AN EXPLORATORY STUDY IN DISPLAYING INTERACTIVE CAR CATALOGUE SYSTEM ON MULTI TOUCH TABLETOP

By

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Dissertation submitted in partial fulfillment of

the requirements for the

Bachelor of Technology (Hons)

(Information & Communication Technology)

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CERTIFICATION OF APPROVAL

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Shanggar A/L Mathawan

A project dissertation submitted to the
Information & Communication Technology Programme
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
BACHELOR OF TECHNOLOGY (Hons)
(INFORMATION & COMMUNICATION TECHNOLOGY)

Approved:

_____

(Dr. Suziah Sulaiman)

Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

May 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Shanggar A/L Mathawan

ABSTRACT

This report covers on the implementation of tabletop tablet to display interactive catalogue system in the car industry. This project is a prove of concept indicating that the multi touch techniques are really useful in car industry as the user can direct manipulate sense of touch on viewing the car catalogue. This is proved when car purchasing activity or car road show take place. It focuses on the background on the catalogue whereby less interactive and low in usability discussed. The prime objective of this project is to investigate whether by having tabletop tablet will add and induce usability via user collaboration enabling more than one user to perform moving, resizing, zooming and rotating the car catalogue projected on the tabletop. On the literature section, it had been mention details of the architectural, design and application component. It also findings and readings on the multi gestural techniques, natural user interfaces (NUI) and the multi touch development platform. On the methodology part touches on the timeline and period how the project being carried out. Attached together the Gantt chart and flow chart on the event flow and task schedule. Discussion and result section talks about the development of the project and outcome of it. Description and explanation was included on how the multi-touch application being developed integrated with the entire component. Discussion regarding the system advantages, recommendation for future opportunity and weakness included in second last section. The recommendation described and explained taking into account of the system weakness and further improvement on the further coming years. Last section is the conclusion, discussing on the hope and key aspect achieved throughout the software development and progress.

ACKNOWLEDGEMENTS

Firstly, I would like to express my gratitude and thanks to my supervisor for this project, Dr Suziah Sulaiman for giving great opportunity to come up with this car catalogue system project using tabletop. She had given full support and guidance to me throughout the project progress. I really appreciate her willingness to spend time in the lab together with me to troubleshoot the problems and issues. Even more constructive ideas were shared to me by her on how to further enhance the project and on how to conduct a good research. Her understandings and encouragement had boost and motivate me to push for better research paper and prototype. The support and help that I received from her had made a smooth project progress.

Besides, I would like to thank the master student, Ahsan, who had taught me a lot about the FTIR multi-touch system setup, which is the hardware for the multi-touch application that I developed.

I owe my deepest gratitude to my best friend, Rohashnur Hazwan for helping me to setup the tabletop hardware since the hardware is big. Thus, it needs at least two people to better handle and position the projector and other heavy devices of tabletop. Besides that, I would like to thank my senior, Eileen for guiding and assisting me throughout the prototype creation. Since she had experience dealing and handling with the tabletop, she had better and strong understanding. I am grateful to my family members, especially my sister, who supported and encouraged me throughout the research.

Lastly, I offer my regards and blessings to all of those who helped me in any respect throughout the project, including the postgraduate students who always open the lab for me, Dr Suziah, who gave me approval to access the usability lab, and also the students who are willing to help me in the testing of the application.

Thanks God as well for making all things possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AS3	Action Script 3.0
CCV	Community Core Vision
CLI	Command Line Interface
FTIR	Frustrated Total Internal Reflection
GUI	Graphical User Interface
HCI	Human Computer Interaction
IP	Internet Protocol
NUI	Natural User Interface
OSC	Open Sound Control
POC	Proof of Concept
TCP	Transmission Control Protocol
TUIO	Table-top User Interfaces Objects
UDP	User Datagram Protocol
USB	Universal Serial Bus
WPF	Windows Presentation Foundation
XAML	Extensible Application Markup Language

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Catalogue is a list or itemized display, as of titles, course offerings, or articles for exhibition or sale, usually including descriptive information or illustrations. Catalogue can be described as book that contain organized information about products and illustrated with pictures. According to The National Mail Order Association, Benjamin Franklin is believed to have been the first cataloguer in the United States. In 1744, he formulated the basic mail order concept when he produced the first catalogue, which sold scientific and academic books. Catalogue was aimed for the business and sales industry. With the introduction of the catalogue, sales people nowadays had an easier way in display their product to the users and customers. This includes the advertising claims, testimonial from satisfied customers and detailed description of the product.

Due to evolution of technology and moving towards a green environment, a mail order catalogue being introduced into the industry. Aaron montgomery was the pioneer in producing the mail order generally which the describes the buying of goods or services by mail delivery. Most the popular ordering method being used in the current days world are the website and through telephone. By creating a direct marketing industry and generate benefit by removing the middleperson (Aaron Montgomery Ward, 1872). This had bigger significance as now the mail ordering had become popular in the current global world and widely used.

From the research conducted, there is yet no catalogue system being implemented in the tabletop multi-touch environment. As being conclude, catalogue in terms of website and mail ordering is widely used and existed in the market. The author would like to come up with the car catalogue system implemented in the tabletop. Tabletop can understand a smart tablet as large as table used to project and support multi-touch features. The concept is to come up with a multi-touch hand gestural car catalogue system. The reason coming up with the automotive industry is because we all

aware that the automotive is the one of the big developing industry globally. According to the statistic being produced by Malaysian Automotive Association, around 550 391 local cars being used in 2010 compared to 343 173 in 2000.This indicating the car industry will not hit it down point and will expand the coming years. Well aware, there few main key car industry players like Proton, Perodua and several methods being used to promote their product. Publishing catalogue are one of the method being used by most of the local car dealers to illustrate their products and providing the users with description. In certain circumstances, there will be road show conducted to gather the car buyer crowd in order to provide them with the real visions of the cars to easier them to make option and choice to buy car. Even certain circumstances, there are company which develop website for secondhand car purchasing and do distribute the handout to reach to the customers.

For a new change, the author would like to introduce interactive catalogue in multi-touch tabletop as final year project. There is a need for a multi-touch system for this type of promotion as we all know that the current technologies is not just tabletop but we do have smart phone and more devices which implementing on the touch senses like being newly released Ipad, Blackberry ,Iphone and others. From most of the users, they had provided a sound feedback from using this kind of devices implementing touch technology. Few key points that had been retrieved from the users' feedback on using touch technology. Tabletop promotes high usability and interactive as the user find it easier to use and enjoy using it. The touch technology does not require us to complete a complex system and we just need to use our natural physical interaction like fingers to touch and complete all the activities. It is highly interactive as not only single user while multiple users can engaged with the activities as the catalogue system in tabletop will be develop in order to involve multiple users. By this the users will be satisfied in using the system and it improve the way the user perceive learns and information about the car description in the tabletop compared to the paper catalogue or web mail. On the other hand, the advancements in touch sensing technologies had allow the reduction in the cost as by introducing the system, there is a factor whereby the car industry player could eliminated the need for the car show as the car catalogue system planned to provide a

3D views. In addition, the hardware tool, tabletop itself does not cause much around 8000 Malaysia Ringgit.

The programming tools that flash with action script 3.0. This action script was the latest and aimed for the following goals, safety, simplicity, performance and compatibility. Action Script 3.0 is a powerful, object-oriented programming language which has built in touch screen function to enable multi-touch. Initially the action script was developed for the 2D vector programming and later evolved into more object oriented programming. The advantages of using object oriented programming is reusability and maintenance. Basically when we create an object, we can reuse it back in different class and program. Furthermore, objects can be maintained separately and fixing problems easier. The undeniable advantages of using the action script is the coding very simplify and complexity is reduced so that the program structure is very clear. The interesting part about the programming tools is that is able to support built in data types like

Movie Clip: a movie clip symbol
Text Field: a dynamic or input text field
Simple Button: a button symbol

1.2 Problem Statement

The problem statements to this project are:

- The online catalogue and other promotion tools induce low interactivity and usability. By using smart devices like smart phones the focus is only on single user rather than multiple users.
- Additional cost incurred to bring real car during car road show.

The author claims that the current catalogue is low interactivity because an online catalogue will be just static and using mouse interaction if the user using computer and this will induce low level of usability and enjoyable experience. Even smart phones is there to add multi-touch features still there are limitation like the display screen is small and the images limitation. Smart phones cannot support multiples images on the

screen and this can reduce the user experiences. Apart than this, normally in the car exhibition there will be only selected car being display and if there are customers asking for other model, the dealers might have to bring them to store or shows them book catalogue which might be static. In case tabletop being use, this can increase the interactivity and the customer can get a better first hand information apart from the good user experiences.

1.3 Objective and Scope of Study

The prime objective in this project research:

- To evaluate the effectiveness of tabletop implementation in displaying car catalogue.
- Enable multiple user interaction whereby multiple users able to interact while moving, resizing and rotate car images on the tabletop hardware.
- To better assists and improvise the decision making of the customer to purchase cars by having customized car software based on gender.

With the introduction of the tabletop technology in the car industry, it would mutually benefit both parties. Users can have high interactive system for car purchasing and this meet all the usability requirement, pleasant to use, convenient and enjoy using. Sales company can cut cost on displaying a real car just by substituting with the tabletop device.

The scope of study is on Action Script 3.0 and WPF touch framework to develop the multi-touch car catalogue system in the tabletop. The WPF functionality is to add the multi-touch features into the program. In addition, the hand gestural techniques are being used and sensitivity of the multi-touch application being looked and studied. With the defined scope, project was targeted to be completed 2 semesters and with the touch up prototype.

CHAPTER 2

LITERATURE REVIEW

2.1 Car Catalogue system

There are many facts and reading materials showing that catalogue is very vital in giving people insight about the product, system or services offered. Due to abundance information, catalog makes life easier as user could easily locate their reference. Although a handful of experimental systems existed as early as the 1960s, the first large-scale online catalogs were developed at Ohio Stgate University in 1975 and the Dallas Public Library in 1978(Borgman C, 1996).

A basic catalogue should include the following requirement:

Information: all the information and content that need to be included to be gathered before the design phase. In this situation the author are developing a car catalogue system and should have adequate details about the cars that will be included in the catalogue.

Pictures: Pictures is very important in order to give a insight to the customer on how the products looks and appealing picture will attract the customer. In this case, a 3D view images need to be considered into the catalogue to provide the user with the realistic vision.

By detailing out all the information, project of building catalogue will be conducted on the multi-touch tabletop devices. A transformation whereby from the current online catalogue, the new car catalogue will be projected and display on the tabletop hardware for generally user view. The changes are on the hardware devices and on the multi-touch features to be added on the catalogues.

For this specific project, minor data mining process will be carried out to gather out general customer car buying preferences sorted by gender whether male or female. The interactive car software will be able to provide the selected choices of car according to the customer preferences which is a new concept idea in the car catalogue.

2.2 Tabletop Tablet Hardware

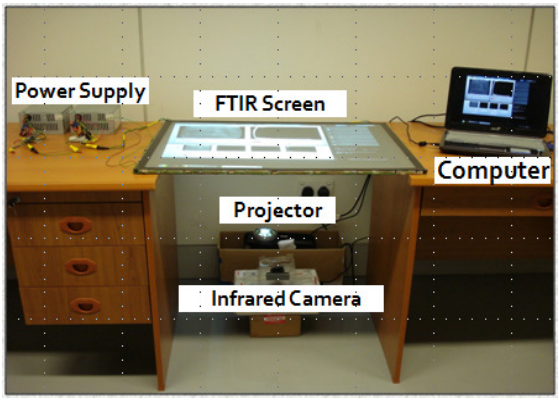

Figure 1: Tabletop Architecture Diagram

The very basic of the tabletop hardware consist of several component which are illustrated as above. The component as being underline as picture above which are

Computer- The computer here serves as the processing unit by running the application software onto it. The input will be then taken from the tabletop as from the gesture of tapping and touch. Tabletop display all the information and software which being executed in the computer once it connects.

Acryclic plane – This plane is the white surface where the application being projected onto and users can touch and perform other activities. Along the rectangled plane, there are infrared diode function to detect any touch signal and later send it to the camera.

Projector – project the light and information onto the acryclic plane.

Infrared Camera – Any signal input being detected, will be captured by this device. Then later it will send to the computer for the processing purposes.

From the research made, tabletop are widely used in the activity education , learning purposes like mind map , museum display and application required users collaboration. The major highlight been mentioned that the tabletop displays encourage a homier, more-familiar,collaborative atmosphere and provide the ability to increase a display interactive area. (Tom Geller, 2006).

2.2.1 Multi User Interaction

Typical desktop computers and handheld smart devices do not support effectively support co-located, multi-user interaction because the underlying single user design paradigm (Stewart et al. 1999). As the IT expands, there is a need for the digital information during collaboration. In order to promote this, many digital tabletops had been developed for variety of purpose. However there still exist question and less comparative studies has been made to determine the suitability of this existing system for the generalized use. Thus in this research project, several studies and comparative testing of the feasibility of tabletop in the use of the automotive industry as the digital car catalogue displayer had been carried out. The Human Computer Interaction (HCI) and usability also will be taken into consideration throughout the user requirements, design and development process. The research experience with the tabletop collaboration and digital tabletop systems observing how people use the digital tabletop, manipulate the environment, and the user experience itself. Advantages using tabletop is the face to face experience that we get by working around the tabletop with the other users or customer. Secondly on the tabletop displays can have a greater interactive area than vertical displays, which are more bounded by the human body limits.

Figure 2: Collaborative work

2.2.2 Larger display

Apart from the multi user display , the studies will also cover on the impact on the user experience using large display which is tabletop over small display probably will be 7 inch tablet. In this, we could gather the importance of large display to the users, how this effects their decision making of purchasing the car and the personal feedback of this system. The comparison of large and small display will be made based on the experience, visibility of the information and decision making process.

2.3 Multi-touch Architecture

In the multi-touch organization, the system being splits into the input processing and applications part. There are several approaches need to be conducted before adding the multi-touch component to the existing widget or application. As shown below, the higher level of the overview is being shown:

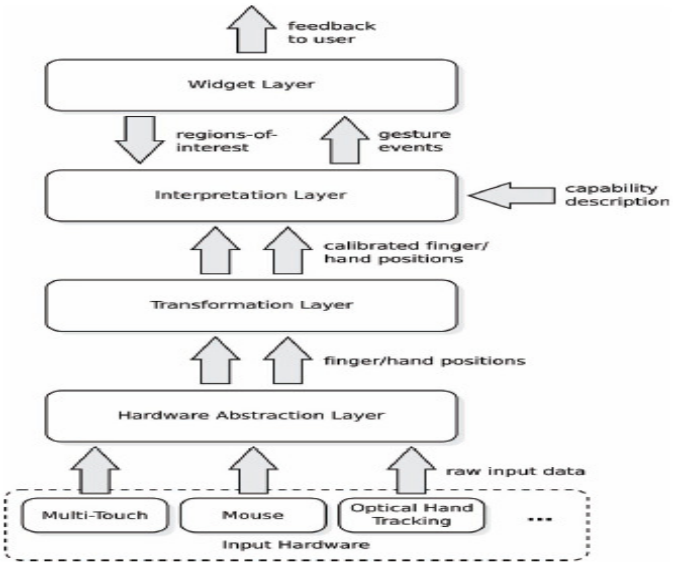

Figure 3: Multi-touch Framework

The lowest is the input hardware which refers to the medium for input generation for the next to be processed in the hardware abstraction layer. A clear text format being used as it has easier debugging. On this layer, the stream generation based on the fingers position or objects from raw data took place. The information is then sent to the transformation layer which mainly will process and transform the position data into the screen coordinates via the calibration procedures. At this very point, the information ready for the interpretation layer. The interpretation layer needs to translate the hands or finger movement into gestures event for the next layer. The main three entities needed for this process are region, events and features.

The region is the area whereby the in given screen coordinates the set of event will matches whereas event is always registered for region. So whenever specific condition meets in the region, the event will be triggered. The features are the specification of the event and when all the features being met, the event triggered. The

information being passed to the last layer, widget which has the task to response on gestures by generating visible output for the users.

2.3.1 Multi-Touch Sensing with FTIR

FTIR stands for the frustrated Total Internal Reflection which is the multi-touch techniques and technologies used in NUIgroup. The name was used by multi-touch community to indicate multi-touch methodology which was developed by Jeff Han (Han 2005). It acquires true touch information at high spatial and temporal resolutions, and is scalable to very large installations. Basically, Jeff Han used the physic and Snell Law to come up with the FTIR concept. The light enters one material from another material with a higher refractive index, at an angle of incidence greater than a specific angle (Gettys, Keller and Skove 1989, p.799). When this happens, no refraction occurs in the material, and the light beam is totally reflected.

2.3.2 Building a multi-touch based on FTIR

The principal mention above had a greater significant on implementing multi displays , the since the light that is frustrated by the user is now able to exit the acrylic in a well defined area under the contact point and becomes clearly visible to the camera below. Precisely when a light trapped inside the acrylic by internal reflection, the infrared camera captures the frustrated light when the fingers touched the acrylic surface and the region become visible. For better result the light should be totally internally reflected in your acrylic

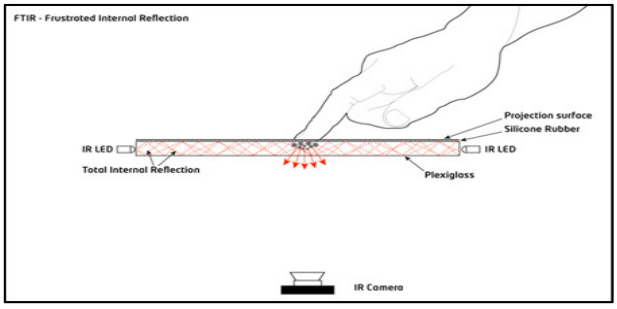

Figure 4: FTIR Framework

A silicone rubber layer is also often used as a compliant surface on top of the acrylic. The layer of silicon helps to help make dragging smoother and increases the touch sensitivity of the device, making it responsive to little or no pressure. If a compliant surface is not used, for example when using an FTIR setup with only bare acrylic, one must press hard or have oily fingers in order to set off the FTIR effect. With a complaint surface (like silicone rubber), this sensitivity is greatly improved.

2.4 CLI to GUIs to NUIs

According to August De los Reyes, director of a Principal User Experience Director of Surface Computing at Microsoft described the NUI as the next evolutionary phase following the shift from the command-line interface (CLI) to the graphical user interface (GUI). In CLI, the users had learned series of codified input and limited range of response. With the introduction of mouse enabled GUI, users could easily learn on the mouse movement and action. However the further development, it has developed into natural user interface (NUI) which is very intuitive and direct. Multi-touch is the early example of the NUI.

2.4.1Introduction to NUI

From Wikipedia, NUI is a common parlance used by designers of computer interfaces to refer to a user interface that is effectively invisible. Natural is used because most computer interfaces use artificial control devices whose operation has to be learned whereby NUI rely on user quickly learn as allow users to carry natural motions, like gestures and movement. Three main points in defining NUI are

I) Designed

II) Used Natural Human Behaviors

III) NUIs have Direct Interaction with Content

2.4.2 Interfaces referred to NUI

I) **Microsoft Surface** is the surface computing that respond and compute the natural hand gestures and real objects movement. The product idea for Surface was initially

conceptualized in 2001 by Steven Bathiche of Microsoft Hardware and Andy Wilson of Research. Microsoft surface ideas is to respond to the user gestures ,users interacting with the content by adding the features of recognizing the objects place on top it.

II) **Perceptive Pixel** is the work being done by Jefferson Han on multi-touch interfaces. He showed a variety of means of interacting with on-screen content using both direct manipulations and gestures

III) **3D Immersive Touch** is the concept of direct manipulation the 3D virtual environment using single or multi-touch surface hardware. Example touch driven hardware like Ipod, Ipad and other growing hardware.

IV) **Xbox Kinect** is a product from the Xbox which uses spatial gestures interaction rather than game controller

2.5 Multi-touch Development Framework

Just as there many framework for the computer vision, same to the multi-touch application development. There are few frameworks that will be highlighted which are Flash Action Script 3.0 and WPF 4 used to develop the multi-touch application. Included with the additional elaboration on how these frameworks integrate and works with the other multi-touch component and computer libraries.

2.5.1 WPF 4 Multi-touch

WPF or more known as window presentation foundation was developed by the Microsoft as the presentation platform for building windows client application with more interactive and spectacular visual user experiences (Adam Nathan, 2006).WPF had the below features:

- resolution-independent
- vector-based rendering engine that is built to take advantage of modern graphics hardware

WPF 4 includes support for raw touch and manipulation (with some inertia support). This support extends throughout the platform; UIElement, UIElement3D, and

ContentElement have all been tweaked to support raw-touch and manipulation. WFP exposes touch event data in three models.Raw touch basically provides access to all touch messages while the message content analyzes and interpretation left to the application. (Jaime Rodriguez, 2009).

Gestures are a very convenient abstraction from raw-touch. Mainly the platform will identified all the low level events and translate into the predefined gesture and notifies the application.The most common gestures are pan, zoom, rotate, and tap. Gestures programming very easy but limitation as usually handle one gesture event per time.
Manipulation here means interacting and influences the touch events or gestures occurred.

2.5.2 Flash with Action Script 3.0 touch events

As was discussed earlier action script is object oriented programming initially targeted for the vector programming developed by Macromedia Inc. There are few version of action script inline with the time evolution. The first was action script 1.0 which was mostly influenced by JavaScript and the ECMA-262. Action script 1.0 has two distinguish features from later versions are that is the loose type system and its reliance on prototype-based inheritance. Loose typing refers to the capability of a variable to hold any type of data allows for rapid script development while prototype-based inheritance is the Action Script 1.0 mechanism for code reuse in the object-oriented programming. The action script 2.0 in later add more features on the compile-time type checking and class-based syntax, such as the keywords class and extends while it allows on the structured object-oriented programming approach. The latest version Action script 3.0 which acquired adobe flex 2.0 with the corresponding flash player 9.0 had added limited support for hardware acceleration (DirectX, OpenGL).

The touch event concept in the action script is just the same in the mouse event in the Action scripts. There is a predefine TouchEvent class which has event type constant listen for the touch events happens. To handle basic touch event, there are few key points need to be included which are the Set your application to handle touch events

by setting the flash, Attach an event listener to an instance of a class , Specify the type of touch event to handle and lastly call a event handler in response to touch event.

In order to process and understand touch event, Touch Event object properties are important. How the object properties being identified is the when an touch event occurs, an event object is created. We need to create coding in the action script need to specify on the object creation occurring whenever the touch event happens. The Touch Event object contains information about the location and conditions of the touch event. Thus by this object properties, we could easily obtained the information and process the touch event that had occurred. Apart from this, important information we need to identify is the touch event phases. Touch event phases is basically categorizing the activities on the beginning, middle and end. By having these phases, we could track touch event through the beginning, middle, and end of a touch interaction. The Touch Event class in the Action Script does provides values for handling touchBegin, touchMove, and touchEnd events to give the user visual feedback as they touch and move object.

However, the Action Script requires other component in order to develop the multi-touch sensing application like Touchlib, reacTIVision and CCV. To start developing multi-touch Flash applications using Touchlib, Flash OSC has been invented to convert UDP socket to a TCP due to the touch data that is using Tangible UI Object Protocol (TUIO) a very simple UDP-based protocol. However, Flash does not understand the touch data in this format hence require for the conversion connection to TCP (NUI Group Author, 2009, pp. 52-55).

2.6 TUIO AS3 Protocol

Currently for the developer and programmers there had not been a proper platform or toolkits for them to develop the multi-touch and tangible input. Being the challenges, later TUIO AS3 was developed to provide the toolkit for the rapid development of the multi-touch and tangible user interface (TUI) interactions. Had been highlighted that there are two main features of TUIO which are

- Offers a sophisticated multi-touch and TUI interaction

TUIO become the platform for the open source protocol TUIO in adobe flash programming language Action Script 3 (AS3). This allows enhancing the user interface (UI) with the gestural interaction and activity.

- Capable to simulate complex multi-touch and TUI interaction via mouse and keyboard.

  As means to simulate the multi-touch and TUI interaction without a need for additional or external simulation packages or programme. Aspects like multi-finger flicking, multi finger rotation and complex gestures are supported via keyboard and mouse interaction.

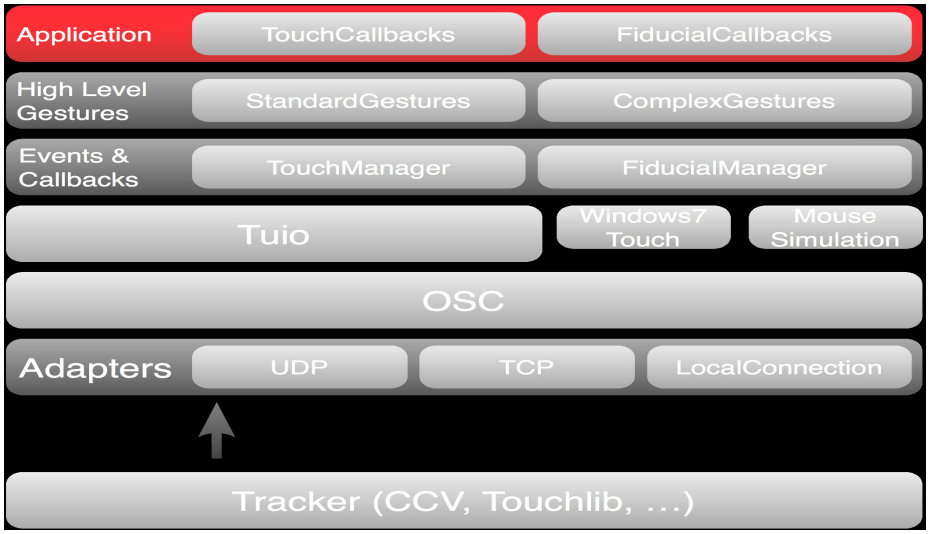

Figure 5: TUIO protocol layer

TUIO AS3 focuses mainly on the user interaction while flash platform have abundant of interactive images, animation and widget available. TUIO and action script work interdependently to provide the multimedia applications with multi-touch interaction and high TUI interactivity. TUIO offers a higher level multi-touch and tangible interaction like dragging, rotation, and scaling, flicking and customized gesture. In addition for TUIO allows the use whole hand gestural for the interaction. With TUIO AS3, TUIO connections can be physically established via one of three protocol adapters: UDP, TCP or the Flash specific exchange format Local Connection.

TUIO messages are based on OSC. Hence, a TUIO connection is set up via OSC and the network protocol adapter of choice with the tracker. (TUIO Community, 2009).

2.7 Multi-touch Computer Vision Frameworks and Libraries

At present, multi-touch being implemented in several ways and the main technologies being used in the multi-touch technologies is the FTIR. Generally there is lot of computer vision frameworks and libraries available for the development of the application of FTIR multi-touch as being describe below in this case POC for the car catalogue system.

2.7.1Touchlib

It is a library that provides all the software you need to set up your own FTIR multi-touch display. Generally it offers a simpler interface for the program to listen to touch event and multi-touch interaction surface. It handles tracking blobs of infrared light, and sends your programs these multi-touch events, such as finger down, finger moved, and finger released. By this, Touchlib is compatible with other several application that support vvvv, Processing and etc. As Touchlib is written in C++, Visual Studio, it is currently just run in Windows system. Overall, Touchlib is a development kit for the multi-touch interfaces.

2.7.2 Core Community Vision

Community Core Vision (CCV), also known as tbeta, is an open source/cross-platform solution for computer vision and machine sensing. It takes a video input stream and outputs tracking data, such as coordinates and blob size, and events, such as finger down, moved and release, that are used in building multi-touch applications. The new recent CCV 1.5 has been released with a lot new features been improvised being added offer stable multi-camera support, enhance code quality and performance.

Compare with reacTIVison and Touchlib, CCV has more filter option, which makes it easier for the users to balance and adjust the multi-touch table value. CCV's filter option includes:

Dynamic background subtraction, high-pass, amplify/scaler and threshold. This means it works with all optical setups (FTIR, DI, LLP, and DSI). CCV supports input switch, this feature has huge help for user who want to make applications themselves.

Requirement	Touchlib	Core Community Vision
TUIO	Support	Support
Operating System	Windows	Windows, Mac OS ,Linux
Camera Support	Webcam(USB or Fire wire)	Support all type of camera with proper WDM drivers, USB, USB2, Fire wire, CMU, DirectShow, PS3, and Kinect. This includes with the new features of automatic camera detection.
Finger Tracking ability	Good	Good
Other feature		Dynamic calibration for multiple size of multiple touch surfaces while maintaining speed and performance

Table 1: Touchlib and CCV Comparison

In conclusion, comparing between Touchlib and Core community has shown certain key indicator that CCV is more fit for tabletop project.CCV is more convenient as it

supports dynamic filter, FTIR and optical setups. Also, cross-platform ensures all kind of projects can work on their own application (Qian Liu, 2009).

2.8 UDP-Flashlc-Bridge

Udp-flashlc-bridge is a free, open-source bridge application between UDP network traffic and a Flash LocalConnection. Running from the command-line, udp-flashlc-bridge listens on a given UDP port and sends any packets that it received through a Flash LocalConnection with a given name and dispatch method, providing a highly performant way of accessing UDP data from within Flash. It has originally been designed to serve as a bridge between TUIO tracking data and Flash, but since it is not concerned at all with the format of the packets that it receives, it can be used to funnel any sort of UDP traffic into a Flash application or SWF file.

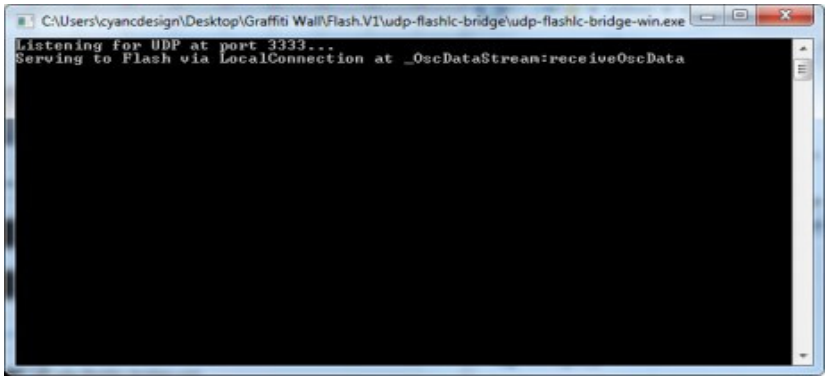

Figure 6: UDP-flashlc bridge

ii) var tc:TuioClient = new TuioClient(new LCConnector());

This line will create the local connection flash OSC as 127.0.0.1 port 3000;

2.9 Automotive purchasing preferences based on gender

Purchasing automotive or vehicle can be varying from different perspective especially on the personal preferences. As a highlight, this research objective will study on the car buying preferences based on gender between the ranges of age 20 to 30 years. There have been studies on vehicle features are considered important when buying an automobile based on genders which more or less underlining the same objective of the

research. The results were young male drivers rated safety lowest, while the level of importance attributed to safety among female drivers was highest. In this context, a vehicle's performance (i.e., speed) is considered the converse of safety. Women prefer cars that are affordable, practical and safe, and with a dash of design flair and easy to manage.

A new study by TrueCar.com has also examined multiple gender buying trends to establish if there is a link between your sex and vehicle preference. Generally speaking, the survey found that men prefer large and flashy vehicles, while females opt for smaller. A review section according to Kristen Andersson, Senior Analyst at True Car.com: “Female car buyers really gravitated toward smaller, more fuel-efficient cars and crossovers. It was the complete opposite for male buyers, who preferred either a fast and sporty vehicle with distinctive curb appeal or a big vehicle.

By taking into account these preferences, this car catalogue system will be developed and suited based to the gender on the generalize preferences and perception. Gathering this information from the surveys conducted and from the literature studies from the Internet, the catalogue systems will be categorized to male and female with different choices of cars for each gender groups. This generalize preferences considering on the cars features overall like, performance, speed, size, colors and types of the cars whether sports or standard.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In most of the IT projects well used the methodologies comprises the System Development Life Cycle (SDLC). The basic concept is the process (as a whole) of developing system or software to meet certain requirements and accomplishing it. "Systems development life cycle originated in the 1960s, to develop large scale functional business systems in an age of large scale business conglomerates" (Elliott & Strachan & Radford, 2004).

The author decided to use incremental and iterative methodology. This methodology allows certain key points as learning for the programmers has the repetitively cycles in smaller portion time. The learning will be on the between the analysis of phases and iteration which can be perform repetitively and allows to perform changes or adaptation. This response to the waterfall methodology which needs to completely to build a new system incases to adapt to the changes and no backtracking. Besides the incremental development the system functionality being divided into several portions which could named as slice while the phases being divided into few alterations, providing faster results and testers to keep their work-product backlog full. Upon completing the slice which dividing the functionality, we could choose the higher priority slice to know as early as possible whether or not this project will succeed. Thus we attack the high-risk areas first.

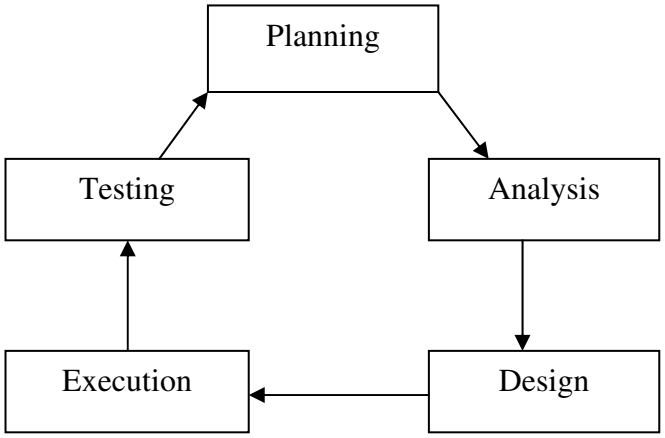

Figure 8: Iterative Methodology Diagram

3.2 Project phases

3.2.1 Iterative 1

Planning

- Plan on the requirement gathering, problem statement and objective study
- Schedule the activities on the Gant chart and time allocation for the activities.

Analysis

- Literature review on the and research on the core community vision and Nui group
- Study on the FTIR and the architecture on the multi-touch screen.
- Identify and research on the touch functionality in Action Script 3.0 with the object oriented programming.
- Questionnaire and interview with the target group users, interns and trainees for data gathering on the user requirement.

Design

- Create System flowchart
- Design System GUI

Execution

- Coding
- Write code on displaying the car images

Testing

- Bug testing and identifying error encountered on the debugging phase
- Evaluate the program functionality and specification aligned accordance to the requirement established

3.2.2 Iterative 2

Planning

- Refine the requirement and narrow down on the objective
- Understand the architecture of the program and how it works.
- Schedule the activities on the Gant chart and time allocation for the activities.

Analysis

- Learning on multi-touch functionality using Action Script 3.0 and gesture.
- Research on the adding pop up functionality on the images and interaction between applications when the touch event happens.
- Data and user requirement gathering via questionnaires and interview with the real working industry people.

Design

- Refine System GUI.
- Create System Use Case
- Create System Architecture

Execution

- Coding
- Write code on adding the multi-touch functionality to the program.
- Write code on displaying value when touch the images

Testing

- Bug testing and conduct bug-fixing
- Evaluate the program functionality and specification aligned accordance to the requirement established

3.3 Project Schedule

	Weeks													
Tasks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Planning:														
Project title selection														
Writing project proposal														
Project title approval														
Requirement and data gathering														
literature review on title														
Select project methodology														
Define project overall flow & Gantt Chart														
Analysis:														
Research on software design														
Perform research on tools (programming language / sample codes) for development														
Perform research on the hardware to be used (configurations / driver installations)														
Analyze on the FTIR multi touch														

	Weeks													
Tasks	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Design:														
Design System Diagram														
Design the program flowchart														
Coding:														
Programming using action script														
Development of multi-touch functionalities														
Testing:														
Prototype testing & Error debugging														
Submission of Dissertation & Project finalized prototype														

Table 2: Project Schedule

CHAPTER 4
FINDINGS AND DISCUSSION

4.1 System Use case

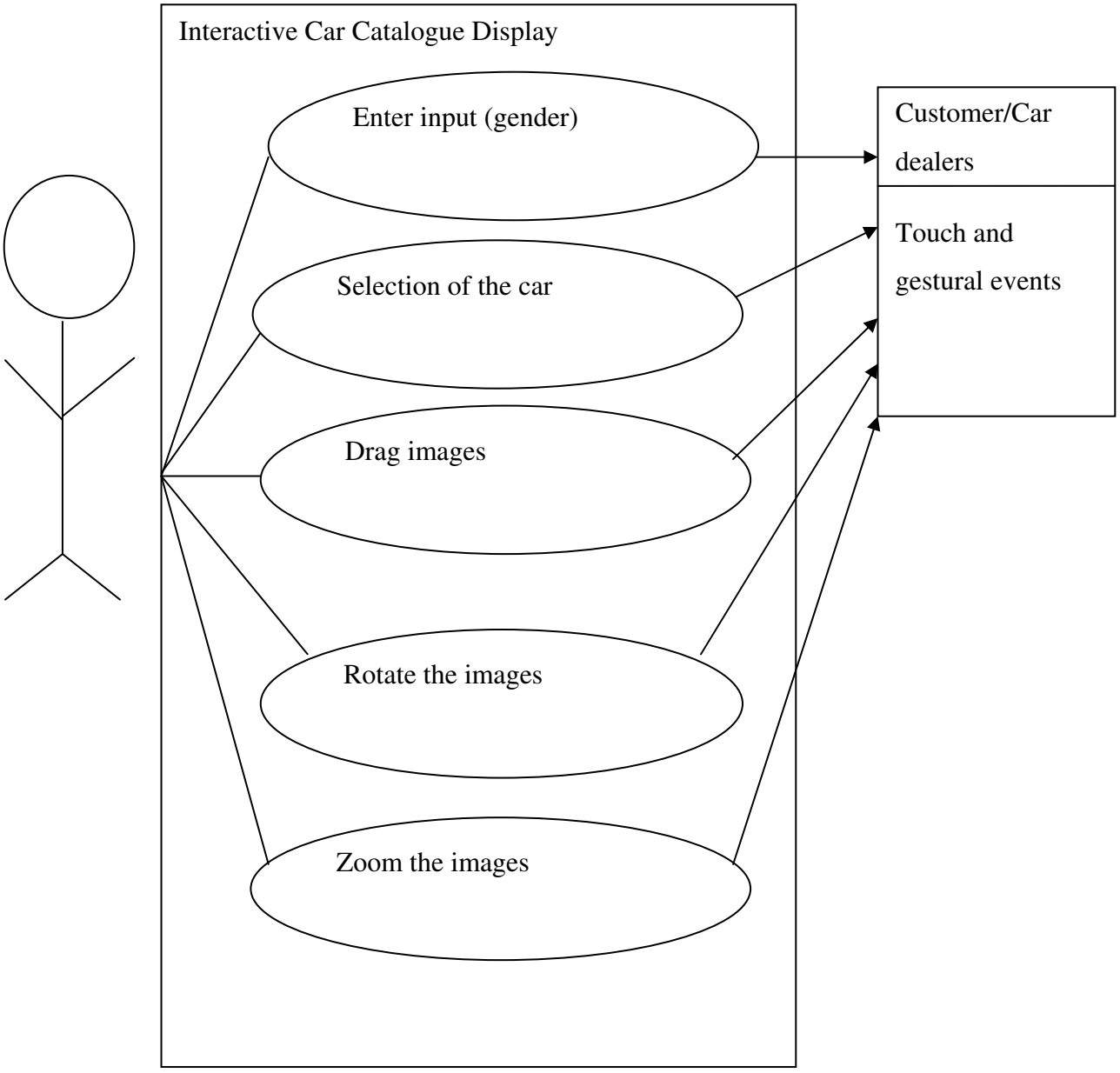

Figure 9: System Use Case Diagram

4.2 System Flowchart

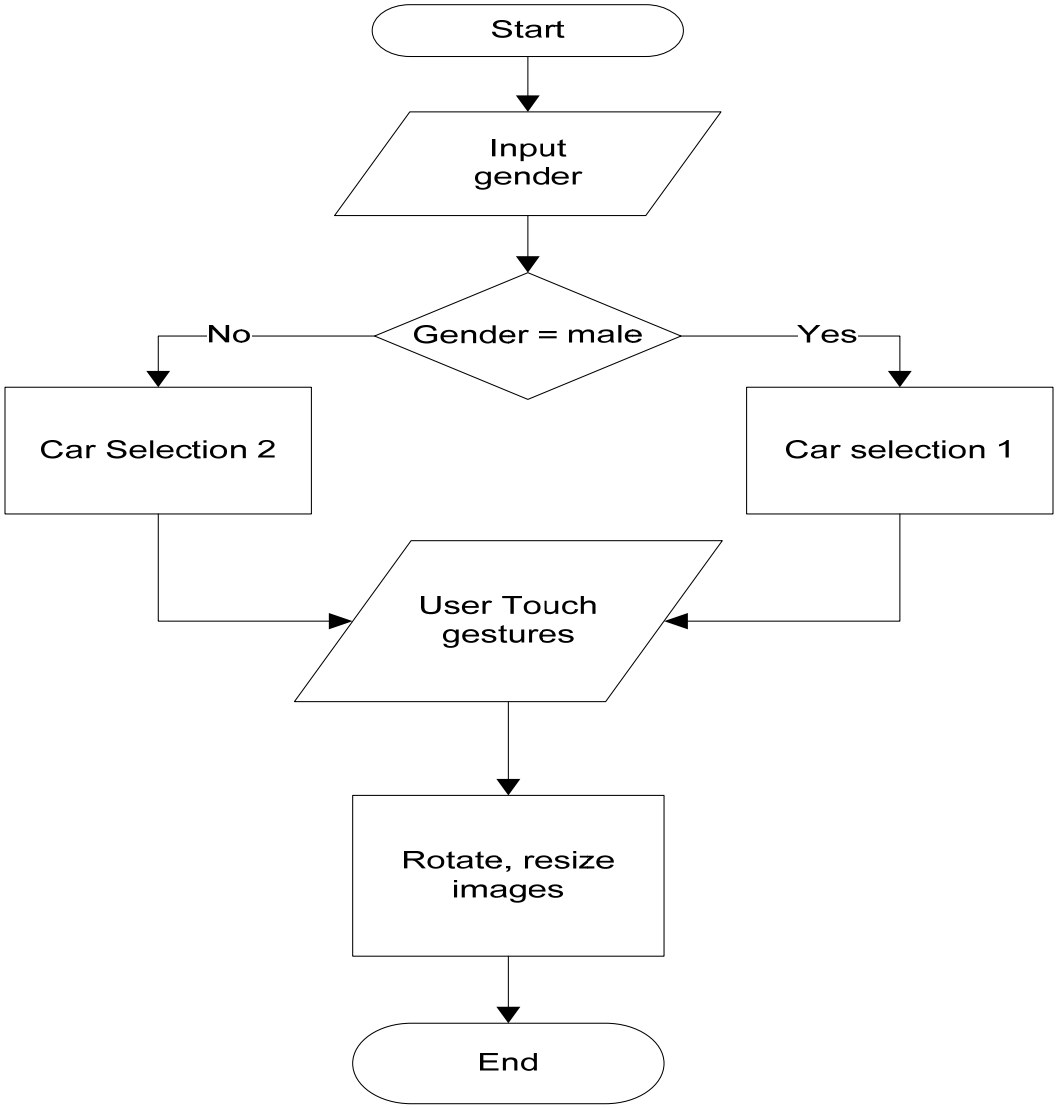

Figure 10: System Flowchart Diagram

Both diagram showing basic process flow on the user interaction between the application software and the related touch event input on the catalogues.

4.3 Discussion on Work Progress

4.3.1 Interview with trainee about tabletop

Before coming up with the project at first place, interview had been conducted with the students who are undergoing their internship in the car industry. The first candidate from the Mercedes Benz Company and her feedback was this kind of multi touch technology is not being implemented yet and currently they are using the paper catalogue book for their customer reference.

The second candidates from Proton Edar Sdn Bhd which do agree that their company also have not implemented this multi touch catalogue technology. Currently they are using the online catalogue for the customer reference and all record keeping through the online.

The author had the chance to project questions to the qualified sales marketing personnel and roughly below the results of the question.

1) How do you think of car multi-touch catalogue?

   Yes I do believe this will greatly promote and induce the interest for the customer to look at the catalogue especially by having multi touch features. In addition tablet or smart phone application software also feasible.

2) Does this help in convincing the customer if the catalogue categorized based on customer requirement?

   In some way it helps, yet there are customers also interested in looking the real cars and would like to go physical car showroom before deciding in purchasing.

3) In roadshow, only selected cars will be displayed. What if the customers want to look at other models?

   Usually there will be new models being displayed and if in case there are customer would like to have to look other models, we have our car store nearby which always have the other models.

4.3.2 Gathering users' requirement for catalogue development.

Questionnaire consists of several question were distribute among 30 students of UTP in order to receive their feedback and comments on multi touch catalogue.

Question 1: Do you feel gathering first hand information about car via promotion tool medium like catalogue is important?

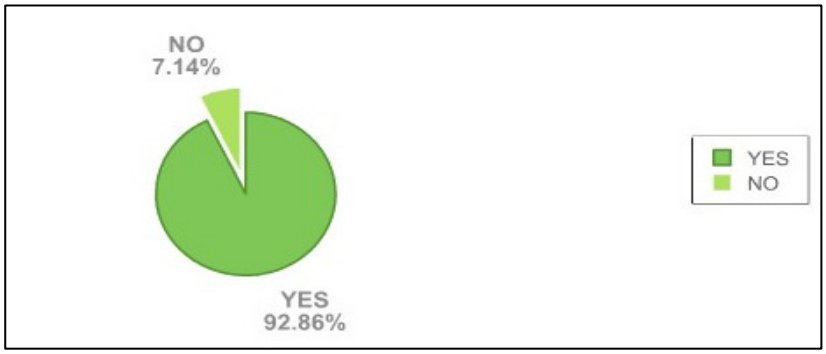

Figure 11: Pie Chart 1

This result shows that 92.8 percent of the respondent agrees that the first hand information is very vital because purchasing the real products. This is to get to know what all the products about, and details on the car specification or features.

Question 2: Does dealer do a great job in providing information when purchasing a car?

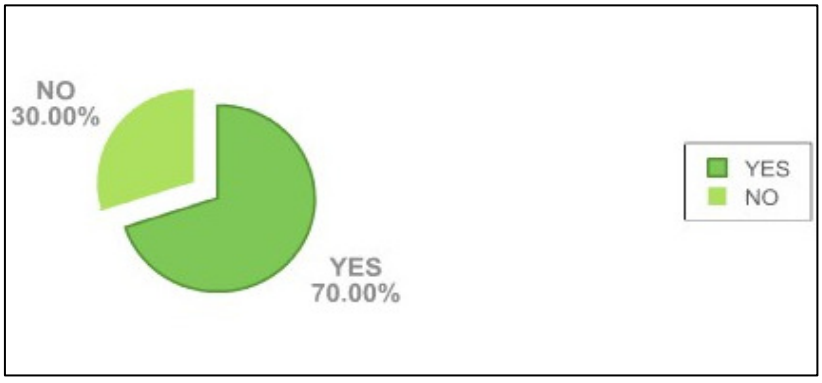

Figure 12: Pie Chart 2

The second question was designed in order to determine whether the current car dealer makes impact on the customer decision of buying car. How well the car dealer makes effort in assisting and giving the information of the cars to the customer. Roughly 70

percent agrees that car dealer help them to purchase the cars. About 30 percent did no because they have already visited other medium tools like website and gather adequate information before making a firm stand. Therefore there are tendency where customer feels that the dealer information and talking to them does matter much as they already made their choice.

Question 3: What are most used promotion tools to display the car products and details?

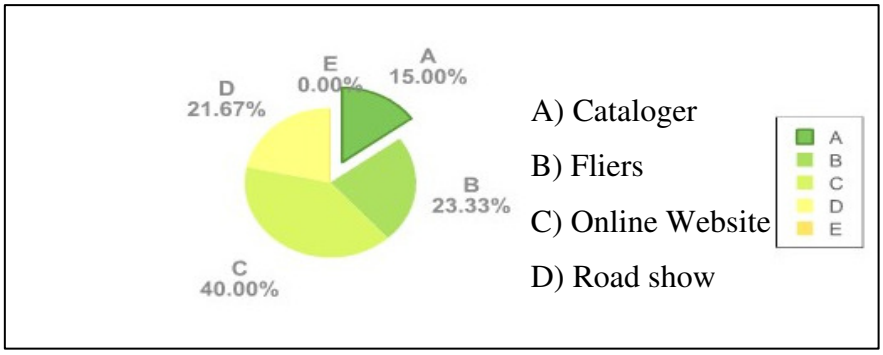

Figure 13: Pie Chart 3

This question was designed to narrow down what is the most common promotion tool people use to gather information about cars. From the pie chart above showing online website had the highest percentage with 40% followed by fliers 23.33%, car road show 21.67% and lastly cataloger with 15 %. This clearly shows the trend today, the buying group is more aware towards technology oriented promotion medium.

Question 4: How do you like having a multi touch catalogue system display on tabletop?

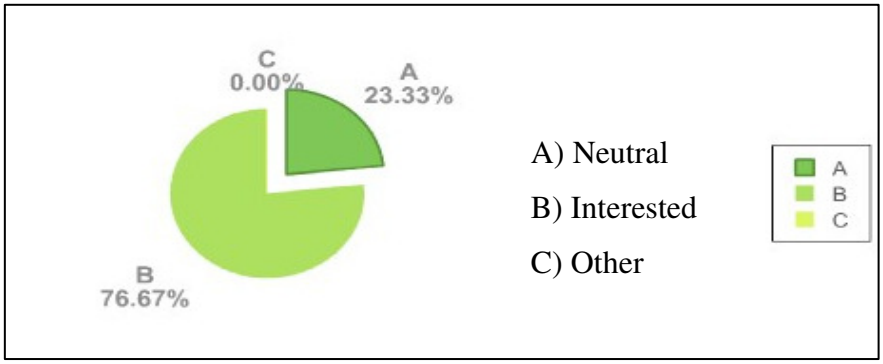

Figure 14: Pie Chart 4

The highest was positive feedback saying yes that is 76% showing that they are keen and interested on this multi touch function and the rest group on neutral.

Question 5: Do you prefer multi touch catalogue compared to paper catalogue and fliers?

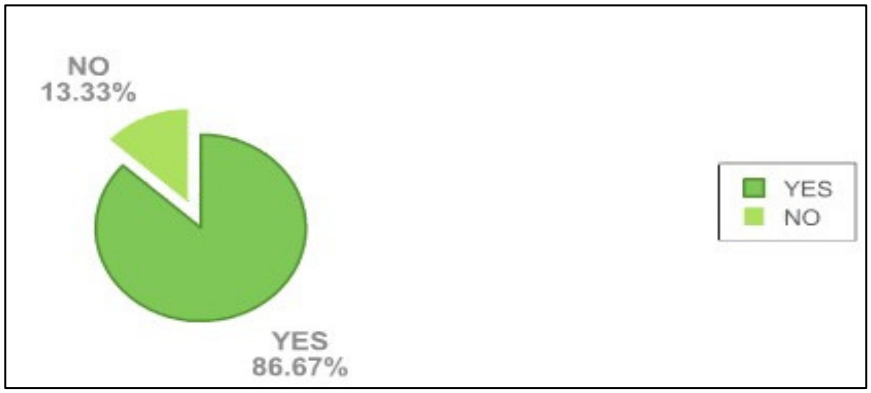

Figure 15: Pie Chart 5

From the chart above showing around 86 percent prefer for multi touch because it is a new technology and young generation are driven to technology. 13 percent of the group did not react positive with saying no because they have not yet experience this kind of technology and therefore could not foresee the importance of having this multi touch technology.

From the survey being conducted above, we can conclude that the customer value information about the car before looking onto the physical product. They prefer to gain as much as information and the most important medium that being used to perform this via website. Based on the data above, website is the popular tool as it is very convenient to the customer in terms of accessibility and super fast information. Something to be understood by the car company that having roadshow would be good but again costly and not everyone can participate depending on the location. Furthermore it is proven that new introduction of multi touch technology are accepted and supported by the customer as they believe this technology is fascinating and interactive. Driven by the evolving technology, more and more customer starting to aware that this multi touch features is a booming technology and excites them.

4.3.3 Gathering car buying preferences based gender

As part of the requirement in car catalogue system development, survey was conducted to determine the purchasing preferences between genders. This results will be useful as the car system will be categorize to genders by displaying selected cars for respective genders accordance to the generalize preferences being interpreted from the survey. The survey was limited to age group 20-30 and respondent consist of UTP students. The questionnaire was distributed evenly to both 15 respondent of respective gender

Section 1: Male

Question 1: Do you prefer driving small car compared to big sized car?

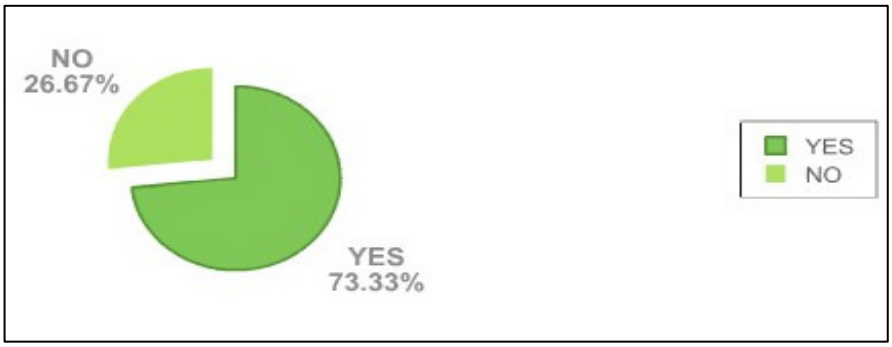

Figure 16: Pie Chart 6

Generally the response was yes with 73 percent saying they prefer to drive small car compared to big sized car due to cost of running of the vehicle. Apart from the reason, they also mention that for time being, being bachelor there are no necessity of having big car as they are not having big family

Question 2: What car color do you like?

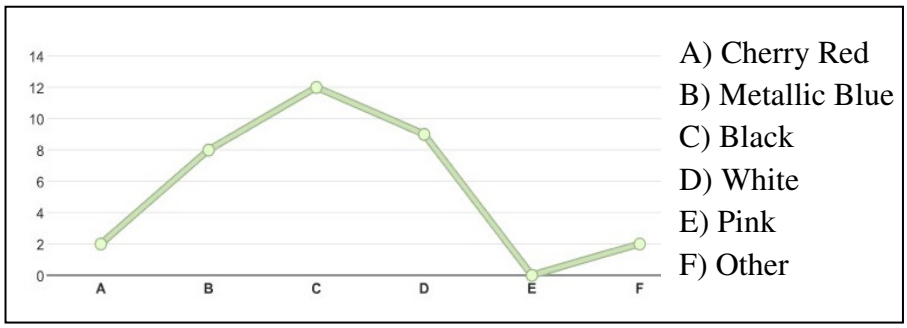

Figure 17: Pie Chart 7

Mostly of respondent had chosen black and manlier colors like metallic blue and white.

Question 3: What type car would you like to drive?

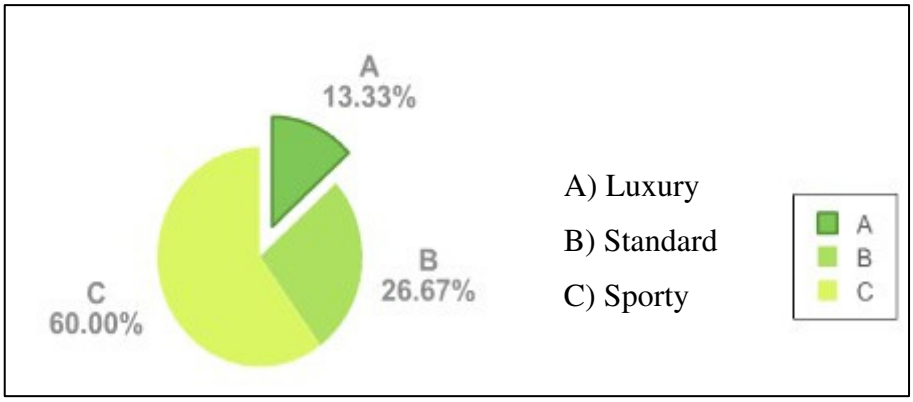

Figure 18: Pie Chart 8

Around 60 percent of the male respondent had chosen to drive sporty type of car as these suits their nature being cool and stylish.

Question 4: What the key features you emphasized before purchasing a car?

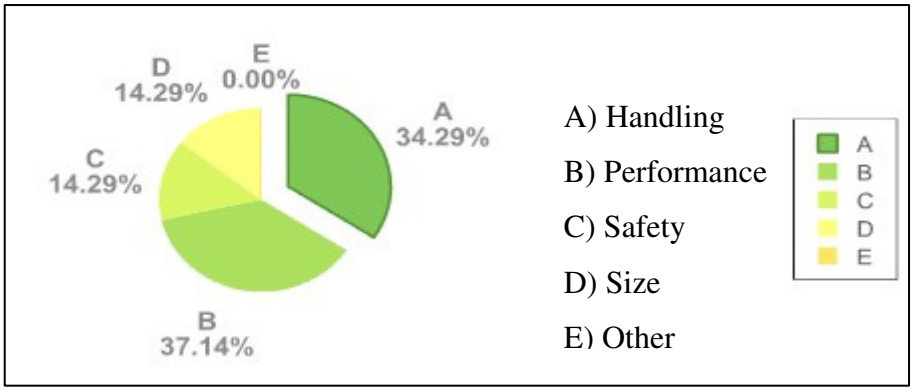

Figure 19: Pie Chart 9

Male respondent had put a high value on the performance and handling of the cars itself compared to the other safety features. Performance and handling of car is a must key factor for male to purchase to a car. They like speed and power in driving any vehicle.

Section 2: Female

Question 1: Do you prefer driving small car compared to big sized car?

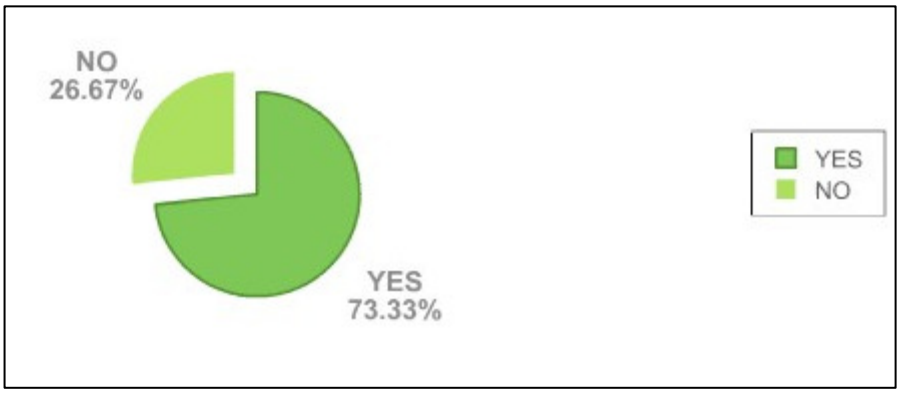

Figure 20: Pie Chart 10

Similarly to the male respondent, female respondent range 20-30 prefer to drive small cars because they feel comfortable driving small cars.

Question 2: What car color do you like?

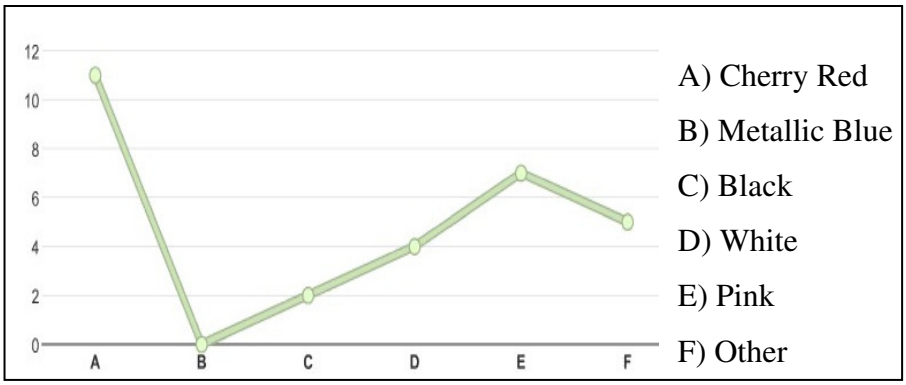

Figure 21: Pie Chart 11

Female respondent choose cheery red around 11 respondents and also pink as their car colors. Apart from that, in the other option, there are choices of oranges and yellow which around 5 respondents choose for orange color which suits more to girls' nature.

Question 3: What type car would you like to drive?

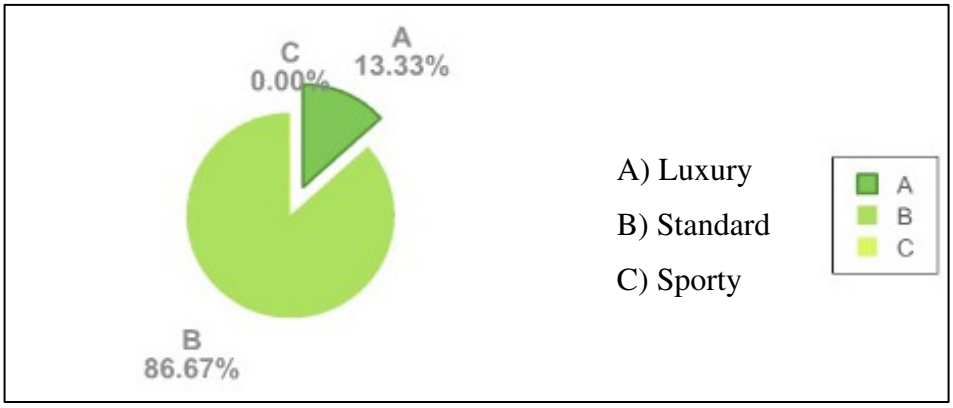

Figure 22: Pie Chart 12

Female respondent have choose to go for standard car because as research made, proven cars look for fuel efficiency and cost savings.

Question 4: What the key features you emphasized before purchasing a car?

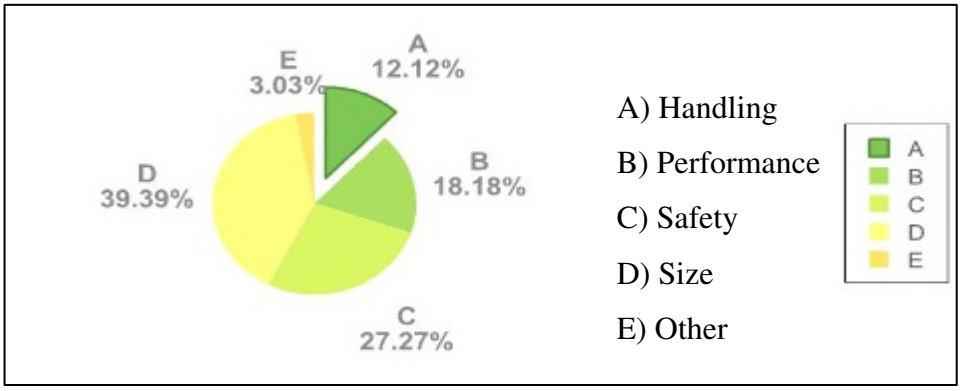

Figure 23: Pie Chart 13

From the results above, the female respondent had put high priority on the size itself which 39 percent of them and safety with 29 percent. This clearly shows for female size and safety does matter.

As summarize from the above survey being conducted, we could clearly see some similarity and differences between buying preferences of male and female within 20 to 30 years. Both of this gender goes for small car as we could see of the cost of running itself. This age group is just started to work or mostly beginning of their career life. So affording big cars with a high running cost is not their resort. Apart from this,

male love to drive sporty kind of cars which for them look more mature, stylish compared to standard for female as they always look any normal car as their vehicle.

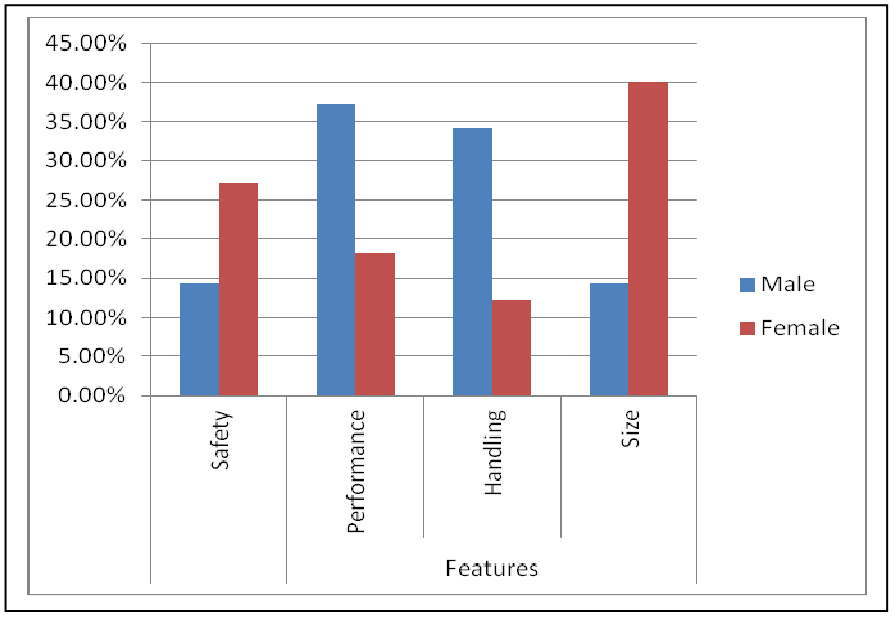

Figure 24: Graph of comparison car features of male and female

From the questionnaire being conducted, the 4 features that being emphasize are the safety, performance, handling and size. As can we can view from the graph above we can conclude that the male has choose performance and handling features higher than the female while the female has chosen the safety and size of car as most important element. The male also looks for car which speed and performance driven as this suits their nature of gender. Even handling is major concern for the male as they prefer to have good firm handling and stable even when driving the vehicle at higher speed. The female group mostly took size and safety into consideration rather than the performance itself. For them the size of car does matter. For age group of 20-30 from the result collected from questionnaire indicate that they much favor of small size car rather than big car like SUV or truck. This is because for the female group small car suits their nature, comfortable and easy to handle. They have their utmost confidence in driving small car rather than the big car as in terms of handling the car and their comfortability in driving the car. Apart from the size, safety also matters for the female group as they want a safe vehicle to drive in and would not jeopardize anything.

4.4 Prototype Work Progress

4.4.1 Car Catalogue development using Action script 3.0

i. Use of the flash Action Script 3.0 to develop catalogue

Introduction

Throughout this project, the catalogue was developed solely using Adobe Flash of AS3 and for the multi touch functionalities, TUIO library was available found in the NUI community group.

Storyboard of catalogue

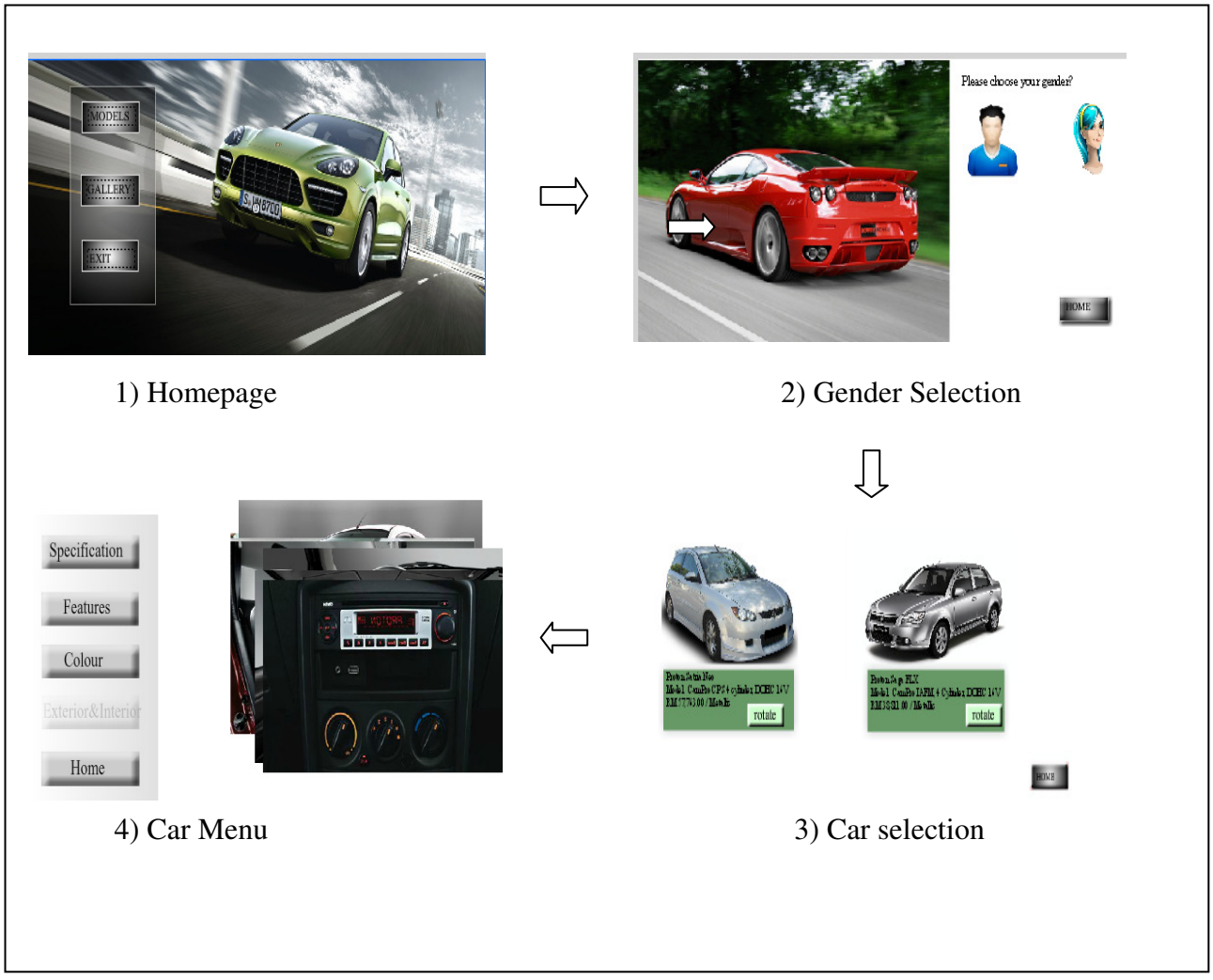

Figure 25: Storyboard of car catalogue system

If the male respondent chooses any of the option either proton Saga or Satria, he will be directed to the cars details which describe on the car specification, colours, features and interior design as shown below:

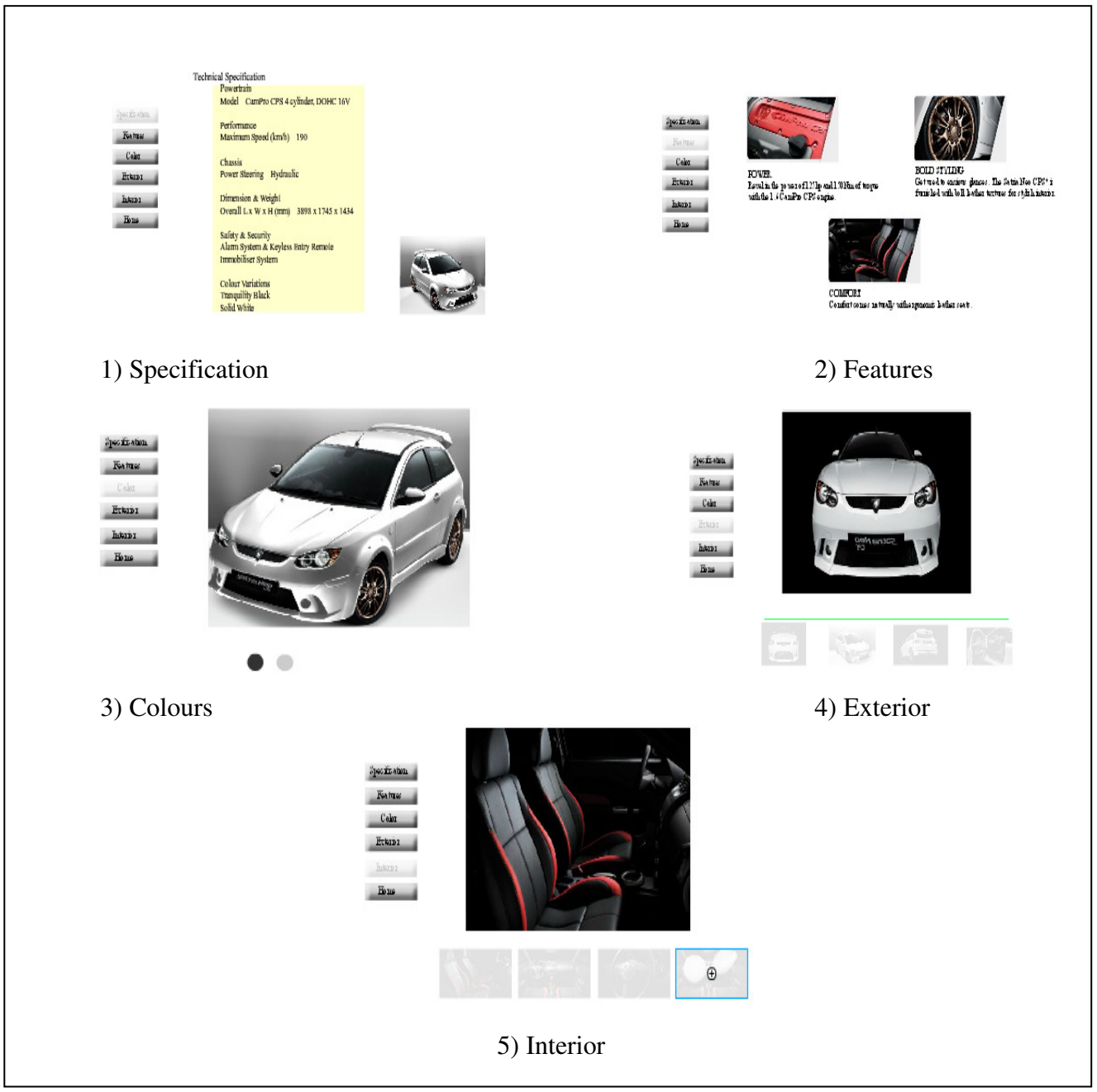

Figure 26: Car Menu

4.4.2 Adding Multi touch features into the program

i) Initialize TUIO to connect with flash application

Code Snippets.

```
var tc:TuioClient = new TuioClient(new LCConnector());

var tm:TuioManager = TuioManager.init(stage);

tc.addListener(tm);

tc.addListener(TuioDebug.init(stage));
```

This command line will set the communication between tabletop and application via local connection and TUIO will listen for touch events.

ii) Using Multi touch features like zoom rotate and drag to manipulate the images

Code Snippets

```
GestureManager.addGesture(new
ZoomGesture(TwoFingerMoveGesture.TRIGGER_MODE_TOUCH));

GestureManager.addGesture(new RotateGesture(5000));

GestureManager.addGesture(new DragGesture());
```

This will tell the gesture manager to call function like rotate, drag and zoom from the TUIO library.

iii) Basic touch, rotates, zoom and drag events call back command

Code Snippets

```
btnhome13.addEventListener (TuioTouchEvent.TAP, homepage4)

this.addEventListener(TransformGestureEvent.GESTURE_PAN, handleDrag);

this.addEventListener(TransformGestureEvent.GESTURE_ZOOM, handleScale);

this.addEventListener(TransformGestureEvent.GESTURE_ROTATE,
handleRotate);
```

4.4.3 Tabletop hardware integration with application

In order to enable touch input detected on the tabletop, integration needs to be done. The program needs to receive blob data and touch events created when our fingers touch on the screen surface. Udp-flashlc open source software found from the NUI group forum allows a client application to receive blob data and touch events (TUIO data) as it is built based on TUIO (Tangible User Interface) protocol. It needs a server to send TUIO data to the client application. For this sending and receiving information we will need CCV 1.2 as shown below

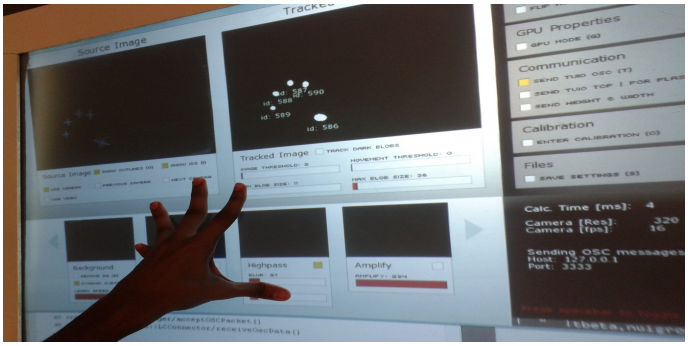

Figure 27: CCV Setup

The NUI group author, in a guideline (2010) on CCV, states, “in order to track fingers, CCV first needs to be configured. The main objective is to get a final perfect finger blob and tracked in the CCV coming from fingers with no background noise or false blobs. When a clear perfect finger tracked, later interacting with the application using fingers gestures will be easy and synchronize. In order to achieve the perfect image, several things need to be done which are shown below:

- Position of the projector and camera align to screen
- Adjust the threshold, amplify and noise value on the CCV option for a clearer blob
- Adjust the camera configuration and exposure

After the configuration, CCV needs to be calibrated as well to detect the correct finger position. By performing calibration, when touching something displayed on screen, the touch is registered in the correct place as CCV translates camera space into

screen space. (NUI group author, 2010, para. 1 on Calibration).CCV will guide users through the calibration process. Users just have to follow the instructions appear on the screen and touch individual calibration points. Figure 18 shows the screenshot for calibration.

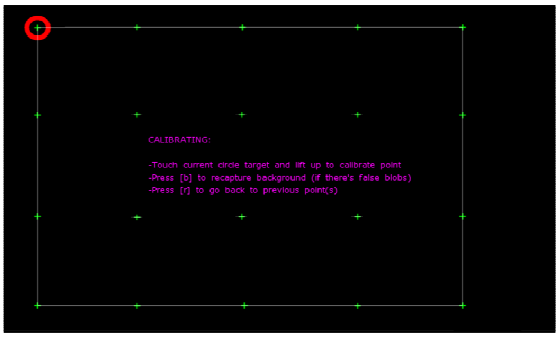

Figure 28: Calibration Setup

4.4.4 Interaction Style with Car Images

In order to manipulate the images, the users have to use proper interaction style which being defined for specific purposes as below:

Drag

To drag the images, only one finger needs to touch it until the blobs visible and then start drag as shown below

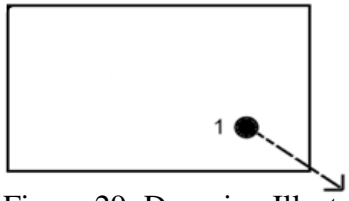

Figure 29: Dragging Illustration

Rotate

To rotate images, two fingers need to touch and perform an arch in opposite direction as shown below

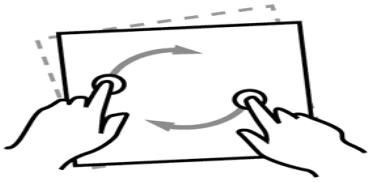

Figure 30: Rotate Illustration

Zoom

To zoom, tow fingers needs to touch and wide spread the fingers to different direction as shown below

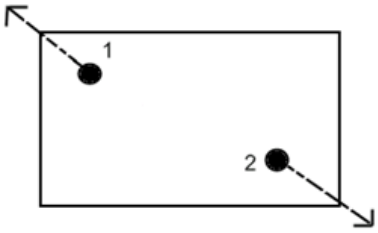

Figure 31: Zoom Illustration

4.5 Discussion on the Comparative testing results

After the catalogue development completed and perfectly running on the tabletop, a comparative testing was carried out to observe and investigate the users' acceptance and feedback on this tabletop technology. The participants will have to use the application on android tablet and also on the tabletop to gather the comparative results for this different technology. About 15 participants were invited to participate in this testing to interact with the application and experience the multi user collaboration of rotating, zooming and dragging on tabletop. Before the testing itself, a presentation and briefing was given to the participant to guide them how to interact with the application. During the presentation, they are being informed on the research background, the problem statements and objectives and basic FTIR system setup. Around 3 to 4 participants interact with the system together at the same time. Lastly, questionnaires were distributed to collect their feedback.

See Appendix B - Questionnaire.

Question 1

Pie chart 14 shows the number of participants who interact with the multi-touch application for the first time.

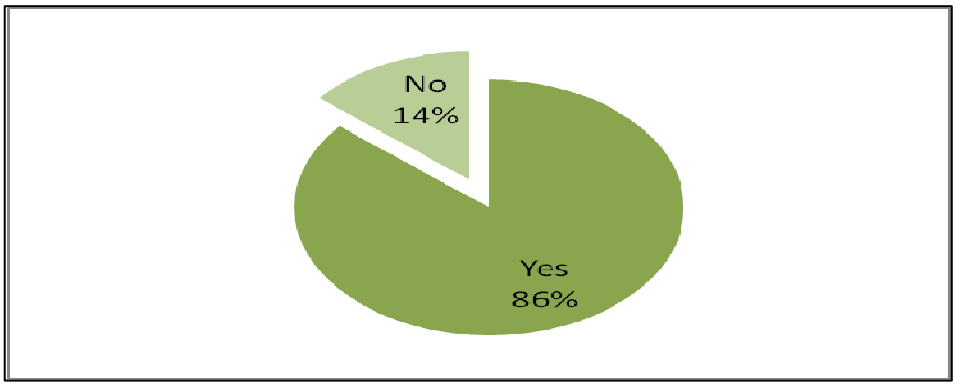

Figure 32: Pie Chart 14

Most of the participants around 86 percent had answer yes indicating that this is their first time experience dealing with the application.

Question 2

Pie chart 15 showing the likeness rank of participant over tabletop whereby 1 is least liked and 5 most liked

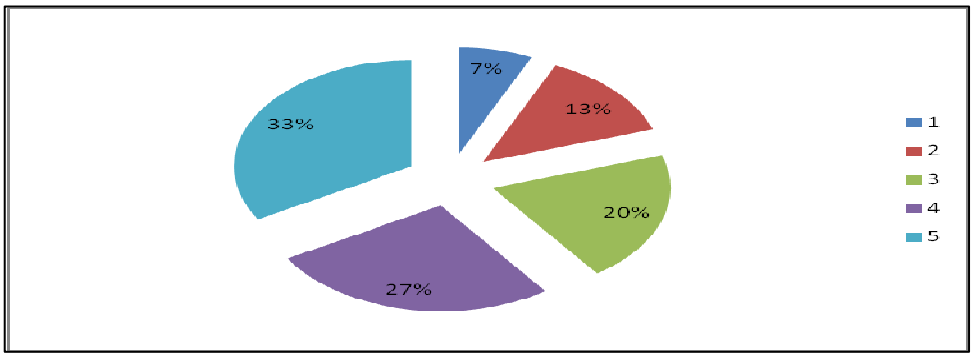

Figure 33: Pie Chart 15

About 33 percent ranked that they like the tabletop the most and followed by rank 4 which 27 percent.

Question 3

Pie chart 16 showing the participant experience interacting with the application together with the other users at the same time.

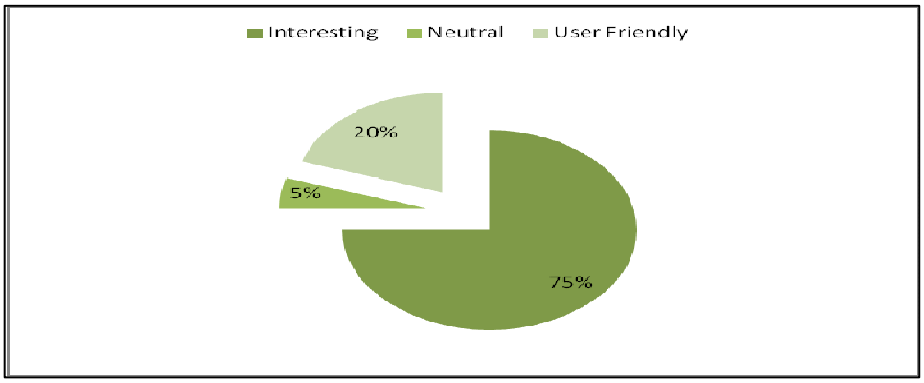

Figure 34: Pie Chart 16

75 percent of the participant had answer interesting and interacting with multi users is a new experiences.

Question 4

Pie chart 17 shows the participant personal feelings when using physical gestures like fingers for rotating, zooming and dragging.

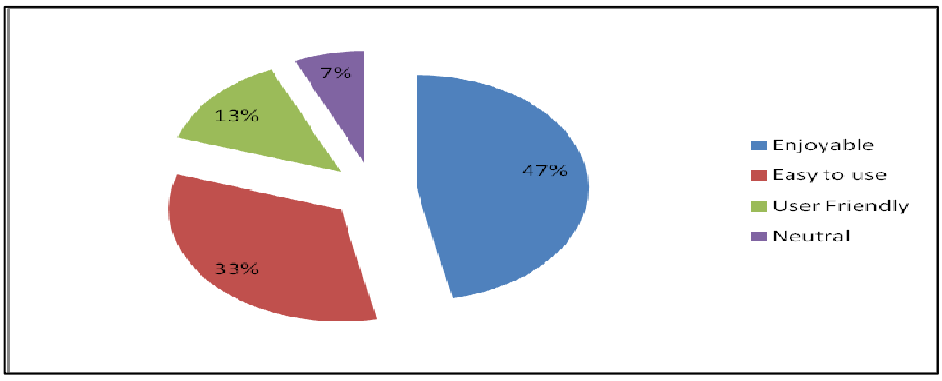

Figure 35: Pie Chart 17

Participant had given feedback that they feel enjoyable when interacting with tabletop and followed by easy to use and user friendly. There are some which felt neutral for this type of collaborative environment.

Question 5

Pie charts18 shows the opinion of participants whether the catalogue is helpful and contain adequate information.

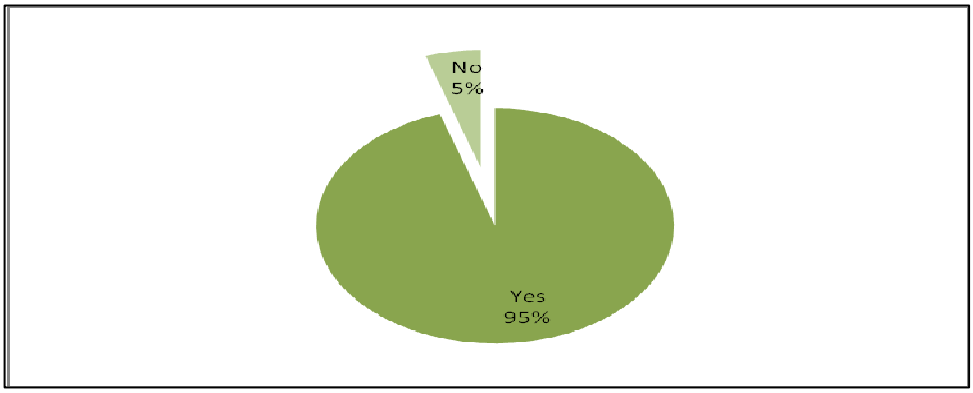

Figure 36: Pie Chart 18

95 percent of the participant answered that the car catalogue system is very helpful for them.

Question 6

Pie chart 19 shows the participants opinions on the question on whether it is easy to perform moving, scaling, and rotating on a multi-touch interface.

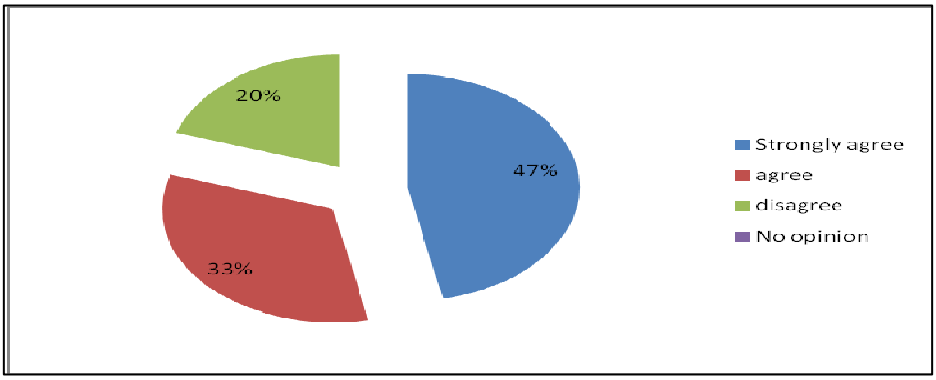

Figure 37: Pie Chart 19

47 percent participant strongly agrees that it is easy to perform multi –touch functionalities on tabletop and followed by 33 percent just agree.

4.5.1 Conclusion

As summarizes from the testing conducted and after a through results analysis, it clearly showing that the participant has high acceptance towards tabletop technology. Positive feedback had been received from the participant during the testing, it indicating that they really appreciate the use of tabletop as the car catalogue display. Further from the statistic had shown that the participant has high favor for large display and easiness in multi-touch functionalities. **They feel by having large display induces high user experiences in terms of enjoyable, easy to learn and friendly environment.** Apart from that, the introduction of multi user input or collaborative work is somehow something that new and interesting as for the most of the participant this is their first time dealing with multi-touch application on tabletop. Surprisingly even most of them well aware of the smart mobile devices, the awareness of FTIR tabletop technology are less as some of them do not know what tabletop tablet is.

4.6 Discussion on FTIR multi-touch and android smart phone

From the comparative testing conducted, there are some distinctive similarities and differences can be found in FTIR tabletop and android smart phones. Currently most of company using online catalogue which can be supported in smart devices as everyone can own smart phones. Based on the testing, the similarities and differences are discussed below:

4.6.1 Similarities between FTIR tabletop and android smart phone

The android smart devices are somewhat similar to tabletop on the basic multi-touch technique and concept. Users can perform 3 actions on the images (for the case of photo-browser) or applications which are translate, rotate, and scale as the tabletop.

4.6.2 Differences between FTIR tabletop and android smart devices

	Android Smart Phones	Tabletop
Size	Smaller and very handheld Smaller screen	Large and heavy. Large screen
Portability/Mobility	Very portable and mobile	Not portable and placed at fixed place
Cost	Has wide range of phones in the market and affordable.	Too costly for one to buy
Inputs	Single user	Multiple user

Table 3: Tabletop and Smart devices

The differences are much visible as first on the availability. Everyone has smart phones and to full utilize the promotion, the car company just publish catalogue which can be supported by this smart devices. Not everyone can purchase a tabletop for themselves. Apart from that, in smart devices it cannot support multiple images on one screen to perform multi-touch functionalities like rotate, zoom and drag while tabletop can. By this, we can conclude that tabletop is suitable to be catalogue display in event like car exhibition and car showroom. It perfectly fit as add in promotion for the car exhibition rather than replacing the online catalogue as tabletop has larger screen and can support multi user input.

CHAPTER 5

RECOMMENDATION

Starting with the application software, the first limitation can be identified is the reachability. Reachable here refers to succeed in getting in contact and communicating with the software. By developing this application to the tabletop, the user can only utilize it on the tabletop. In addition to this, the accessibility to this software is limited. This software can be only access at the car company and not at any particular time and anywhere. This induce to very low accessibility to the customer as in terms of the accessing the software. Another key point here are the hardware, tabletop being used rather than the smart phones. We need to consider the factors that nowadays less people having tabletop than phones as smart phones can cater all the basic functionalities of a tabletop. What matters is just the performance, size and screen resolution of tabletop is much better than a smart phones. Roughly three limitation of the software being highlighted which are the reachability, accessibility and medium used.

Possible recommendation is to develop multiplatform application software than just standalone. The application software build for the tabletop compatibility should be made available even for the mobile platform. By introducing this application in the accessibility and reachability limitation can be overcome. Since the programming tool is flash and action script3.0, this application can be made available for the mobile phones. This can be achieved by installing Adobe Air or Adobe Flash Lite. The Adobe Air runtime allow developer to deploy standalone applications with built with HTML, JavaScript and ActionScript across platforms and devices including IOS devices, android and blackberry. While Adobe Flash Lite lightweight version of Adobe Flash Player published by the Adobe Systems. This software was intended for the mobile phones and other portable electronic devices and allows users of these devices to view multimedia content and applications developed using Adobe's Flash tools. Flash Lite should not be considered a mobile operating system like Symbian OS, Windows Mobile, and BlackBerry OS, instead it is the technology for developing applications that run on a mobile operating system. The suitable and latest version Flash Lite is Flash Lite 4.0 which supports ActionScript 3 and is a browser plugin, rather than a standalone

player. It further extends features with multi-touch support, an advanced text rendering engine.

Apart from that, another recommendation to add in more realistic 3D view or holographic display for further future expansion. Current application software made being includes the images either 2D or 3D images. However there are still exist product category risk which refers to the functional apparel o functional products such as apparel, car specs and electronics that have functions that cannot fully be experienced through the application software. Most of the customers worried that the products will not be same with what shown and expected by most.
This is clear disadvantages for the software as the likelihood decreases with the increases product risk

Holographic display is a technique that allows the light scattered from an object to be recorded and later reconstructed so that when a camera is placed in the reconstructed beam, an image of the object will be seen even when the object is no longer present. This type of technology can be used to cater the problem highlighted above. A holographic recording can be made and shown to the customer on the cars. This will induce a better insight and confidence on the products as it was shown clearly. Plus it is very interactive and high in usability. A hologram, however, requires a laser as the light source, since lasers can be precisely controlled and have a fixed wavelength. Again this holographic display requires cost and hard to implement but with further studies and research this could be made available.

To make a hologram, the following are required:

- a suitable object or set of objects
- a suitable laser beam
- optical components which enable the laser beam to be split into two, with one beam (the object beam) directed onto the object, and the other beam (the reference beam) directed onto the recording medium,

A recording medium which converts this interference pattern into an optical element an environment which provides sufficient mechanical and thermal stability

For the tabletop hardware, it is suggested that a frame is built for the FTIR system to be portable. Besides, a fixed position of projector, camera and screen and there is no need for redo the calibration every time this gadget position change.

Another recommendation is by having the tangible interaction on the tabletop. A tangible user interface (TUI) is a **user interface** in which a person interacts with digital information through the physical **environment**. (Wikipedia, 2012). This type of interaction is very direct, manipulative and perceptible. This interaction is increasing relevant for collaborative applications, embodied interaction and 3D information. Briefly, user interacts with a digital system through the manipulation of physical objects linked to and directly representing a quality of said system. Example, we just need to place any physical object on the screen, the image will be copied and understand and perceived by the tablet. A simple pop up appears listing out information when clicking on the car images can be add in as functionalities for future recommendation.

Figure 38: Tangible Interaction

CHAPTER 6

CONCLUSION

The author hopes that this final year project had successfully met the objective being acknowledged early. The purpose of this final year project is to serve group of society or possible customer by providing an interactive catalogue. Overview is that by developing this software, it clearly demonstrates the needs for multi touch in car catalogue as additional interactivity features had been underlined and implemented especially on the multiple user manipulation and touch features value as rotating, resizing , zooming on the catalogue. The whole software was developed using the flash and Action Script 3.0 in order to implement the touch features and then being integrated into the tabletop.

What matter the most throughout this project development is to meet a perceived need and requirement of some set of potential customers. In order to gather the requirement several stage of approaches being carried out as shown below,

- Market research
- Gathering requirement
- Analyzing problem

Thus, this project was developed based on all the data gathered and meeting the user requirement. The author hopes that this project will be successful and could be greater needs in all the big car organization to use this car catalogue as a promotion strategy. Not just this, that this idea further developed using high technology like holographic display and implemented into all electronic smart devices for future growth and expansion.

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APPENDICES

APPENDIX A

DragRotateScaleMe.as File

```
package examples.gestures {
        import flash.display.Sprite;
        import flash.events.TransformGestureEvent;
        import org.tuio.TuioTouchEvent;
        import flash.geom.*;

        public class DragRotateScaleMe1 extends Sprite {

                public var minScale:Number = 0.1;
                public var maxScale:Number = 2.5;

                private var curID:int = -1;

                public function DragRotateScaleMe1(x:Number, y:Number,
width:Number, height:Number) {

                        var l:sat1 = new sat1();
                        addChild(l);
                        this.x =455
                        this.y =200


        this.addEventListener(TransformGestureEvent.GESTURE_PAN,
handleDrag);

        this.addEventListener(TransformGestureEvent.GESTURE_ZOOM,
handleScale);
```

```
        this.addEventListener(TransformGestureEvent.GESTURE_ROTATE,
handleRotate);

        this.addEventListener(TuioTouchEvent.TOUCH_DOWN, handleDown);
                }

                private function handleScale(e:TransformGestureEvent):void {
                        var p:Point  = this.localToGlobal(new Point(e.localX,
e.localY));
                        p = parent.globalToLocal(p);

                        var m:Matrix = this.transform.matrix;
                        m.translate( -p.x, -p.y);
                        m.scale(e.scaleX, e.scaleY);
                        m.translate(p.x, p.y);
                        this.transform.matrix = m;

                        if (this.scaleX > maxScale) {
                                m = this.transform.matrix;
                                m.translate( -p.x, -p.y);
                                m.scale(maxScale/this.scaleX,
maxScale/this.scaleY);
                                m.translate(p.x, p.y);
                                this.transform.matrix = m;
                        } else if (this.scaleX < minScale) {
                                m = this.transform.matrix;
                                m.translate( -p.x, -p.y);
                                m.scale(minScale/this.scaleX,
minScale/this.scaleY);
                                m.translate(p.x, p.y);
```

```
                    this.transform.matrix = m;
                }
            }

            private function handleRotate(e:TransformGestureEvent):void {
                var p:Point = this.localToGlobal(new Point(e.localX,
e.localY));
                p = parent.globalToLocal(p);

                var m:Matrix = this.transform.matrix;
                m.translate(-p.x, -p.y);
                m.rotate(e.rotation * (Math.PI / 180));
                m.translate(p.x, p.y);
                this.transform.matrix = m;
            }

            private function handleDrag(e:TransformGestureEvent):void {
                this.x += e.offsetX;
                this.y += e.offsetY;
            }

            private function handleDown(e:TuioTouchEvent):void {
                if (curID == -1) {
                    stage.setChildIndex(this, stage.numChildren - 1);
                    this.curID = e.tuioContainer.sessionID;

        stage.addEventListener(TuioTouchEvent.TOUCH_UP, handleUp);
                }
            }
            stage.removeEventListener(TuioTouchEvent.TOUCH_UP,
handleUp);     }}}}
```

APPENDIX B

QUESTIONNAIRE

1. Is this your first time experience using multi touch application on tabletop?

- Yes
- No

2. How do you rank your likeness on large display over small display (1-least liked, 5 –most liked)

- 1
- 2
- 3
- 4
- 5

3. How do you feel when using physical gestures like fingers for the rotating, scaling and dragging operation?

- Enjoyable
- Easy to use
- User friendly
- Neutral

4. How do you feel interacting with multi-touch application together with the other users at the same time?

- Interesting
- User friendly
- Neutral
- Other:_____

5. To perform drag, scale and rotate on multi-touch application interface on tabletop is easy compared to other handheld devices

- Strongly agree
- Agree
- Disagree
- No opinion

6. Do you find the catalogue helpful in providing information about car?

- Yes
- No

An Exploratory Study of Displaying Interactive Car Catalogue System on Multi-Touch Tabletop

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ABSTRACT

This report covers on the implementation of tabletop tablet to display interactive catalogue system in the car industry. This project is a prove of concept indicating that the multi touch techniques are really useful in car industry as the user can direct manipulate sense of touch on viewing the car catalogue. This is proved when car purchasing activity or car road show take place. It focuses on the background on the catalogue whereby less interactive and low in usability discussed. The prime objective of this project is to investigate whether by having tabletop tablet will add and induce usability via user collaboration enabling more than one user to perform moving, resizing, zooming and rotating the car catalogue projected on the tabletop. On the literature section, it had been mention details of the architectural, design and application component. It also findings and readings on the multi gestural techniques, natural user interfaces (NUI) and the multi touch development platform.

I. INTRODUCTION

Catalogue is a list or itemized display, as of titles, course offerings, or articles for exhibition or sale, usually including descriptive information or illustrations. Catalogue can be described as book that contain organized information about products and illustrated with pictures. From the research conducted, there is yet no catalogue system being implemented in the tabletop multi-touch environment. As being conclude, catalogue in terms of website and mail ordering is widely used and existed in the market. The author would like to come up with the car catalogue system implemented in the tabletop. Tabletop can understand a smart tablet as large as table used to project and support multi-touch features. The concept is to come up with a multi-touch hand gestural car catalogue system. The reason coming up with the automotive industry is because we all aware that the automotive is the one of the big developing industry globally.

The current online catalogue and other promotion tools induce low interactivity and usability. By using smart devices like smart phones the focus is only on single user rather than multiple users. is low interactivity because an online catalogue will be just static and using mouse interaction if the user using computer and this will induce low level of usability and enjoyable experience. Even smart phones is there to add multi-touch features still there are limitation like the display screen is small and the images limitation. Smart phones cannot support multiples images on the screen and this can reduce the user experiences. Apart than this, normally in the car exhibition there will be only selected car being display and if there are customers asking for other model, the dealers might have to bring them to store or shows them book catalogue which might be static. In case tabletop being use, this can increase the interactivity and the customer can get a better first hand information apart from the good user experiences.

The scope of study of development tool is on TUIO Action Script 3.0 and WPF touch framework to develop the multi-touch car catalogue system in the tabletop. The WPF functionality is to add the multi-touch features into the program. In addition, the hand gestural techniques are being used and sensitivity of the multi-touch application being looked and studied. With the defined scope, project was targeted to be completed 2 semesters and with the touch up prototype.

The prime objective in this project research is to evaluate the effectiveness of tabletop implementation in displaying car catalogue. Second is to enable multiple user interaction whereby multiple users able to interact while moving, resizing and rotating car images on the tabletop hardware. Following to better assists and improvise the decision making of the customer to purchase cars by having customized car software based on gender

II. LITERATURE REVIEW

II.1 Tabletop Hardware

The very basic of the tabletop hardware consist of several component which are illustrated as above. The component as being underline as picture above which are
Computer- The computer here serves as the processing unit by running the application software onto it. The input will be then taken from the tabletop as from the gesture of tapping and touch. Tabletop display all the information and software which being executed in the computer once it connects.
Acryclic plane – This plane is the white surface where the application being projected onto and users can touch and perform other activities. Along the rectangled plane, there

are infrared diode function to detect any touch signal and later send it to the camera.
Projector – project the light and information onto the acryclic plane.
Infrared Camera – Any signal input being detected, will be captured by this device. Then later it will send to the computer for the processing purposes.

II.I.I Multi User Interaction

Typical desktop computers and handheld smart devices do not support effectively support co-located, multi-user interaction because the underlying single user design paradigm (Stewart et al. 1999). As the IT expands, there is a need for the digital information during collaboration. In order to promote this, many digital tabletops had been developed for variety of purpose.

II.I.II Larger display over small display

Apart from the multi user display , the studies will also cover on the impact on the user experience using large display which is tabletop over small display probably will be 7 inch tablet. In this, we could gather the importance of large display to the users, how this effects their decision making of purchasing the car and the personal feedback of this system. The comparison of large and small display will be made based on the experience, visibility of the information and decision making process.

II.II Multi-touch Architecture

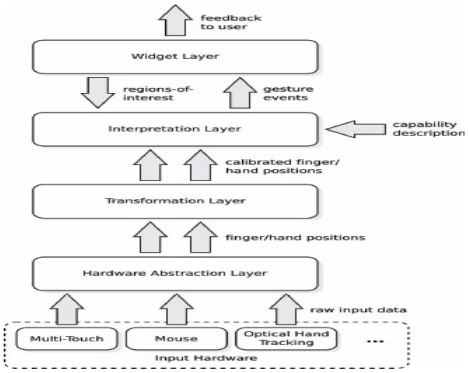

Figure 1: Multi-touch Framework

The lowest is the input hardware which refers to the medium for input generation for the next to be processed in the hardware abstraction layer. The information is then sent to the transformation layer which mainly will process and transform the position data into the screen coordinates via the calibration procedures.At this very point, the information ready for the interpretation layer. The interpretation layer needs to translate the hands or finger movement into gestures event for the next layer. The information being passed to the last layer, widget which has the task to response on gestures by generating visible output for the users.

II.III Building a multi-touch based on FTIR

The principal mention above had a greater significant on implementing multi displays , the since the light that is frustrated by the user is now able to exit the acrylic in a well defined area under the contact point and becomes clearly visible to the camera below. Precisely when a light trapped inside the acrylic by internal reflection, the infrared camera captures the frustrated light when the fingers touched the acrylic surface and the region become visible. For better result the light should be totally internally reflected in your acrylic

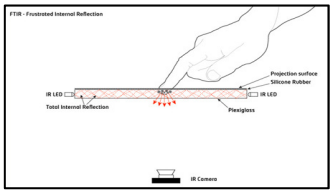

Figure 2: FTIR Framework

II.IV Introduction to NUI

From Wikipedia, NUI is a common parlance used by designers of computer interfaces to refer to a user interface that is effectively invisible. Natural is used because most computer interfaces use artificial control devices whose operation has to be learned whereby NUI rely on user quickly learn as allow users to carry natural motions, like gestures and movement.

II.V Touchlib

It is a library that provides all the software you need to set up your own FTIR multi-touch display. Generally it offers a simpler interface for the program to listen to touch event and multi-touch interaction surface. It handles tracking blobs of infrared light, and sends your programs these multi-touch events, such as finger down, finger moved, and finger released.

II.VI Core Community Vision

Community Core Vision (CCV), also known as tbeta, is an open source/cross-platform solution for computer vision and machine sensing. It takes a video input stream and outputs tracking data, such as coordinates and blob size, and events, such as finger down, moved and release, that are used in building multi-touch applications.

Requirement	Touchlib	Core Community Vision
TUIO	Support	Support
Operating System	Windows	Windows, Mac OS ,Linux
Camera Support	Webcam(USB or Fire wire)	Support all type of camera with proper WDM drivers, USB, USB2, Fire wire, CMU, DirectShow, PS3, and Kinect. This includes with the new features of automatic camera detection.
Finger Tracking ability	Good	Good
Other feature		Dynamic calibration for multiple size of multiple touch surfaces while maintaining speed and performance

Table 1: Differences between Touchlib and CCV

III METHODOLOGY

The author decided to use incremental and iterative methodology. This methodology allows certain key points as learning for the programmers has the repetitively cycles in smaller portion time. The learning will be on the between the analysis of phases and iteration which can be perform repetitively and allows to perform changes or adaptation.

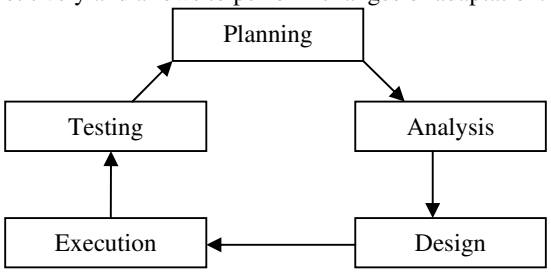

Figure 3: Iterative Methodology Diagram

The first phase is planning whereby in this phase the data and requirement gathering will be conducted. It defines all the information that will be required to develop the prototype accordingly to ensure the success. In this phase, the steps will be defined into several key functions as the steps are deciding the development tools, Gantt chart scheduling, time allocation for each necessary task, and appropriate data gathering method for information gathering.

In the analysis phase, the data and user requirement collected during the planning phases will be analyzed. The author will follow the data gathering method which had been decided during the planning phases. The steps taken are conducting interviews to the car dealers and trainees to gather the current promotion tools, problem faced and requirement. Following, pre surveys also been conducted to investigate and analyse the user acceptance towards the multi touch technology. Construct system use case and flow chart that describes the application process based on the data gathered.

For the designing phase, the author develops the application interface, system architecture, conceptual design, based on the user requirement and data gathered. A through research had been done by the author to come up with a good design which suits the users' requirement and by making a comparative study with the current the application which is in use in the market.

After a complete analysis and design, the author starts to develop the prototype which is real working car catalogue software.

The car catalogue was developed using Flash cs5.5 using action script 3.0 and for the multi touch functionalities, TUIO library was available found in the NUI community group. The car catalogue developed separated page according to gender like for male option, it will direct to different page and for female option selection, it will direct to page with different car choices.

The execution phase divided into two parts, which the first part is

- The author needs to refine the prototype that meets the users' requirement.
- The prototype been build based on the conceptual and the graphical user interface design.
- Coding and development of the prototype to display the car images.

The second part of execution will be on the multi-touch introduction to the application software

- Coding on adding the multi-touch functionalities like, zooming, dragging and rotating value on the car images.
- Define and develop multi-touch interaction style to manipulate with the car images using one finger to drag and two fingers to rotate and zoom.
- Calibration of the tabletop hardware by using the CCV 1.2 software to enable a perfect finger tracking and touch inputs.
- Perform the linking of the application and hardware via the Udp-flashlc software bridge.

After the prototype had been successful completed according the user requirement, the author starts with the last phase which is the testing of prototype. This testing will be conducted to investigate the users' feedback onto the project and this data will be used for the debugging purposes.

The testing method conducted via two ways first on self testing and end user testing. Self testing had been carried out by the author itself to verify and rectify whether all the functionalities had been developed with no errors and the system is working perfect. The end user testing was conducted by requesting the users who are mainly the university students to try and use the car catalogue system on the tabletop and also on 7inch Samsung tablet. A comparative testing had been carried out to investigate the effect of user experience while interacting with two different technologies. The users will first try the Samsung tablet and then proceed to try the application on tabletop. For this end user testing, the interaction using tabletop and Samsung tablet had been recorded by the author to view the users' natural interaction and experience. A post survey questionnaire had been distributed to the students to collect their feedbacks to investigate their experience interacting large display over small and multi user interaction on the tabletop.

By obtaining this feedback, the author can come with strong claims to support the project existence. Apart from this, the author can implement the comment given by users' and further improvise the system for betterment.

IV RESULTS & DISCUSSION

IV.I Interviews

There are two target users for interview which are the car dealers and trainees. A series of questions was raise by the author to the both parties. The interview conducted basically to identity what the current promotion tools being used and their opinion on the car catalogue system on multi-touch tabletop idea. Based on the interviews, the authors able to list out two main key points which are

- The technology of multi touch tabletop is new and is a exciting prospect to be implemented to display car catalogue system
- A categorised catalogues according to gender preferences somehow will be helpful the dealers to convince the customers and able to assists in decision making.

Besides that the author had made pre survey questionnaire to investigate the acceptance of user towards multi-touch technology.

Pie chart 1 showing the participants opinion whether they value first hand information .This pie chart results shows that 92.86 percent of the participants do value first hand information very important before viewing the physical car. Before buying product, we must gather the information about the car first. By this the author believes that the first hand information process must be interactive, provides greater user experiences like enjoyable and user friendly environment which can be achieved by introducing car catalogue in tabletop compared than just using static fliers and book catalogue.

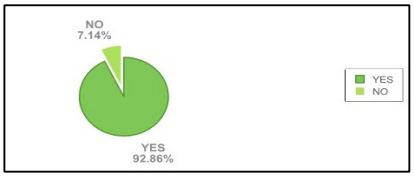

Figure 5: Pie chart 1

Pie chart 2 showing participants' response of whether they like having a multi-touch car catalogue compared to fliers or book catalogue. 87 percent of the participant shows positive response of yes stating their interest on the multi-touch technology. This clearly shows that the current generation is valuing the evolution of technology and felt that this multi-touch technology is something that exciting.

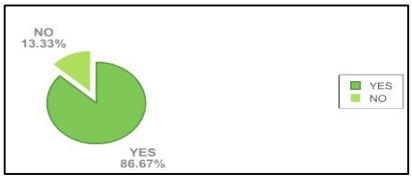

Figure 6: Pie chart 2

By the information gathered from the pre survey, the author believes he can proceed with the idea of implementing a categorised car catalogue system on tabletop to further enhance the promotion and display tool.

Both diagram showing basic process flow on the user interaction between the application software and the related touch event input on the catalogues.

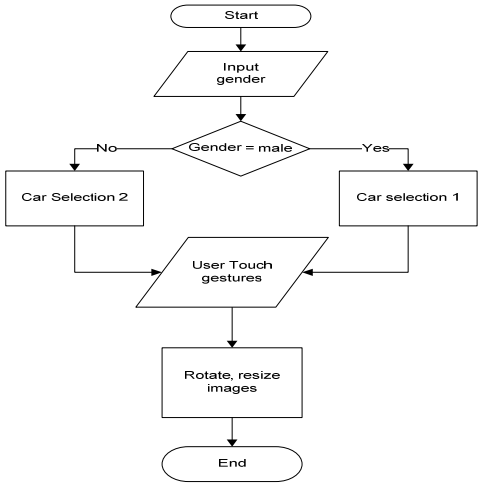

Figure 7: System Flow chart

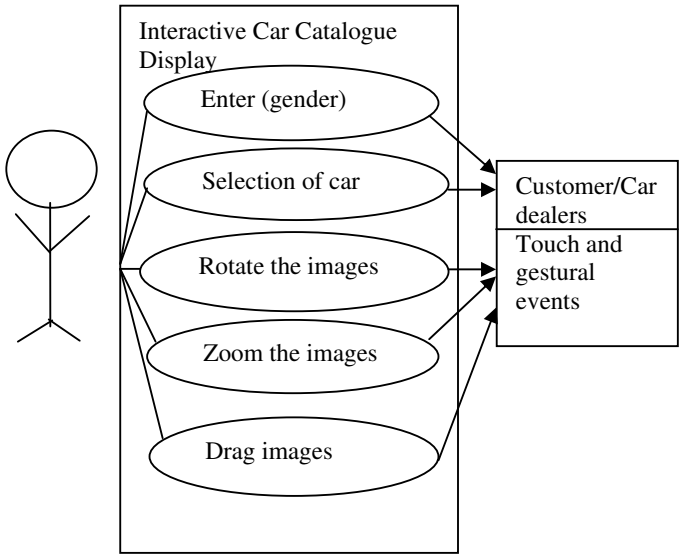

Figure 8: System use case

By breaking down the interaction and process flow as shown above, author is able to come up with clear picture of how the catalogue should be developed. In order to create a categorised catalogue system, first the author need to gather male and female gender preferences, which a survey was distributed to investigate the gender differences in choosing car features. The result of the survey shown below

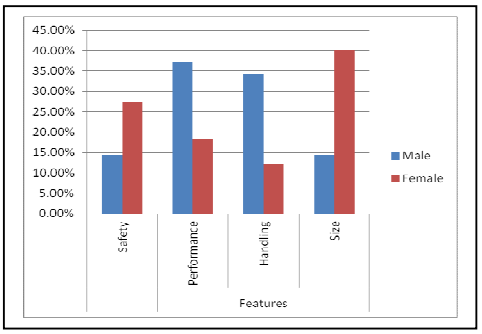

Figure 9: Graph of comparison car features of male and female

The above survey results shows that the 4 features being emphasize are the safety, performance, handling and size. As can we can view from the graph above we can conclude that the male has choose performance and handling features higher than the female while the female has chosen the safety and size of car as most important element. The male also looks for car which speed and performance driven as this suits their nature of gender. Even handling is major concern for the male as they prefer to have good firm handling and stable even when driving the vehicle at higher speed. The female group mostly took size and safety into consideration rather than the performance itself. For them the size of car does matter. For age group of 20-30 from the result collected from questionnaire indicate that they much favor of small size car rather than big car like SUV or truck. This is because for the female group small car suits their nature, comfortable and easy to handle. They have their utmost confidence in driving small car. By this following data, author able to come up with choices of car for male and female.

IV.II Project Development

The project developments divided into two phases. The first phase is whereby the author develops a real working car catalogue displayed and compatible in computer using adobe flash. Thus the car catalogue will have a homepage and three buttons which are exit, model and gallery. When users click on the model, it will direct to the gender page. Now the user has to choose their gender and later they will be directed to the respective choices of car.

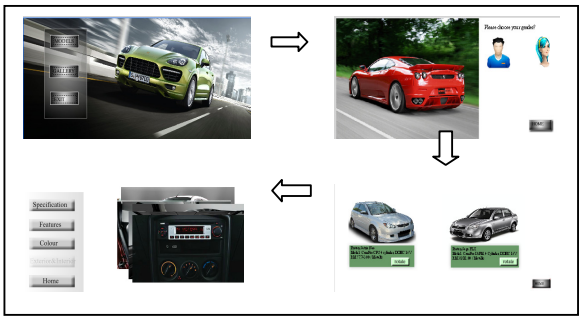

Figure 10: Storyboard of car catalogue system

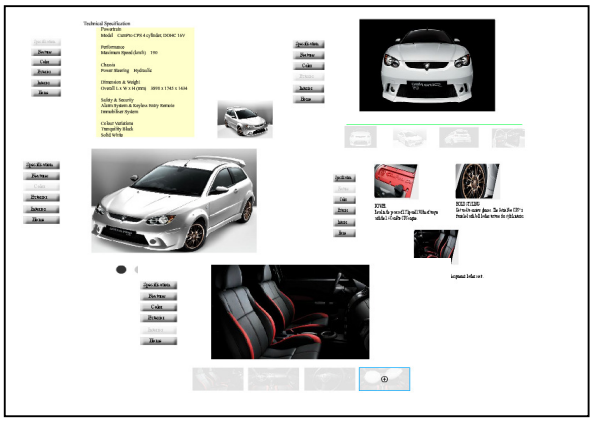

Figure 11: Car catalogue menu

The second phase of the project development are the multi-touch coding whereby the author use TUIO action script for touch library downloaded from the NUI group. This library will add the multi –touch functionalities to the car images like value like zoom, drag and rotate. Thus when the user touch on the exterior and interior design, there will be collection of images where the users can manipulate and perform the touch function.

IV.III Tabletop integration with application

In order to enable touch input detected on the tabletop, integration needs to be done. The program needs to receive blob data and touch events created when our fingers touch on the screen surface. Udp-flashlc open source software found from the NUI group forum allows a client application to receive blob data and touch events (TUIO data) as it is built based on TUIO (Tangible User Interface) protocol. It needs a server to send TUIO data to the client application.
The NUI group author, in a guideline (2010) on CCV, states, “in order to track fingers, CCV first needs to be configured. The main objective is to get a final perfect finger blob and tracked in the CCV coming from fingers with no background noise or false blobs. When a clear perfect finger tracked, later interacting with the application using fingers gestures will be easy and synchronize. In order to achieve the perfect image, several things need to be done which are shown below:

- Position of the projector and camera align to screen
- Adjust the threshold, amplify and noise value on the CCV option for a clearer blob
- Adjust the camera configuration and exposure

After the configuration, CCV needs to be calibrated as well to detect the correct finger position. By performing calibration, when touching something displayed on screen, the touch is registered in the correct place as CCV translates camera space into screen space. (NUI group author, 2010, para. 1 on Calibration).CCV will guide users through the calibration process. Users just have to follow the instructions appear on the screen and touch individual calibration points.

IV.IV Interaction Style with Car Images

In order to manipulate the images, the users have to use proper interaction style which being defined for specific purposes as below:

Drag -To drag the images, only one finger needs to touch it until the blobs visible and then start drag as shown below

Rotate-To rotate images, two fingers need to touch and perform an arch in opposite direction

Zoom-To zoom, tow fingers needs to touch and wide spread the fingers to different direction as shown below

IV.V Comparative testing results

After the catalogue development completed and perfectly running on the tabletop, a comparative testing was carried out to observe and investigate the users' acceptance and feedback on this tabletop technology. The participants will have to use the application on android tablet and also on the tabletop to gather the comparative results for this different technology. The results were collected and the participant showing a positive feedback as interacting with the application on tabletop induces higher user experiences. Below are few pie charts with results from the testing.

Pie chart 3 showing that around 47 percent participants are feeling enjoyable while interacting with the application.

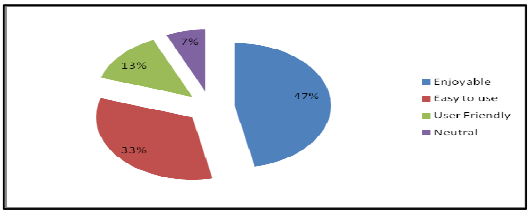

Figure 12: Pie chart 3

Pie chart 4 showing 33 percent of users ranked 5 which are most liked for the tabletop.

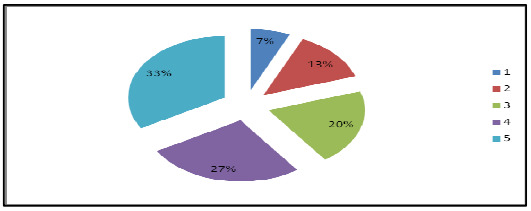

Figure 13: Pie chart 4

The table below shows the general differences between smart phone devices and tabletop:

	Android Smart Phones	Tabletop
Size	Smaller and very handheld	Large and heavy. Large screen
Portability/Mobility	Very portable and mobile	Not portable
Cost	affordable	Too costly for one to buy
Inputs	Single user	Multiple user

Table 2: Differences between smart phone and tabletop

V CONCLUSIONS & RECOMMENDATION

In conclusion the author hopes that this final year project had successfully met the objective being acknowledged early. The purpose of this final year project is to serve group of society or possible customer by providing an interactive catalogue. Overview is that by developing this software, it clearly demonstrates the needs for multi touch in car catalogue as additional interactivity features had been underlined and implemented especially on the multiple user manipulation and touch features value as rotating, resizing , zooming on the catalogue. For recommendation, adding holographic functionalities could further enhance the usability and user experiences.

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