

Smart Shopping: Building a Tool Based on Augmented Reality

W.A.L.Madushanka¹, P.H.A.M.De Silva², B.A.L.Madhushani³, M.G.T.H. Malalagama⁴ and S.G.S.Fernando⁵

¹Undergraduate Student, ⁵Lecturer
Sri Lanka Institute of Information Technology, Metro Campus, Colombo 03, Sri Lanka.

Abstract: In today's world, most of the people do not consider health and the fruit they eat and some people do not know even the name of the fruit they eat and most of the people are addicted to quick shopping. Since people do not consider about their health, it is important to provide a solution. Augmented Reality (AR) plays major role in current technology. AR is mapping real world environment with computer based virtual environment. This research is a Mobile Application, based on AR. Once user selects a picture of a fruit, the image would be processed and display details lively. The application was developed based on client server Architecture. Main objective of this research is provided accurate details for user lively. This study is helpful for the researches who are interested in Augmented Reality concept and image processing to design and develop similar models or to develop same model further.

Keywords: Image Based Augmented Reality, Calorie Details, Vitamin, Fruit, Health, Image processing, Neutral Formula

I. INTRODUCTION

Augmented reality (AR) is a field of computer research which deals with combination of reality with computer generated data. It is related to a real world and virtual world which is created or modified by a computer or related device. As a result of the technology updated from day to day such things like AR will be discovered. By contrast, virtual reality replaces the real world with a simulated one. The information about the surrounding real world of the user becomes interactive and digitally manipulate with the help of advanced AR technology. It is still in an early stage of research and development. AR applications generally use one of two approaches such as marker-based and location-based [1].

A technology revolution is fast replacing human beings in virtually every sector and industry in the global economy. So people do not spent more time with shopping. Because of that they just go and buy foods. By analyzing literature review it was found that there are many issues in health. In this research focused on particular fruits in supermarkets.

SmartShopping is a Mobile Application, based on AR. Once user selects a picture of a fruit, the image would be processed and display details lively. The main problem people do not care about their health when they were

shopping. So this research helps people to shopping more compatibly.

The Following research questions there will be in order to complete this research.

- How to introduce augmented reality concepts to enhance day to day activities?
- What algorithms will be used to process images?
- How to developed server based application with quick response time?
- What is the best technology that can be used to store and retrieve image details?

The general objective of this research paper was developed a mobile application for customers by using Augmented Reality concept. The following was a list of specific objectives based upon the material in this paper:

- Developed a mobile application and display details using augmented reality concept.
- Developed an Algorithm to compare two images.
- Developed a web service can be use through mobile device and database.

This paper is organized as follows: section 2 describes Literature Review that describes background study of the

research and section 3 describes how research team did this research. In section 4 discuss results that of the team gathered from this research. Section 5 includes discussion and the final section will consist of all the references that have been cited in this paper.

II. LITERATURE REVIEW

In recent years a great deal of time and effort has been spent on developing systems based on Augmented Reality [AR] concept. Project team need to use high performance computers and camera to perform complex image processing and connect to system to get information. Project team typically follows some paths to meet requirements. First should be analysis about image processing. Then transfer them to application created by using visual studio. After that it should retrieve data from data base.

There were many AR related research done in many countries for some purposes.

Piekarski and Thomas have developed The Tinmith System – Which Demonstrating New Techniques for Mobile Augmented Reality Modeling.

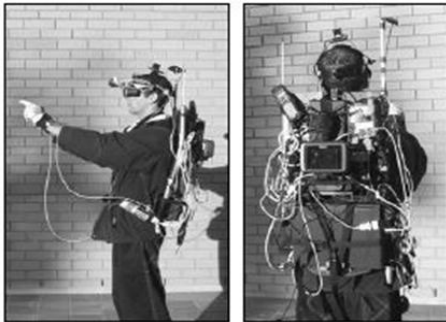


Figure I: The Tinmith System

This research was based on user interface technology which is built using a glove based menu system and 3D interaction techniques in late 1999. This system was designed to support applications that allow users to construct simple models of outdoor structures [2].

An Informational Tool in Tourism



Figure II: Tourism Application [3]

This research was the most successful application using AR in Ireland in 2013. This application was built to use as an informational tool in tourism. You can know about content relevant to a place by pointing your phone at a particular location, the phone, using GPS, knows what it is seeing and automatically generates content [3].

Regards have developed A Survey of Augmented Reality

This survey was identified the rapidly changing technologies and the revolution of AR. Nowadays 3-D virtual objects are integrated into a 3-D real environment in real time. It has been used and explored various areas like the medical, manufacturing, visualization, path planning, entertainment and military applications. [4].

Augmented reality makes shopping more personal-new mobile application from IBM Research helps both consumers and retailers.

This research is an existing system which was developed by IBM Researches. This is a mobile application which will provide a personalized shopping experience with immediate product comparisons and special offers as they move throughout the store. Using advanced image processing technology, it capture images via the built-in video camera on a user's smart phone or tablet to quickly and accurately identify a product or row of items. When it identified the products it will display information above the product images and rank them based on a number of criteria, such as price and nutritional value. It will also provide the shopper with any loyalty rewards or incentives that may apply and suggest complementary items based on what the customer has already viewed [5].

By analyzing the literature review, the development team identified that there is no Augmented reality based mobile application for the supermarket shoppers to get details of a fruit to sure that the fruit is good or not. Also because of the peoples busy life style, they always requiring for an efficient ways to do their day today work. So the development team decided to give them a mobile application which can track a fruit and give details of that fruit instantly.

III. METHODOLOGY

To provide a quality software product it is essential to use a suitable methodology [6]. Smart Shopping is a client based system. Development team has to get a feedback in order to finitude it. Because of that reason development team used prototype methodology [7]. That was most suitable methodology for developed this kind of research.

A. Planning

In this phase project team identified why this tool should built and determined how the project team should built it.

In this phase development team was done following, identify project value, feasibility study, developed work plan, staffing the project, doing literature review and etc.

B. Requirement Gathering and Analysis

Development team carried on an empherical study to get the details regarding the past systems. Team gave paper based and online questionnaires to selected customers. Samples were selected using random sampling method and there were 50 participants. In final question in questionnaire team asked “Do you prefer to use mobile based tool to select fruits?”

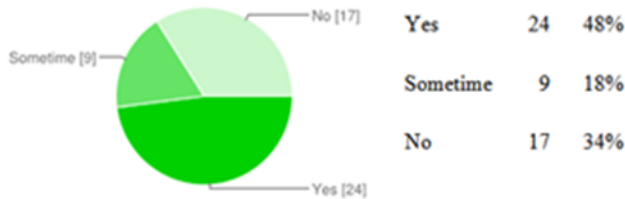


Figure III: Summary for prefer to use mobile based tool to select fruits

When the team considered about above result 48% people directly said they like to use mobile based tool for select fruits. 18% of people also have some idea to use that kind of tool. After analyzing 10 questions and responses development team decided to build a mobile based tool for select fruits, it will display name, vitamins, nutrition and calories included in detected fruit. Secondary data was gather analysis on Image processing, Augmented Reality, Mobile Application.

C. Design

In this stage, the tool was custom developed from scratch and the skills of the team members were used to come up with their own system looks and functions to suite the requirements. In architecture design the plan for the hardware, software and communications infrastructure for tool was performed. This system has basically two applications; they are mobile application and desktop application. In this system user capture picture using mobile application, it was connected with the web service application via Internet. Then web service application was connected with database and tries to gather information. If that information was not in the database, service application is connected with search engine. Finally that information is passed to mobile and displays those details. Research was developed mobile application using android technology and desktop application was developed using visual studio.

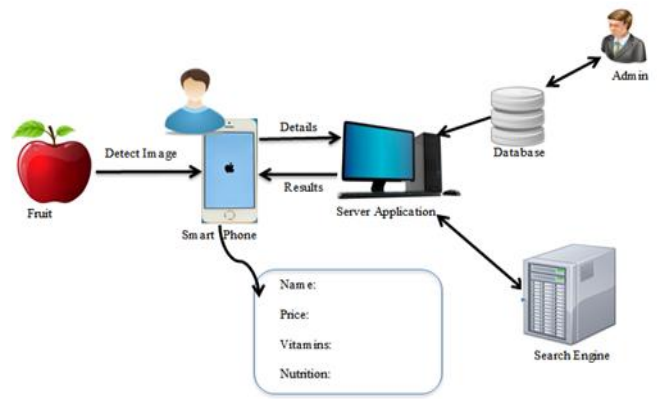


Figure IV: High-level Architecture Diagram

D. Implementation

SmartShopping system has desktop application as well as a mobile application. Desktop application was implemented by using ASP.NET. Mobile application was implemented by using android technology and created the database using SQL Server 2008. Finally android application and desktop application were connected using web service. Web service also implemented by using IIS server.

E. Testing

After implementing the system development team was checked whether the system works properly and gives the correct output. The project accuracy is considered prominently. Development team checked whether that the mobile application and desktop application and web service method are worked properly as expected by using dummy data. Development team used white box, black box, stress and unit testing for test the system. Several test cases were designed and testes using TestLink software. The system was tested on prototype level.

IV. RESULT AND DISCUSSION

In this result & discussion section contains the result that the development team founded from SmartShopping research scope and what were the new approaches found to address further researches.

A. Evidence

This section includes the research findings that the team was able to gather during the research project. This composed with constraints that the team had to face within the parameters of knowledge, time and local standards. The findings here are a stepping stone to a more advanced research.

The development team developed android mobile application for capture fruit from user own mobile phone (Figure V). That application was developed by using Android Studio software. After user capture fruit that image process through web service and display details of the fruit lively via mobile application.

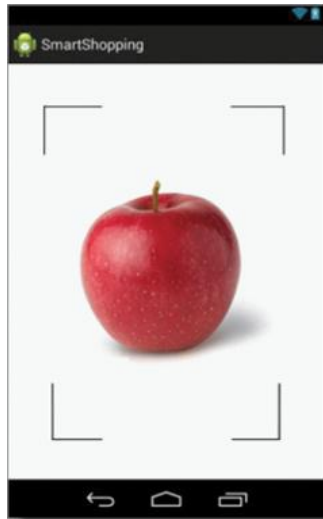


Figure V: Capture Fruit interface

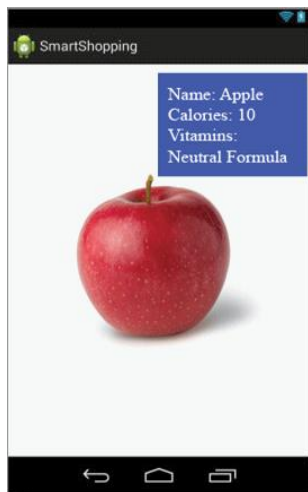


Figure VI: Display details interface

Using backend application (Figure VII) development team stored image data in SQLServer 2008 database. Those

image data are name, image of the fruit, vitamins, nutrition and color of the fruit.

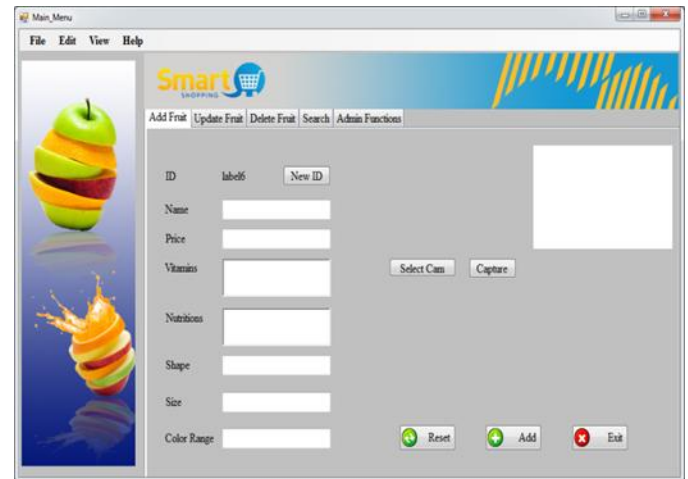


Figure VIII: Main Interface of Backend Application

The developers stored image as a byte array. In sql server 2008 database has an image type column called “Image Data”. Using an algorithm the team convert image in to byte array (Figure IX) and insert that data in database. Development team stored color of the image in RGB format. The team used special algorithm to get RGB color of the image. That color of the fruit image was very useful for developed an algorithm to compare capture image with stored images in data base.

Development team used a web service which can be used through mobile device and database. In that web service the developers used our own algorithm to compare two images. The team developed that algorithm using three approaches. They are compare by pixels, color and byte array length. For compare by pixels method the developer retrieve all images from “ImageData” column in fruit table. For that developer used special method. Then that image store in temporary folder and compare one by one with capture image. If those images are not same 100%, using (Figure X:) algorithm developer found difference as a percentage. Then take that percentage, color and length of the byte array the developer find ImageId of the fruit. Then using sql queries the team retrieve details that stored in database and pass to the mobile application. The mobile application was display details of the fruit.


```

void conv_photo()
{
    if (pictureBox1.Image != null)
    {
        MemoryStream ms = new MemoryStream();
        pictureBox1.Image.Save(ms, ImageFormat.Jpeg);
        byte[] photo_array = new byte[ms.Length];
        ms.Position = 0;
        ms.Read(photo_array, 0, photo_array.Length);
        cmd.Parameters.AddWithValue("@img", photo_array);
    }
}

```

Figure X: Algorithm for convert image to byte array

```

public bool compareImages(string captureFile)
{
    bool status = true;
    bool isFoundImage = true;
    SqlConnection con = new
    SqlConnection(DBHandler.GetConnectionString());
    SqlCommand sqlCmd = null;
    SqlDataReader sqlReader = null;
    string tempFile = "";
    int fileCount = 0;
    try
    {
        con.Open();
        sqlCmd = new SqlCommand("select ImageData" + " from
        Fruit", con);
        sqlReader = sqlCmd.ExecuteReader();
        while (sqlReader.Read())
        {
            byte[] barrImg = (byte[])sqlReader.GetValue(0);
            tempFile = getTempFile(barrImg, fileCount);
            status = compare(captureFile, tempFile);
            if (status == true)
            {
                isFoundImage = true;
                File.Delete(tempFile);
                tempFile = "";
                break;
            }
            else
            {
                isFoundImage = false;
                tempFile = "";
                File.Delete(tempFile);
            }
            tempFile = "";
            fileCount = fileCount + 1;
        }
    }
    catch (Exception ex)
    {
        tempFile = ex.GetBaseException().ToString();
    }
    finally
    {
        con.Close();
    }
}

```

Figure XI: Algorithm for compare two images

A. Discussion

This section reveals the failures and attempted technologies that were used during the period of the development of the proposed system. The reliability and accuracy level of this SmartShopping tool is not high. That issue comes up with comparison algorithm and image processing algorithms. This tool handles all the fruit details in the database. The development team act as the admin panel and team will

update all fruit details. Due to that issue percentage of maintenance was low.

The main reason for not having high accuracy was due to the algorithms that were used for image processing and comparison process. Development team tries to tracked fruit using color and shape of the fruit. Very difficult to track fruit using both color and shape, because opencv library not efficient to do that properly. Due to that issue development team developed android application only for capture fruit image. If development team could found another library rather than opencv, team could be able to develop this tool more accurate.

In the testing process for the fruit recognition, in some cases the team did not get the actual output as team expected. The development team tested the system in different aspects to detect this fault and finally the team found that, mainly it is happening due to the poor lighting conditions, higher lighting conditions and due to the dark backgrounds. Therefore in order to get the accurate output, it is required to have moderate lightning conditions with an appropriate background.

Reliability of the SmartShopping tool was not much higher, the main reason for that is details that are displaying to the user depend on the color of the tracked fruit. When user try to detect the fruit in more lightning environment tool failure to detects the fruit different color. Due to that reason there is high probability to display wrong details.

All the maintenance of the tool is done by the development team. Development team always tries to update database according to the new arrivals. They are human beings. So there is a possibility to happen mistakes.

During the development phase of the system the team used various approaches to handle the complexities of the proposed system development. In very earlier phase of the development team decided to use Android studio to develop mobile application. Development team could not found any technology to detect fruit using Android. Then development team developed image processing part using visual studio console application and C++ programming language. After that development team tries to convert that console application in to windows platform mobile application. That converting process was not successful. Finally the development team develops android application to capture fruit and pass that image to web service. In the web service we tried to do image processing part to identify fruit.

Another problem that development team faced was connecting web service with database and image processing Android application. Development team did web service using C# language. Mobile application was done by using android Technology. Android plat form is Java. Due to that reason development team faces lot of problems to connect both applications. If the team had done

web service using php programming language team could do this connection very easily.

In earlier stage development team decided to develop SmartShopping Tool for both fruits and vegetables. In development time period it was difficult to do. This research development team limited scope to only five fruits. There is another limitation about view of the fruit Development team developed this tool by using side view of the fruit. Because of those issues this tool does not give correct output for top or bottom view of the fruit.

V. CONCLUSION

There is no doubt that in today's world, most of the people do not consider health and fruit that they eat and some people do not know even the name of the fruit that they eat. Due to busy life style people are addicted to do quick shopping. Here developing "SmartShopping: Building a Tool Based on Augmented Reality", development team was provided accurate tool for display fruit details lively. Main objective of this research is displayed accurate details for user lively. Once the user selects the fruit, the image would be processed and display details 1-2 seconds. Here using this precious tool consumer can lively see fruit details like fruit name, price, vitamins and nutrition.

Consider about quality of the system this tool is one of the high quality product in the world. Consumer does not worry about trustworthy of this tool because all the details about the fruits are inserted by administrator. Development team acts as administrator. Another person cannot enter details, because by using user name and password for admin, prevent access from unauthorized persons misusing the system. Trustworthiness of this SmartShopping tool is higher than other systems. Sometime you will think how details are updated according to new arrivals. Do not worry about that, development team is responsible for this product and all the maintenance and modifications are done by development team as soon as possible. When a new fruit is recognizing or scientists figure out the tremendous ability of fruits curing diseases that details also add in to the database immediately. In the world most of the applications are not available when user wants it. This tool is not like that, it is available 24/7. Using this SmartShopping tool definitely customer can select fruit quickly and spend healthy life.

If customers like to use this mobile application for select the fruits they should consider about same limitations. This tool displays fruit details using real time image processing and development team used color and shape tracking methods for real time image processing. Because of that detected image output details will be depended with environment light. Due to that reason user should consider about changes in the environment.

Development team implemented this tool for limited no of fruits. The user try to detect fruit that is not in research scope this tool won't work properly. Another constraint of

this tool is view of the fruit. The tool will identify the fruit by using side view of the fruit and should track whole view of the fruit. Tool cannot identify top or bottom view of the fruit.

This mobile application connected with database using web service. Therefore fast internet connection is very essential and failure of the internet connection will affect performance of the tool. User wants to get best performance from this tool, should have a fast internet connection. When compare with other augmented reality applications this limitation won't be major issue and customer does not want to worry so much about these limitations.

The development team could not be able to develop an algorithm to separately identify one particular fruit from a lot. That is not a major issue. User can select one fruit and capture photo. If user can do it that manner he can get result very soon. This SmartShopping tool accuracy is not much high that issue comes with comparison algorithm. Because development team compare two fruits using color and pixels of the image. In the world, fruits have many colors and shapes. An example Apple fruit has two colors, red and green. When user tries to move from red apple to green sometimes tool did not display details accurate. Rather than using this algorithm the development team could use another algorithm to compare accuracy of the tool can be increased.

In the future this SmartShopping tool can be developed further in many ways. Within our research scope development team limit only five kinds of fruits. Therefore researches who likes to implement another system based on our research they can develop this for both fruits and vegetables. Here development team failure to detect fruit using android technology, developers only implemented this tool for capture image. In future other researches can be implement this tool for detect fruit using android technology. And also Researches can implement this research to separate a particular fruit from lot. As a development team we also wish to implement this research further for all fruits.

Finally the team hopes that the research would be of benefit on a global level. The team hopes that this study will be helpful for the researchers who are interested in Augmented Reality and image processing to design and develop similar models or to develop the same device further and use this concept with their projects.

ACKNOWLEDGEMENT

As the SmartShopping team would like to express our deep and sincere sense of gratitude and indebtedness to our institution - Sri Lanka Institute of Information Technology (SLIIT). Then we would like to express our sincere thanks to the lecture panel and the generous people in the SLIIT administration division. The team is extremely thankful to our beloved parents, our family members and friends for

their help and blessings which helped us directly and indirectly in this research. The team also takes this opportunity to thank all the 3rd year students for showing up some grate brotherhood in helping us in all the aspect of the research. Last but not the least the team is really grateful to all the authors whose contributions provided us with great knowledge which helped us to successfully complete this project. There are too many other people who directly or indirectly helped us along the way and we know that we have missed some of you here; to each of you, the team thank you all for your contribution.

REFERENCES

- [1] Wikipedia,"Augmented reality",Wikipedia, Feb.24, 2014 [online]. Available: http://en.wikipedia.org/wiki/Augmented_reality. [Accessed:Feb.3, 2014].
- [2] W. Piekarski and B. H. Thomas ," The Tinmith System – Demonstrating New Techniques for Mobile Augmented Reality Modelling", [online].Available:<http://www.tinmith.net/papers/piekarski-auic-2002.pdf>. [Accessed:Feb.8, 2014].
- [3] DotMobile,"Augmented Reality", Augmented Reality, [online].Available:<http://doit-mobile.com/augmented-reality/>. [Accessed:Feb.8, 2014].
- [4] W. W.Regards,"A Monthly Journal of Computer Science", International Journal of Advanced Research in Computer Science and Software Engineering,Vol.4,no.2, February 2014.
- [5] Forrester Research," Augmented reality makes shopping more personal", IBM Research,[online].Available: <http://www.research.ibm.com/articles/augmented-reality.shtml>. [Accessed:Feb.20, 2014].
- [6] Wikipedia," Systems development life-cycle",Wikipedia, Feb.24, 2014 [online].Available:http://en.wikipedia.org/wiki/Systems_development_life-cycle. [Accessed:Feb.26, 2014].
- [7] "THE PROTOTYPING METHODOLOGY",[online].Available: <http://www.wwetc.com/UoR/WhPp/Prototyping.html>. [Accessed:Feb. 24, 2014].
- [8] Wikipedia," Interface design", Wikipedia, Oct.29, 2013 [online]. Available:http://en.wikipedia.org/wiki/Interface_design. [Accessed:Feb.26, 2014].