can aggregate the results into comprehensible data outputs.

5.2. Proposed Solution

Proposed SAP solution is used so that the avaliabel processing capabilites will output the desired data points that are expected. This in turn will make the results more usable to our solution.

5.3. Functional Overview

This system is a completely SAP HANA ERP based solution. By feeding the data with the meta data such as age, gender ect., the inbuilt R-Studio analytical operations will calculate and aggregate the raw data sets into meaningful information.

5.3.1. Functional Requirements

Main Requirements form end-users.

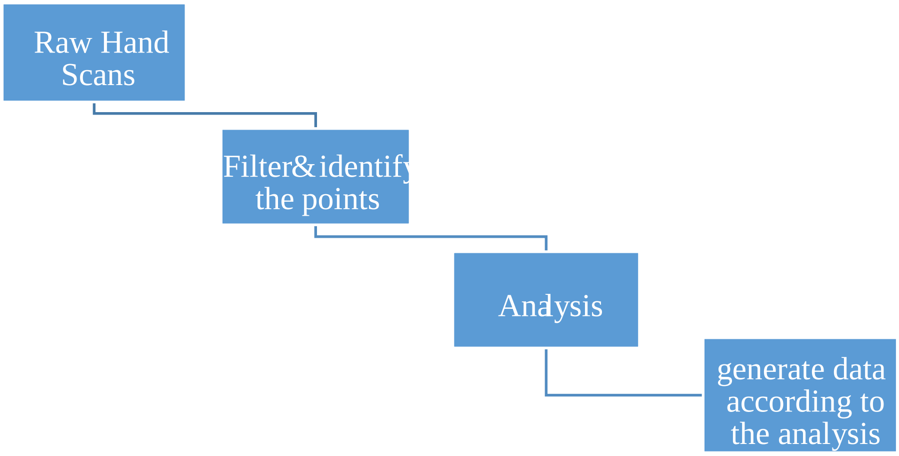
- Design pattern calculation
- Distribution of hand sizes according to different demographics Marketing points

5.3.2. Non-functional requirement

- System shall provide a method to mitigate the data upload issues to SAP HANA.
- System shall maintain a log of all interactions with the data
- Usability: Easy to use interfaces that will enable the users to interact with the system.
- Create personal data
- Collect data from social media

5.4. System Design

5.4.1. Flow Diagrams for Proposed system.



5.4.2. SAP Module Pool Programming (GUI Designing)

Designing the SAP HANA system to capture the functional Requirement. SAP Specific Programming Patten & designing guide line to implement proposed solution.

5.4.3. SAP Database Structure.

All the scanned details are maintain in sql data base and only filtered contain stored under the SAP HANA . this data for processing using the In-Memory architecture, so the data model is dynamic and is time bound.

5.4.4. GUI Designing process in SAP

All the user interfaces are designed in SAP. Therefore the standard SAP GUI design methodology is performed. Following SAP standard GUI design methodology is performed in user interface design. Therefore no need of user training for the user interfaces.

5.5. Summary

This chapter discussed full detailed analysis and design methodology of Hand Scanning

System. Starting with analyzing current system, system analysis's goes up to the proposed systems class. Next chapter will cover the implementation details of the system.

Chapter 6

6. Implementation Hand Scanning System

6.1. Introduction

Implementation information is included in this chapter. I will be discussing most of the critical and vital implementation methods

6.2 Capturing the Hand Model

When an user is subjected to the hand scan, the person must first fill out a form containing the following information;

- Country
- Region
- Race
- Weather Conditions
- Age

This information helps to identify the meta data about the specific scanned hand.
Then the user proceeds to place the hand in the scanning area after selecting which hand that the user has placed. The scanner is then activated which proceeds to build a model of the subjects hand.

6.3 Processing the Model

(1) The model is then cropped to remove the excess model features till only the hand remains in the model. For this model, Noise Reduction techniques are applied to get a clearer model of the hand. Using the reduction techniques, the following types of noise can be removed;

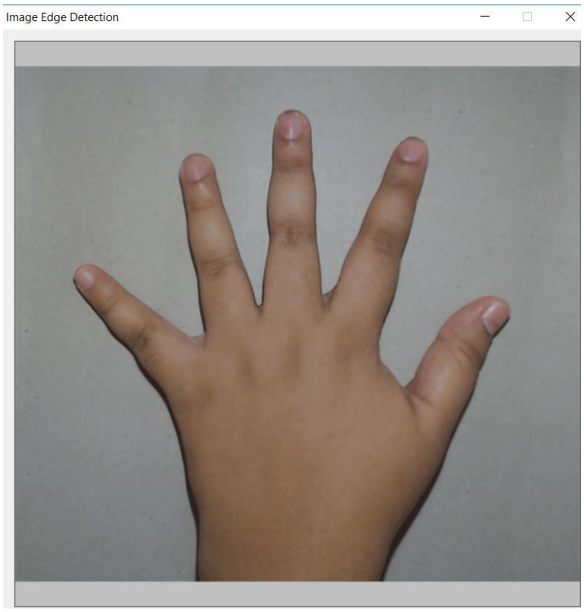
- Salt & Pepper Noise

- Gaussian Noise
- Reduction filter used; 3x3 Mean Filter

Mean filter

The mean filter is a simple sliding-window spatial filter that replaces the center value in the window with the average (mean) of all the pixel values in the window. The window, or kernel, is usually square but can be any shape. An example of mean filtering of a single 3x3 window of values is shown below.

How It Works



The idea of mean filtering is simply to replace each pixel value in an image with the mean (`average') value of its neighbors, including itself. This has the effect of eliminating pixel values which are unrepresentative of their surroundings. Mean filtering is usually thought of as a convolution filter. Like other convolutions it is based around a kernel,

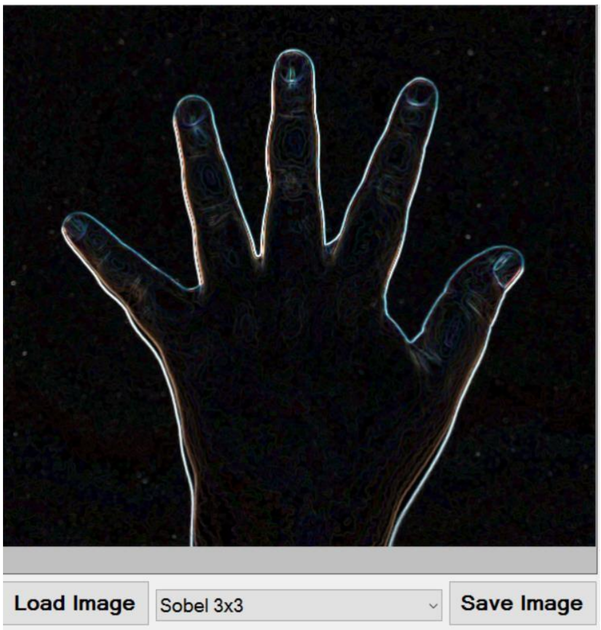
which represents the shape and size of the neighborhood to be sampled when calculating

the mean. Often a 3×3 square kernel is used, as shown in Figure 1, although larger kernels (e.g. 5×5 squares) can be used for more severe smoothing. (Note that a small kernel can be applied more than once in order to produce a similar but not identical effect as a single pass with a large kernel.)

(2) **A Grey Scale** filter is applied to the image. When doing so it helps the identification of the features in the image much easier.

(3) **Edge Detection** is applied. To so do the following methods are available;

- Sobel Method
- Canny Method
- Prewitt Method
- Roberts Method
- Robinson Compass Masks - Krisch Compass Masks - Laplacian Operator.



Out of the above methods, I’ve used the Sobel Method for Edge Detection. Edge detection is applied so that most of the shape information of an image is enclosed in edges. We detect these edges in an image and by using these filters and then by enhancing those areas of image which contains edges, sharpness of the image will increase and image will become clearer.

Using edge detection, I’m able to identify each individual finger. This means that I’ve will obtain the following data sets;

Finger	Length	Thickness	Width every 10px interval						
1									
2									
3									
4									
5									

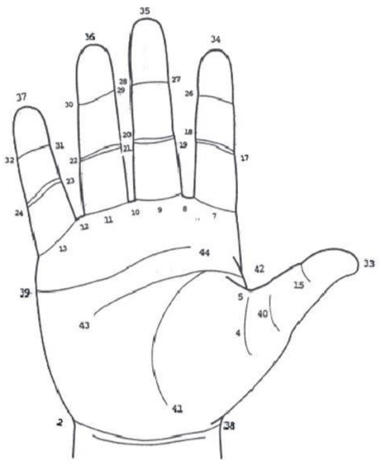
Length: The length of each finger

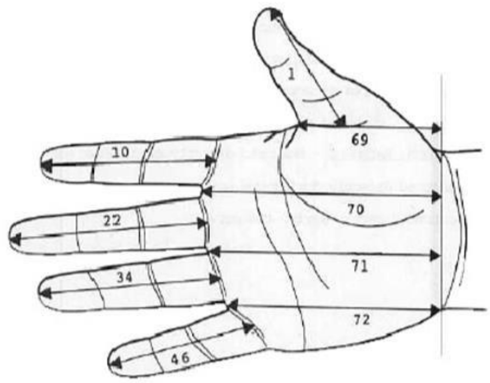
Thickness: The thickness of each finger

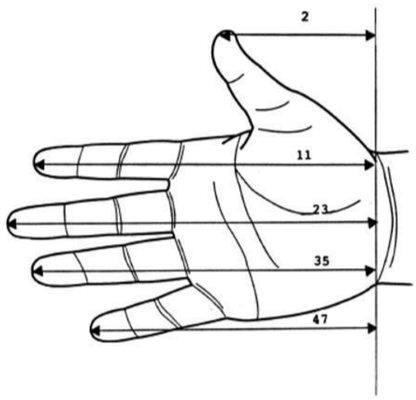
Width: The width of the finger is taken every 10px intervals. This will give a reading of the shape of the finger along the length of the finger.

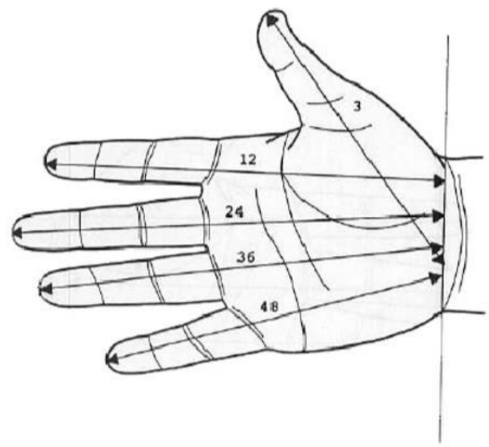
The volume of the hand without the fingers is also calculated here.

And also calculate the following lines

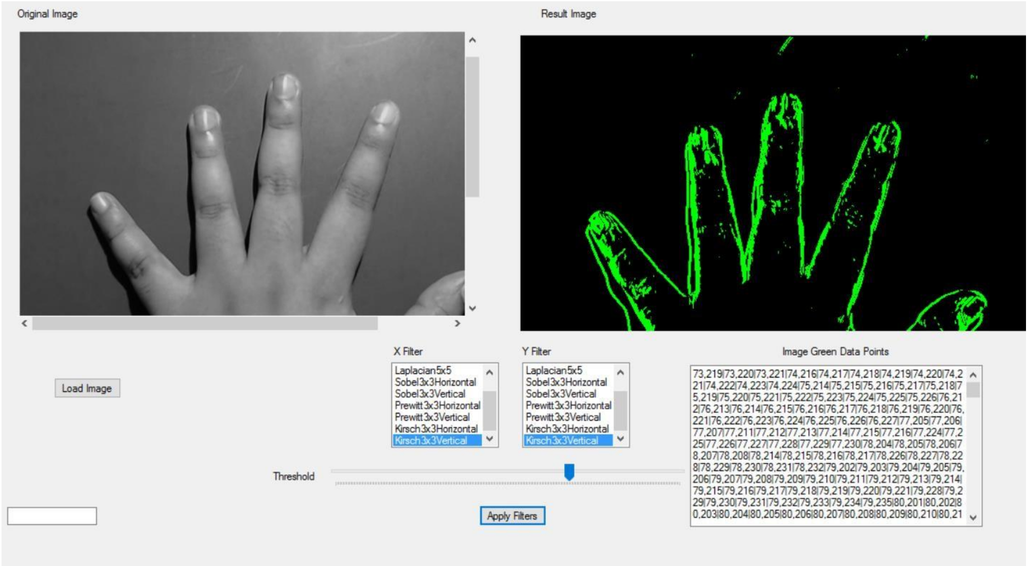


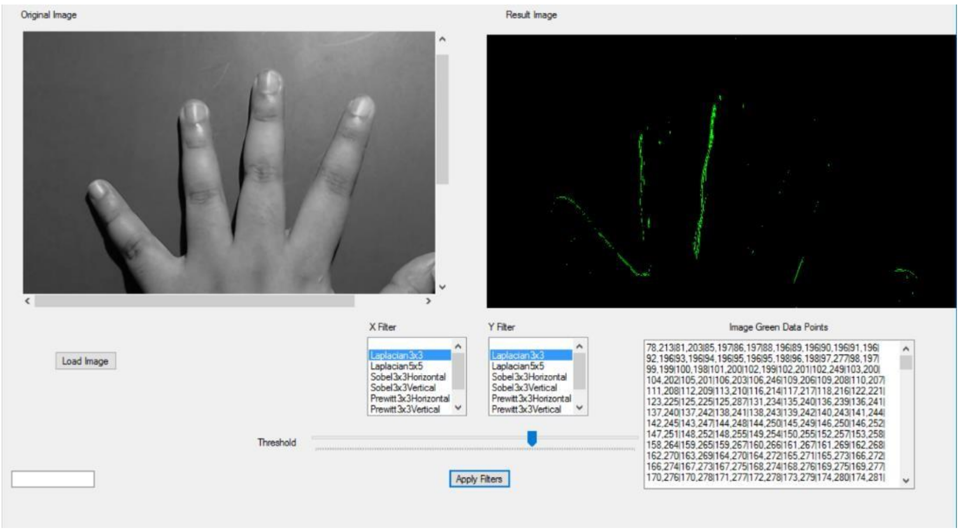






(4) **Calculating the Actual Dimensions**





The dimensions that are obtained from the scanned image are then referenced with data from actual physical hand measurement data. This then gives a measurement of the hand in the physical space in the standard Unit of Measure.

All the data set that is obtained from the models are then fed into the database. By keeping the ratio's we can calculate the dimensions of the hand for future references.

(5) Analysis

The collected data can then be grouped by the meta data that was obtained earlier. Using this we can build a dashboard to represent the data in a scalable manner. The dashboard will then help users to identify patterns that are present within the data set that is in store.

The data will be sorted by country, age, gender. By using various representation methods such as drill down charts and scatter plots, we can easily drill down the lower levels of the data and specifically pin point the patterns of spread throughout the region.

The for the target audience defined by the customer, we can propose the quantities of the glove sizes that would be the best fit for the region.

Scale Definition Algorithm

For the obtained datasets, by plotting them in a linear scale, when can get a quantity that best fits the sizes for the hand. By averaging this out, we can say that for this specific sector, the proposed hand glove size would be the most suitable.

By using the frequency of the data plots in the size sector, we can propose the size ratio that would be required for a specific region.

Chapter 7

7. Product Evaluation.

7.1 Introduction

In evaluating the validity of the project one key component is measure the accuracy of the hands that were measured. This is a key factor that determines the success of the approach taken in gathering the necessary data that is the core part of this project.

7.2.1 Volume Measure

To get a sense of the accuracy of the measured data from the scanner, the best method of validation would be to compare the volume outputs from the scanner to the physically measured result.

To obtain the physical measurement the following steps were carried out;

1. Measure the length, thickness and varying width of a subject's hand using a tape measure.
2. Measuring the volume of a subjects hand by using the displacement method of placing the hand in a jar of water and measuring the displaced volume.

The results were then compared and found that there is a 5% variance between the actual and the calculated volume which is in the scope of the error that is negligible.

The 5% error rate was actually higher, and after diagnosing the width measurement had to be finer, we settled on the 10px interval that the width is measured.

7.2.2 Length Measurement

The length of the fingers also has to have a high rate of accuracy when taking the measurements. For this individual finger were measured using a tape measure and then the calculated length of each individual finger was compared. This this comparison yielded a high rate of accuracy mostly due to the Edge Detection pinpointing the dimensions of the finger in an accurate manner.

7.2.3 Spread Validation

In order to validate the accuracy of the spread, hand data of subjects were taken at large scale from a localized geographical area so that the density of the data in that area would be sufficient to validate the data and its drill downs. As subjects, employee of the organization volunteered and were able to gain a calculable amount of data.

7.3 Validation Conclusion

From analyzing the data that was obtained from the validation, we can come to a conclusion that the data accuracy is in a scale that is sufficient to be taken decision from. This meant that proposal can be made to the customer about the size of the gloves with certain accuracy.

Chapter 9

8. Conclusion and further work.

8.1 Introduction

This chapter is for the conclusion and further enhancements to the system. There I will discuss the success of this development and the capabilities of further enhancements

8.2 Conclusion

One of the key parts of the system was to facilitate the customer with an option to know the movement of the product beforehand so that more focus can be given to the purchase of gloves in different sizes according to the region. One key part that had that had an issue was the unavailability of data which to make decision upon and a system that could potentially collect such information in a large scale and display it in a sensible manner.

Possessing such a system will also gain a competitive advantage over other business organizations, business stakeholders should be able to make the most beneficial decisions at the right time.

As a proof of concept, the demonstrations done showed that the system implemented can be broken down into sections and then scaled so that the required data can be collected from various locations simultaneously. If large amounts of data collection is successful in a scale that decisions can be made, this is an invaluable methods of keeping the customer satisfaction to a very high level.

Since the degradability of the collected data is low, the data set can be utilized for a considerable amount of time without much maintenance.

The data collection methods proved to be much more scalable than initially estimated since it required very little input from the user and the process is a quick one.

Using the dashboard various levels of analysis can be done with ease and the drill down levels that are created from the meta data collected during the time the data is collected can provide a good insight to the patterns that run through each specific region.

Since the manual tasks that has to be carried out in data collection is at a minimal level, the accuracy of the data can also be increased since the chance of user induced errors are at a minimal level. Automation of the calculations meant that large input volumes can be handled easily with little effort.

8.3 Future Work

One of the main methods of increasing the accuracy is to apply outlier detection to the data set. Using this method, any erroneous data in the set can be easily identified and cleansing of the data can be carried out. This too can be done with little effort thereby integrating such a feature to the system hassle free to the end user.

On expanding the collection criteria, we can proceed step by step to the upper hand and thereby increasing the scope in which the data can be used for proposing the sizes that is most suitable for the specific region on a wide range of personal safety equipment. Initially expanding the scanning capabilities to the upper regions of the hand can be done with little physical modification to the scanning equipment.

The collected data can also be utilized in R&D when for say designing new products to the market. By also changing the scanning method to a 3D model, finer details of the subject can be captured, thereby in turn increasing the accuracy and the usability of the data.

One such example of utilizing the 3D models is in retail where consumers can use the scanned 3D models to test fit the products virtually before purchasing them.

Productivity on the manufacturing process can also be increased. This can be done by analyzing the patterns of the hand and then reducing the excess material usage in the manufacturing process. This would also mean that the gloves would also fit the hand in a more suitable and comfortable fashion.

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