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FACULTY OF INFORMATION TECHNOLOGY

Virtual Reality Store

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Abstract

One of the greatest things that the internet has brought us is online shopping, Although this concept is widely used, most people struggle with the fact that They get to see only pictures of the product they want to buy; they want more Than just pictures, and this is when our project comes in hand. A virtual reality Shopping application .In this project, we found a way to make shopping fun, easy and most importantly Effective, our approach is to find a new reliable way to serve the customers by giving them the experience of a real-life shopping trip, and in that way the customer will have the ability to find the product they want, examine it in a 3D way and real all about its details, which gives them the feeling that they actually went to a shopping centre, and that is our main goal.

Acknowledgement

“In The Name of ALLAH, The Most Gracious, The Most Merciful”.

“ALLAH Will Raise Those Who Believe From Among You and Those Whom Knowledge is Given to Degrees of Rank. And ALLAH is Well-Aware of What You Do.” (The Holy Qur'an, surah Al-Mujâdilah , 11)

First and above all, All praise belongs to ALLAH who has the almighty for providing us this opportunity and granting us the capability to proceed successfully.

And we could not have guidance, if ALLAH had not guided us.

This project appears in its current form due to the assistance and guidance of several people. We would therefore like to offer our sincere thanks to all of them.

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This work is dedicated to all our family members, especially our parents, whose great support has given us the opportunity to pursue the highest level of education.

Project Team.

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CHAPTER 1

INTRODUCTION

The phenomenal development of technology has occurred since Michael Aldrich invented online shopping [1][2]. In the UK followed the World Wide Web (WWW) by Tim Berners-Lee and gave the first web browser to view the web which changed most of things; a whole new revolution began [3]. Later, Netscape released the Navigator browser, and provided Secure Sockets Layer (SSL) encryption for the secure transaction [4]. Then transactions and business began to happen across the web urging every company to get a .com. To address security issues, Netscape 1.0 introduced SSL encryption for secure handling. When the money was involved in doing business online, "PayPal" was launched, and it provides online payment facilities. E-commerce sites, such as Dell.com, Amazon.com and eBay.com, have started selling their products online, as well as a search engine like Google, Yahoo, Facebook.com and others [5]. All of these companies are creating 2D website. These business activities have redefined products, distribution channels and industries [6].

Quickly, online shopping sites become a very attractive way for customers to use because of their advantages, such as convenient price, easy, fast shipping, price comparison, recent customer reviews and social shopping, especially in developed countries. Moreover, these online shopping websites are becoming very popular with customers because it considered entertaining and time consuming for customers. Development of online shopping sites and adding more facilities, such as converting these two-dimensional sites to three-dimensional (3D) through the additional use of virtual reality [7].

Virtual Reality is a computer-made fictional reality to make it similar so close to reality that it creates a real 3D experience for the user. Virtual Reality relies on a special tool kit (Gadgets) called virtual reality glasses that displays pictures or sound

clips through the projector and sound system designed specifically to create an environment that is completely similar to reality, Which will allow the user to "experience" the displayed reality [8]. On the other hand, augmented reality (AR) differs from the default in that it does not need special tools, yet it creates an interactive 3D environment for any stereoscope that is designed within the application used to activate it. The AR mechanism is simple and it depends on the presence of a special program that includes stereoscopic data in 3D in addition to a projector compatible with the application (Android phone or IOS or any other compatible device) This application displays a three-dimensional embodiment of any product or stereoscopic within the application library [9].

The online shopping is in constant evolving and always need to be updated to cover all the user needs and making there life much easier, creating new customer experiences that are memorable and unique, With virtual reality (VR) makes a whole new experience and an evolution in the online shopping experience and changing the market in the same way that the internet did.

According to Goldman Sachs, the AR and VR market for retail will reach US \$ 1.6 billion by 2025. Statistics show that two-thirds of internet users will care about VR, and 63% said such technologies will change their way of shopping [10].

VR is becoming a more accessible technology that can soon gain much appeal in the market - so it's not just a fad, VR is something that really goes ahead and should be seriously considered by online sellers. VR can make a great help in the design, also research, and more improving the customer shopping experience. It provides lots of advantages when considering how to cover consumer's wants and needs, especially when they're constantly changing. VR provides competitive features by being up to date with current trends. It also accomplishes all this with the funniest and most exciting shopping experience [11].

Therefor making an app that provide the VR and online shopping in one environment a great idea because its solving the problem where the customer can't trust the product

he is getting, due to there is not enough and worthy visual representation of a product with the usual online shopping, with our application we are taking the very first huge steps with virtual shopping experience to provide the customer with a unique and funny experience.

1.1 Project Background

Shopping is one of the important processes that people perform frequently, as the person goes to the market to buy what he needs of goods, and this process requires time and effort, and do not forget the time we spend going and returning and sometimes the roads may be crowded, which requires more Time is on the way.

We have made an application that can save time and effort and we tried to maintain the benefits of online shops, like search functionality and availability, while simultaneously focusing on shopping experience and immersion. By touching the third dimension, VR provides a more advanced form of visualization, which can increase the customer's satisfaction and thus shopping experience.

As this application uses the technology of VR, which is a technology used by the smartphone, and it has more than one use, it is used in the field of games and watching movies, we have used this technology in this application to provide an easy and convenient shopping process[12].

1.2 Problem Statement

The idea of this project is to break the traditional online retail problems that goes under the lack of visual representation of the product and to Save the time And money of going to an actual store . So Instead you can use the VR to feel like you're inside the store.

You can walk around the store and inquire about the specifications and price of the product you need from your home or your office.

1.3 Project Objectives

This project aims to develop a virtual environment in which a 3D view of products is created for customers to view from every aspect, and to explore the main characteristics of stores inside and outside the Internet regarding the behavior and frequency of customer shopping. Our software can save time and effort for anyone using it, which is better than traditional ways to keep up with the technological development in this world. Using virtual reality stores VR may increase customer satisfaction as well as the ability to display detailed items.

There are other objectives of the project that can be summarized as follows:

1. Creating a whole new e-commerce experience.
2. Solving the problems of traditional e-commerce experience.
3. The user will be able to examine the item with his eyes fully open creating an actual live shopping experience.
4. Making online shopping more interesting.
5. Delivering a new generation of e-commerce.

1.4 Project Significance

Buying things online is not just a trend and has an end things in this field are getting greater and bigger , but though it quiet helped the shopping process to be greater but it can be a lot more , the online shopping has its flaws in the user experience field , you see the user does not feel like he is actually shopping he cant see the actual product until it comes .

Question is how did we solve this ?

Well we came up with implementing a new tech with old tech and that is the virtual reality with online shopping

In our project we are going to represent the online shopping experience in whole new standing where its mixed with virtual reality , in this method the user will have a living experience of almost real life shops

1.5 Gantt Chart

Gantt chart is one of the essential tool for project managers in order to construct and schedule different tasks and see these tasks against time [13]. The tool simply offers to visualize different tasks, their dependencies, time limitations and other project management related specifications in order to allow project managers to follow and act for completing the intended work at intended time duration. In short, the tool offers project managers to define problems, control them and accept different solutions when there is a need [14].

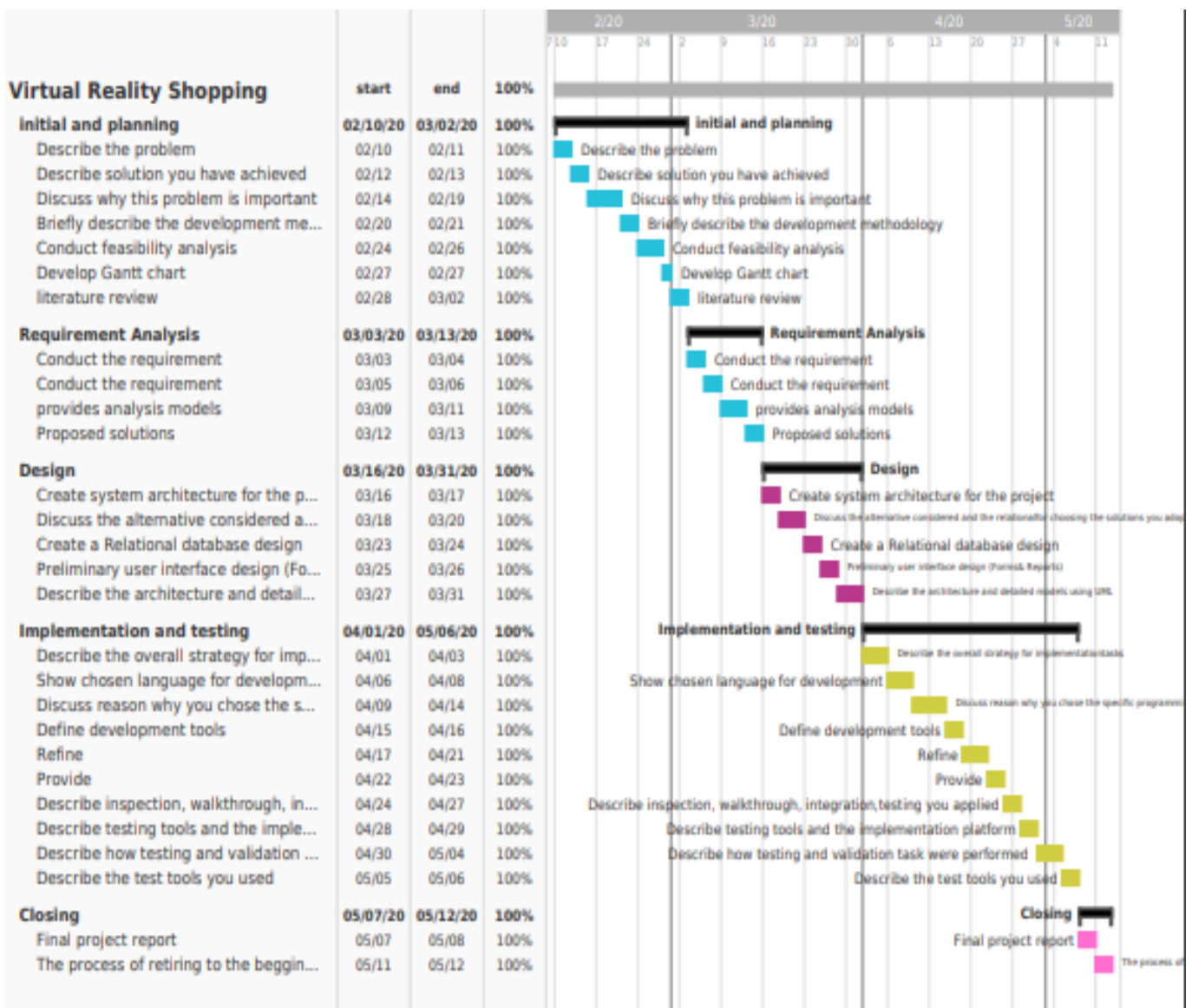


Figure 1-1: Gantt chart of Virtual Reality Store

1.6 Task Responsibility matrix

After completing the Analysis and design Stage now we are going to the findings Chapter. Therefore, we organized the tasks and responsibilities among the project team as shown in table below.

Project: Virtual Reality Store		Prepared by: Project Team			Legend : P = primary S = support
Manager : DR. Ali Al-Ghonmein		Page 1 of 1			
		Responsibility matrix			
ID	Task	Rashed Alkhatib	Mohammad Al-athamneh	Abdullah Al-baker	Mohammad Abd-Alsalam
A	Team Leading	P			
B	Document Inspection	S	S	P	S
C	Analysis	P	P	P	P
D	Programming	S	P	S	S
E	Design	P	S	S	S
F	Testing	S	S	S	P
G	Validation and Verification	P	S	S	S

Table 1 : Task and Responsibility of Project Team

CHAPTER 2

LITERATURE REVIEW

Online shopping and virtual reality

Online shopping is a process of exploiting and hosting many electronic media in order to promote the product; this allows the sale and exchange of goods over the Internet. Online shopping began with the development that accompanied technology in 1971. Online-shopping is widespread in all parts of the world and is available to everyone and is less expensive and more effective. Online shopping faces many challenges, including big data analysis and merchandise presentation. Currently, a major problem for online shops is lack of clarity, realism and immersion. Buffa et al. Describe the advantages and limitations of 3D stores, adding a third dimension can add these gaps in the virtual shopping experience. Customers will then benefit from always-open unstaffed warehouses, time-saving shopping and multi-modal product information. This applies for online shops, but not for physical stores [15][1]. Virtual reality (VR) applications were first recognized by game and entertainment industry. However, they have become widespread in education, health and many industrial application technologies in recent years. The history of VR applications, which entered the market with 3D video games, dates back to the 1930s when a vision simulator was produced that gave the feeling of a real environment with the help of light [26]. 3D virtual worlds have the potential to revolutionize business and bring significant implications and activates to business including opportunities for co-creation and enhancing customers' perceptions and value of a brand. The idea of the virtual world environments technology can be used to create environments that are closer to the field and easily implement in many important applications [16]. 3D virtual technology provides a rich environment for customers that help to improve the user interface by interacting with each other, and increase the user's motivation to navigate within realistic-looking environments [17]. 3D technology provides customers with the ability to view and manipulate physical objects using 3D technology so they can display items within their preferred environment. Meanwhile, the agent technology is applied to greatly enrich the customer's shopping process by emulating the body language of the customer symbol such as its position and the console response in the virtual environment [18].

In 1984 NASA launched the Virtual Visual Environment Display (VIVED) project, followed by the Virtual Interactive Environment Workstation (VIEW) project. NASA Ames Research aims to develop a multi-functional and multimodal user interface to facilitate natural

interaction with complex operational tasks and raise awareness of complex and independent integrated systems. The areas of application that NASA AMES focuses on are remote presence control, monitoring and management of large-scale IT systems and human factors research [21]. Despite the success of the search, virtual reality was not announced until June 6, 1989, when Jaron Lanier, president of VPL, defined the concept of virtual reality (VR), which wanted all existing virtual projects to fall into one category. However, in the early 1990s, the literature on this topic began to describe this concept in more detail [22].

Sheerman defined virtual reality as a medium consisting of interactive computer simulations sensing the position of the participant and his actions, replacing or increasing the feedback of one or more senses, offering the participant a sense of being mentally submerged or present in the simulation (in the virtual world). Coates (1992) explains that virtual reality includes electronic simulations of environments experienced by head-mounted glasses and wired clothing that enable the end-user to interact in realistic 3D situations [23]. Simultaneously with the term virtual reality, the term augmented reality (AG) was introduced by Tom Caudell and David Mizell in Boeing. They developed the first pilot training systems [24]. This was followed by the use of AR to train doctors. At the same time, the entertainment industry was getting ready more and more computer games using augmented reality. Today, virtual and augmented reality is used not only in the entertainment industry, but also in medicine, engineering and education. In Asian countries, virtual reality is used in education from primary school to university [25].

A key characteristic of a great VR experience is the feeling of ‘presence’—users feel like they are truly in the synthetic environment being presented.” A related technology, augmented reality (AR), involves overlaying digital objects and/or information in the real world through digital devices (such as Google Glass or smartphones).

VR affords marketers the opportunity to provide potential consumers with the most realistic experience of a product, service or place yet without necessary physical co-location. This provides an advanced, rich and immersive medium that is able to deliver distinctive, high-impact and memorable messages, and engage audiences and potential consumers [31].

Masaya Ohta et al. propose a concept of a mixed reality shopping system to allow the user to explore a virtual store in virtual reality using a smart watch as an input. Their goal was to support disadvantaged shoppers and help customers accelerate their shopping trip. As one of the first, it provides a clear distinction between online and offline shopping and the announced features. They claimed that e-commerce reduces the inconvenience of shopping, but search by name (speech or textual input) contains issues like wrong entries or lack of knowledge of the store name for the desired product. Moreover, product images can also be insufficient to check

the details, and many products change their appearance frequently, which may lead to high maintenance effort [19].

In contrast to traditional retail stores, online shopping offers many advantages, such as unlimited opening hours and a stronger focus on functionality. But this is accompanied by a complex classification, limited visualization of the product and immersion. The development of VR, together with other technological innovations will shape the future of e-retailing. VR has the potential to create new shopping experiences that combine the advantages of e-commerce sites and conventional brick-and-mortar shops. We examined the main features of online and offline shops in terms of buying behavior and customer frequency. Furthermore, we designed and implemented an immersive Web VR online purchasing environment and aimed to retain the benefits of online shops, such as search functionality and availability, while focusing on the shopping experience and immersion. This VR shop prototype was evaluated in a case study with respect to the VR Shopping Experience (VRSE) model. The next step is to classify, investigate and evaluate the next generation of VR shops, including product interaction and navigation techniques, as well as store and product representations.[30]

As Gartner noted in 2016, VR is one of the most promising technological innovations in business. The aim of this paper is to analyze the possibility of using innovative tools, based on VR and AR in marketing communication. The source base of the study is the available literature on the subject, secondary sources, own analyses and research, as well as studies carried out by foreign research institutes. The paper presents the results of owner search conducted in 2018 with the CAPI method on a group of 114 respondents. It should be stressed that although the results of their search indicating limited use of VR and AR are not representative, they indicate a dependence which is worth exploring in a larger research group. A self-assessment of marketing activities using VR and AR technologies based on the SERVQUAL model was also conducted[52].

The VR Shopping System and methods provides the means to extend to the Internet shopper the same shopping experience as being in the physical store. The system and methods of the VR Shopping System Software builds upon commercially available software tools in the areas of multi-media and Internet shopping cart software. It uniquely combines the features of these tools and adds functions so to provide a VR Shopping System that realistically conveys the physical store's intended atmosphere, environment, and customer's shopping experience, which uniquely brands that store.

This project presents a new type of e-commerce system, which obviously brings virtual environment with an active 3D model. This system implemented to allow consumers to access into real physical environments to enrich shopping experience and user interaction.

Use of VR and AR in marketing :

VR is a relatively new medium offering new possibilities of content communication. The features of VR make it capable of manipulating the sense of time and space being interactive and making the user "control" their experiences. VR is considered one of the most promising technological innovations in business (Gartner, 2016). Due to its affordability, this method has become more accessible to consumers, also drawing marketing attention to a new way of advertising products and brands (Adams, 2016). VR's scope of application is increasing regularly, and other examples of its use are given below. Emirates allow its customers to virtually visit the aircraft before buying a ticket (replacing the existing form: photos and videos). A Swedish company, Ikea, offers to design its own flat. The customer gets the impression that she is being painted with cosmetics of her choice and then can admire the effects of the make-up. Consumers can use the AR with a smartphone in their daily shopping, e.g. by checking the composition of products, the most popular applications. The most important aspects that distinguish VR from other methods include: accessibility (every customer with a smartphone and goggles can move to the virtual world. The test drive can be used at an appropriate time, without agreeing to pollute the environment), low costs of designing and operating simulators, attractiveness (the applied solutions attract the attention of customers), lack of barriers (fully engaging the show that brings the viewer directly to the promoted or desired locations). According to a survey conducted by eMarketer in October 2015, 64 % of respondents indicated that they

prefer to see objects in their true size and shape when shopping online. Other surveys show that 36.54 % of marketers surveyed found VR to be the most exciting digital marketing activity (VR is an Immersive Medium for Marketers, 2016). VR enables experiences not only anywhere and anytime, but also those that would not be possible in the real world. This may give you a significant advantage over the competition on the market [8]

BACKGROUND OF THE INVENTION

In the past, consumers were required to physically visit stores and shopping malls to purchase products. Currently, with the expanding use of the Internet and World Wide Web, there are many web pages allowing users to browse and purchase merchandise without ever leaving the computer terminal. For consumers who dislike shopping, are limited in time, live in rural areas where shopping is limited, or for some reason cannot physically visit the mall or store, shopping online is an ideal way to purchase products. Mail order catalogues and television shopping channels have attempted to address this need in the past. However, mail order catalogues are limited in their shopping choices and television shopping channels are not readily available in every city and/or consumers do not have control over what items are viewed to buy. Furthermore, a user may have to connect to each store's web page to shop at the store. This requires the user to open a new browser each time, which takes time and space on the computer. Thus, there is a need for a way to enhance a user's shopping experience to make shopping online more efficient and appealing. The aim of this study is to find out whether the VR shopping centre user interface has a positive impact on customer satisfaction compared to the regular shopping centre. For this purpose, we have developed a prototype of the VR mall in which the user interface consists of both 3D graphics, in order to measure comfort, enjoyment and quality assurance are improving in the VR mall, and whether customer satisfaction is also a big boost in the mall VR compared to the ordinary shopping mall [4].

IT Relations Instrumental Relations between Consumer and virtual Technology in Shopping Activities

General 2D websites, containing width and height coordinates, currently used with most online shopping facilities are considered interesting to the users and provide several market activities and actions of selling, buying and advertising over the

Internet. Due to the development of information technology (IT) and Internet, Business activities could expand 2D web environments to be used in 3D virtual world environments [27].

Where 3D virtual worlds have the potential to revolutionize business and bring significant implications and activates to business including opportunities for co-creation and enhancing customers' perceptions and value of a brand [28].

The idea of the virtual world environments technology can be used to create environments that are closer to the field and easily implement in many important applications.

Product in VR

we can simplify the meaning of fully AR as a normal picture of the real world surrounding us, to which some information, data or digital elements are added, so that it can interact with it in any form, whether text, audio or visual

There are several main methods that the AR technology relies on to enhance the actual reality with tangible digital elements, the most important of which are:

1-Overlay.

2-Projection.

3-Depending on the still image.

The inability of the shopper to check and preview the product between as in the case of traditional stores, was one of the most difficult challenges facing the spread of e-commerce;

however, the matter completely changed with the emergence of these two technologies.

All e-stores and online selling sites can use AR and VR:

1-Help shoppers experiment with products.

2-Enable customers and shoppers to preview what the products they choose to look like before purchasing.

3-Solve the measurement problems of many products that shoppers are reluctant to buy because of their fear of the size while they cannot determine their exact size before purchasing the product.

4-Increase the confidence of customers and shoppers and drive them to purchase safely and with great reassurance. [12]

"VR IN MARKET RESEARCH AND PLANNING"

Marketing psychology has a new tool in its repertoire with VR – planning stores doesn't have to be guesswork when you can trial potential layouts before you build them, Displaying various products and services through VR can let you understand whether your proposed ideas will be successful before they are released into physical stores. It can also be used for home design, an idea embraced by the likes of IKEA. Their VR app is 98% accurate in terms of how precise it is. It allows you to get a feel for the texture, pattern, and even how the lighting in your room will affect the look of the furniture. You can bring your plans to life in a matter of minutes to design your perfect living space. It has an incredible amount of depth to it too, even allowing you to open the drawers in the kitchen, letting consumers view products in context is preferential in terms of ease and efficiency. But it also benefits the retailer by offering a feature which is personal and appeals to the needs of the modern consumer [29].

CHAPTER 3

METHODOLOGY

The chapter presents an overview of the project's model, and describes the system architecture, Framework, analyze and design the system, the system prototype, the programming language used to implement the project and the engine we use.

3.1 The Project Model

In this project, the waterfall methodology was used. The waterfall model was the first Process Model to be introduced it is very simple to understand and use. In a Waterfall model, each phase must be completed before the next phase can begin and there is no over lapping in the phases. The waterfall model is the earliest SDLC approach that was used for software development. In “The Waterfall” approach, the whole process of software development is divided into separate phases. The outcome of one phase acts as the input for the next phase sequentially. This means that any phase in the development process begins only if the previous phase is complete. The waterfall model is a sequential design process in which progress is seen as flowing steadily downwards (like a waterfall) through the phases of requirement gathering & Analysis, system Design, implementation, Testing, deployment of system, and Maintenance [32].

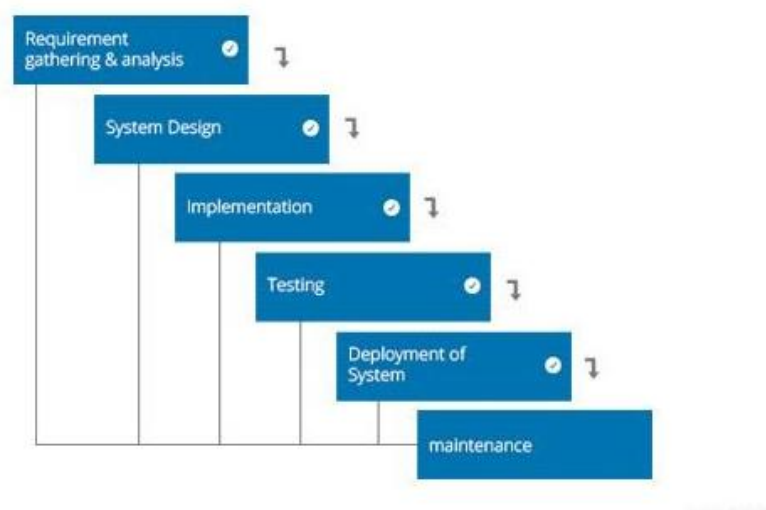


Figure 3-1 : Waterfall Model

The sequential phases in Waterfall model are:

- **Requirement Gathering and analysis:** All possible requirements of the system to be developed are captured in this phase and documented in a requirement specification doc.
- **System Design:** The requirement specifications from first phase are studied in this phase and system design is prepared. System Design helps in specifying hardware and system requirements and also helps in defining overall system architecture.
- **Implementation:** With inputs from system design, the system is first developed in small programs called units, which are integrated in the next phase. Each unit is developed and tested for its functionality which is referred to as Unit Testing.
- **Testing:** All the units developed in the implementation phase are integrated into a system after testing of each unit. Post integration the entire system is tested for any faults and failures.
- **Deployment of system:** Once the functional and nonfunctional testing is done, the product is deployed in the customer environment or released into the market.
- **Maintenance:** There are some issues which come up in the client environment. To fix those issues patches are released. Also to enhance the product some better versions are released. Maintenance is done to deliver these changes in the customer environment.

All these phases are cascaded to each other in which progress is seen as flowing steadily downwards like a waterfall through the phases. The next phase is started only after the defined set of goals are achieved for previous phase and it is signed off, so the name "Waterfall Model". In this model phases do not overlap [33].

Why did we choose the waterfall model?

1. Simple and easy to understand and use.
2. Simple enough to handle as model is rigid.
3. Saves significant amount of time.
4. Allows for easy testing and analysis.
5. Easy to manage due to the rigidity of the model .

6. Each phase has specific deliverables and a review process.
7. Phases are processed and completed one at a time.
8. Clearly defined stages.
9. Well understood milestones.
10. Easy to arrange tasks.
11. Process and results are well documented.

3.2 Construct Framework

This project was implemented through a research method, through which one of the most problems that result from repeated activity by people was clarified, as people make shopping almost daily, so the purchase process in the traditional form may result in many of the problems mentioned previously, we have By searching for solutions to get rid of these problems or reducing them, we have built this application, through which the shopping process is easier and faster than the traditional way, it has dispensed with road congestion and the distances that are covered to reach the market.

3.3 Develop System Architecture

In this project, a virtual store was adopted, through which products belonging to a website are often displayed, as it gives the customer an impression as if he is inside the store, as it allows the customer to tour the store and navigate with ease, allowing the customer to see the products he wants to buy and view from a three-dimensional perspective and It also allows the customer to fully inquire about the product specifications and see the price, and through this application the customer can buy more than one product at one time as if it was inside a realistic store.

3.4 Analyze and Design the System

Based on the System Architecture, virtual reality shopping requires Viewer, Model and Controller.

Viewer: virtual reality glasses google VR (cardboard).

Model: Windows , IOS , and Android.

Controller: Bluetooth controller.

3.5 Build the Prototype System

Our application was developed using Unity, there are many reasons why we chose Unity ?

1. Android is an open source development platform that supports multiple connectivity technologies.
2. Android supports various types of audio, video and other media formats with high quality and since our application will contain videos and images, android will be perfect for us.
3. Android supports multiple languages.
4. According to the StatCounter global stats reports, Android is the most popular OS for smartphones.

Unity

C# is used to create our application using Unity engine.

Unity is the most widely used VR development platform, and over 91% of HoloLens experiences are made using unity. Unity engine can be used to create 3D, 2D and virtual reality as well as simulations and other experiences.

What is C#?

C# is a general-purpose, modern and object-oriented programming language pronounced as “C sharp”. It was developed by Microsoft led by Anders Hejlsberg and his team within the [37].Net initiative and was approved by the European Computer Manufacturers Association (ECMA) and International Standards Organization (ISO) [34]. The .NET platform includes tools, technologies, and methodologies for writing Internet applications [35]. It includes programming languages, tools that support XML Web services, and new infrastructure for writing HTML pages and Windows applications. At its core are a new virtual machine and an extensive runtime environment. Compilers for C# and other .NET languages generate code for this virtual machine, called the .NET Common Intermediate Language or MSIL for short[36].

Reasons to use C#:

1. It is a very easy language to learn, it is entirely based on the C and C++ languages.
2. It is a simple language that has a rich set of library functions and it doesn't require header files.
3. C# has grown so much since it was first created.
4. According to GitHub, C# is one of the most popular programming languages in the world.

VR overview

Unity VR lets you target virtual reality devices without any external plugins. It has been designed to provide forward compatibility for future devices and software.

By using VR support in unity, you gain:

1. Stable versions of each VR device.
2. A single API interface to interact with different CR devices.
3. A clean project folder with no external plugins for each device.
4. The ability to include and switch between multiple devices in you applications.
5. Increased performance.

3.6 Observe and Evaluate the System

The total number of active VR users worldwide is forecast to be around 171 million as of 2018, around 16 million of these considering themselves to be hardcore gamers. VR technology is often used with some sort of optical headset device, with major VR hardware developers such as Sony, HTC, and Oculus combining to ship millions of these devices each year[38].

Especially for VR:

Shockingly, 77.24% of shoppers abandon their carts before completing a purchase. This indicates that retailers need to do a lot more to convince customers to follow through with their choice and purchase items online. VR is an emerging technology that could provide the answer. Along with its sister technology - AR - it has the potential to reshape the world of retail, and nearly a third of customers believe more should be invested in these technologies to ensure they play a larger role in their shopping experience [39].

CHAPTER 4

ANALYSIS AND DESIGN

4.1 Introduction

These requirements provide a clear picture of the work required, a description of the operation of the program, its method of use, and the design of this program, through the drawings used and drawn by programs designated for this purpose such as (use case) and others.

In this chapter, the requirements activity is described in more accurate details, and it presents some techniques used specifically to discover the area of the problem, determine what will be created and define the target audience.

Software Requirements Knowledge Area is related closely to the Software Design, Software Testing, Software Maintenance, Software Configuration Management, Software Engineering Management, Software Engineering Process, Software Engineering Models and Methods, and Software Quality Knowledge Are.

In this section, we will prioritize requirements according to costs and the extent of its impact on the project's workflow.

We use the three-level scale method:

- <H>: High priority
- <M>: Medium priority
- <L>: Low priority

4.2 User requirement

- The user download and install the app.
- The user opens the app after downloading it from the play store.
- The user list the items.
- The user moves around the store.
- The user selects the desired product.
- The user purchase the desired product.

4.3 System requirement

User must have sufficient knowledge and information about this application, Because the use will be different groups of users , and it will be for self-use.

4.3.1 Hardware Requirement

- As for hardware, there must first be a device that connects us to the site from which we will buy it which is either a smartphone or tablet device or it is a personal computer.
- VR Glasses are required that will transform the virtual store into a virtual reality world
- Constant Updates are required to apply
- A Bluetooth controller
- Phone must have a gyroscope. Older and budget versions of certain smartphones do not have gyroscopes
- Phone must have an accelerometer (almost guaranteed for any phone)
- Android phones need to be Android 5.1 (lollipop) or higher.

4.3.2 Software Requirement

- The application is available on the following operating systems (ANDROID)
- Google cardboard application

4.3.3 Performance Requirement

- Allow the User to navigate the store easily
- 3D shopping is available
- The ability to pay by bank card

4.4 Role and priority

Customer access to the application:

By entering the application, the customer will be able to purchase products, view product information, and also bid.

The main interface for system Customers:

This part consists of the common job between the user and the store owners, how they interact and interact with the application interface and the functions that are provided to them through it.

4.5 Functional Requirement

- The process of opening the application and start buying:
- The customer opens the application. <H>
- The application allows customer to walk towards the store. <H>
- The app allows the customer to move between shelves. <H>
- The customer directs the indicator. <M>
- The customer chooses all the products that he needs. <M>
- The application allows the customer to view the product in 3D. <H>
- The customer clicks on purchase when the product search process is completed. <M>
- The application allows the customer to cancel the purchasing process. <H>
- The customer cashes out when the purchasing process is complete. <M>
- The main interface of the application user (customer):
- The app shows the shelves that carry the products<H>
- The application shows the customer the product in 3D<M>
- The application shows the customer all the information related to the product<H>
- The application informs the customer about the price of the product<H>

4.6 Non-Functional Requirement

The official definition of a non-functional requirement is describing how the system works and specifies, how the system should behave?

4.6.1 Flexibility

The application Customer can use the application easily and simply, and shopping in a flexible and comfortable way, without complication.

4.6.2 Availability

This application is always available , due to its presence on the smartphone.

4.6.3 Technology

- The application supports the term e-shopping
- The application supports the electronic payment process
- The application provides access to the product from a three-dimensional perspective

4.6.4 Usability

The use of the application is easy and flexible and it has been designed in a way that is suitable for all age groups

4.6.5 Consistency

The application is designed to perfectly coordinate with the realistic store, so that it gives the customer a sense that he is inside the virtual store

4.6.6 Interface

- The code was written using C# and unity engine in application design.
- The application has a simple and easy to use interface, which makes it easy for the Customer to shop.

4.6.7 Extensibility

Initially, this application will be programmed on a simple store, and in the future it will be put on the market to be applied to electronic shopping sites and stores.

4.7 Use Case Scenario

Customer Use Case scenario :

First of all The Customer downloads the application from the internet then ,The Customer opens the application through the smartphone, then the Customer chooses the store, the Customer enters the store through the store portal, so that the Customer moves between the store shelves that carry the products, then the Customer selects the desired product, the Customer directs the indicator on the product that was identified, information about the product is displayed And the price of the product for the Customer, after that the Customer decides to make the purchase or not to buy, the Customer clicks on the "Buy" button to purchase, after the purchasing process is complete, the Customer cashes out at the cashier.

Administrator Use Case scenario (store owner):

The administration list the items in sever ways based on his future choice some ways could be contacting the IT department or ordering a designed app so he can mange him self, then after the customer make order he go to the purchase stage where his order conformed or not based on id , age , and credit card or payment ,method are all checked

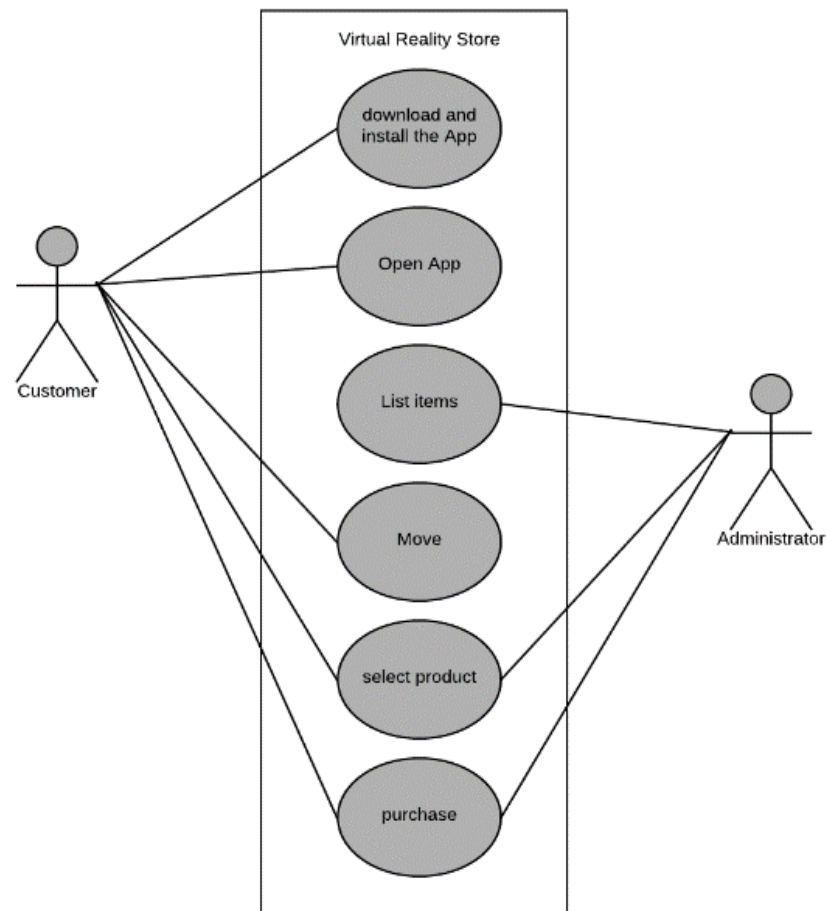


Figure 4-1 : describe the use case diagram for virtual reality store

4.7.1 Download and install the app

- **Actor:** The Customer.
- **Summary:** the Customer downloads and install the apps .
- **Precondition:** the Customer must have a google account (Gmail) to be able to download the App
- **Description:** after the Customer signs in, they search for the app name to download and install it on their smart phone.

4.7.2 Use Case Name : Open App

- **Actor:** The Customer.
- **Summary:** the Customer opens the App after downloading it from the Play Store.
- **Precondition:** the phone must run on Android and support VR.
- **Description:** After downloading and installing the App, the Customer clicks the app icon to launch it ,The Customer chooses the desired store.
- **Alternative :** If the app doesn't open, the Customer should reinstall the app ,If any of the App's functions doesn't, the Customer should restart the app.

4.7.3 Use Case Name : List Items

- **Actor:** Administrator.
- **Summary:** the Administrator list the items.
- **Description:** when the Customer enters the store, the administrator list the items so the Customer can choose them.

4.7.4 Use Case Name : move

- **Actor:** The Customer.
- **Summary:** the Customer moves around the store.
- **Precondition:** the Customer must have a joystick or a wireless controller.
- **Description:** The Customer uses the D-pad on the joystick to move forward, The Customer uses his head to directs the camera.
- **Alternatives:** If the player doesn't move, the Customer should reconnect the joystick or replace it.

4.7.5 Use Case Name : select product

- **Actor:** the Customer.
- **Summary:** the Customers selects the desired product.
- **Description:** the Customer aim at the product for 3 seconds to select it.
- **Alternatives:** if the Customer doesn't want to select a product, he should stop aiming at it before 3 seconds are passed.

4.7.6 Use Case Name : purchase

- **Actor:** the Customer.
- **Summary:** the Customer purchase the desired product.
- **Description:** The Customer uses the indicator to display the product's details.
The Customer clicks purchase if he wants to buy it.
- **Alternatives:** the Customer clicks on cancel if he doesn't want to buy the product.

4.8 Sequence diagram

sequence diagram simply depicts interaction between objects in a sequential order i.e. the order in which these interactions take place ,this sequence diagram is based on the Use Case scenario.

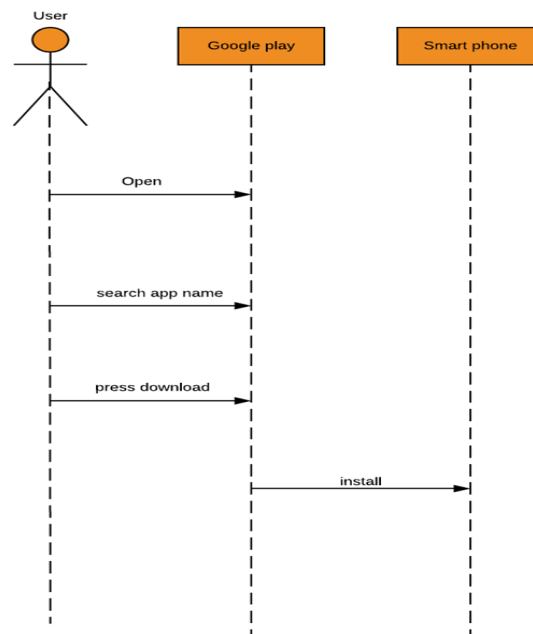


Figure 4-2 : describe the sequence diagram(Download and install the app) for virtual reality store

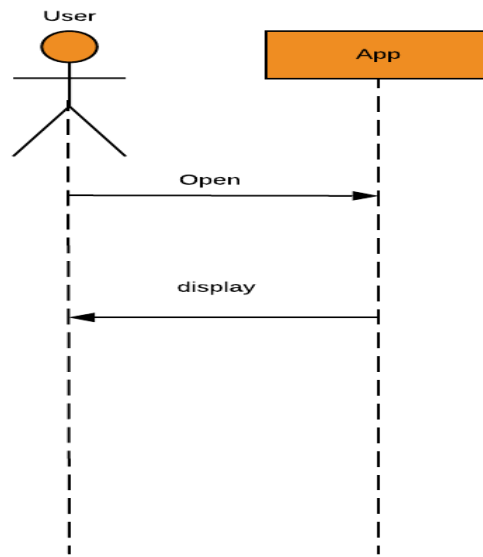


Figure 4-3 : describe the sequence diagram (Open App) for virtual reality store

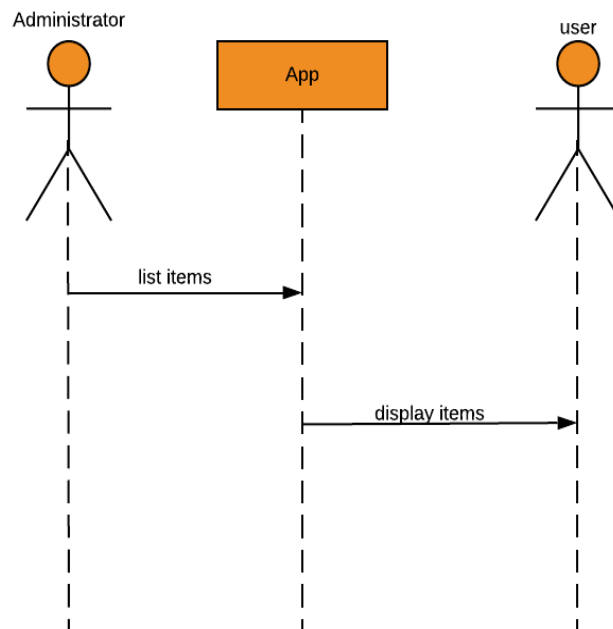


Figure 4-4: describe the sequence diagram (List Items) for virtual reality store

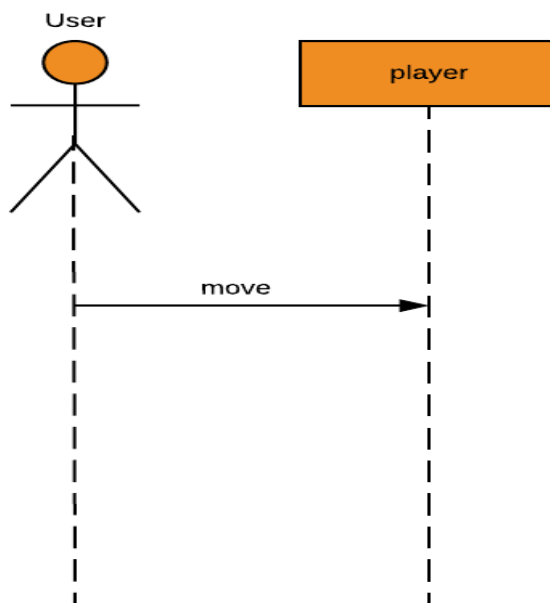


Figure 4-5 : describe the sequence diagram (move) for virtual reality store

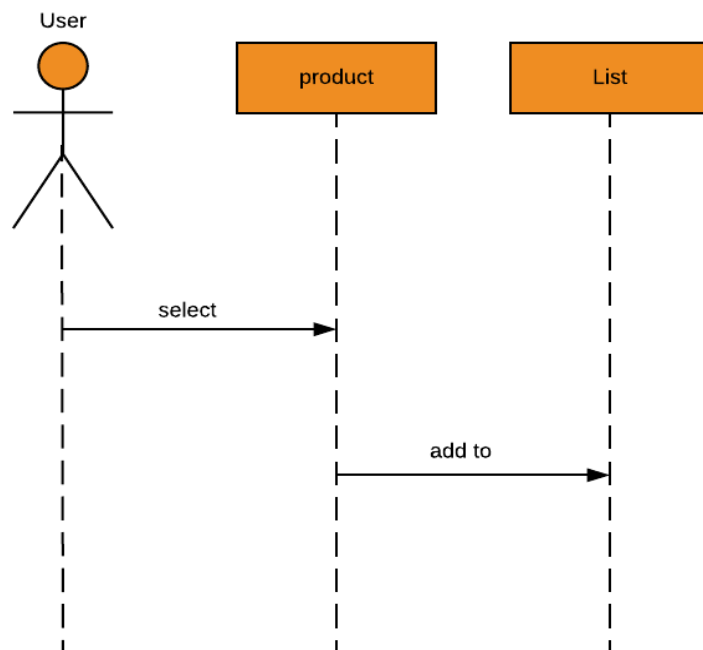


Figure 4-6 : describe the sequence diagram (select product) for virtual reality store

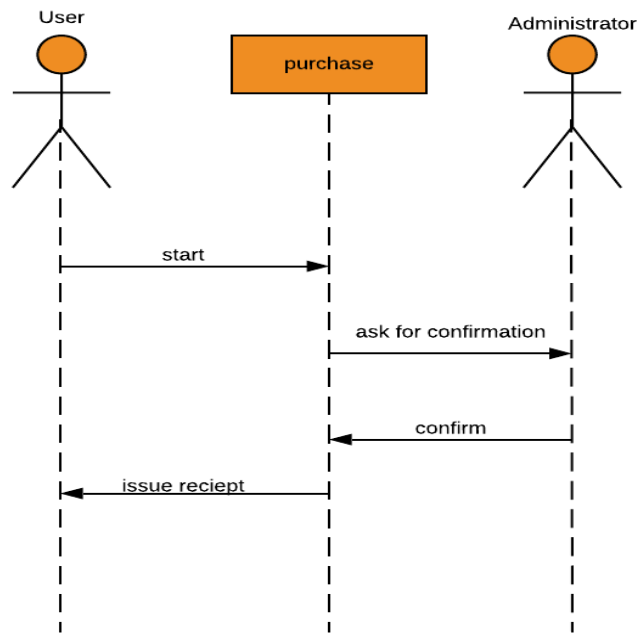


Figure 4-7 : describe the sequence diagram (purchase) for virtual reality store

4.9 Data Flow Diagram

4.9.1 The context diagram

is used to establish the context and boundaries of the system to be modelled: which things are inside and outside of the system being modelled, and what is the relationship of the system with these external entities.

A context diagram, sometimes called a level 0 data-flow diagram, is drawn in order to define and clarify the boundaries of the software system. It identifies the flows of information between the system and external entities. The entire software system is shown as a single process

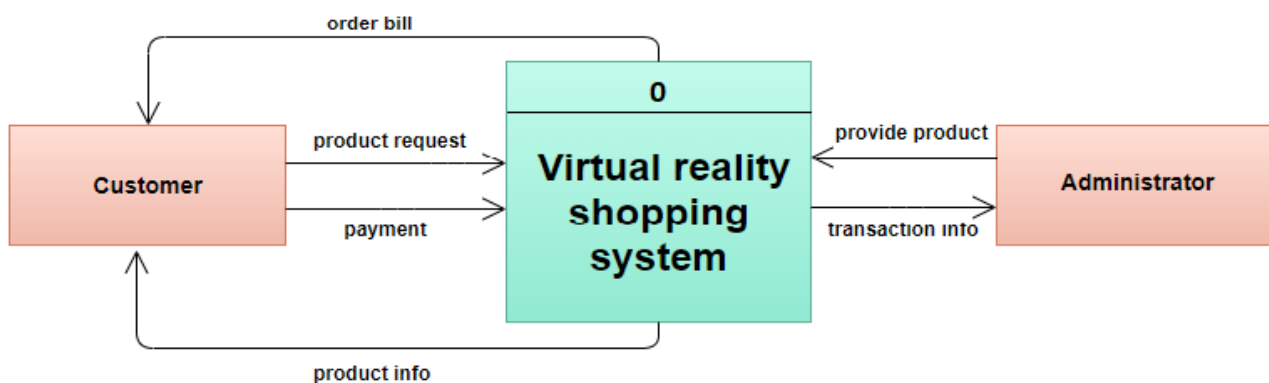


Figure 4-8 :describe the context diagram for virtual reality store

4.9.2 Data Flow Diagram

DFD is graphical diagrams for specifying, constructing and visualizing the model of a system, and it is a way of representing a flow of a data of a process or a system (usually an information system). The DFD also provides information about the outputs and inputs of each entity and the process itself [41]. figure 4.9 describe the level 0 (L0) of DFD for virtual reality store.

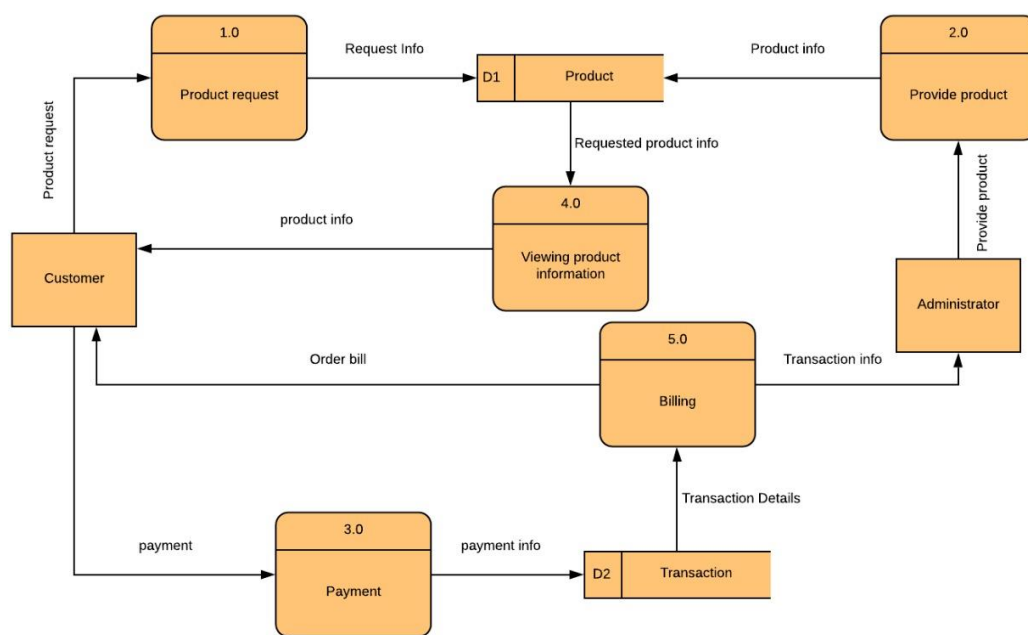


Figure 4-9 : describe the Data Flow diagram for virtual reality store

4.10 Activity Diagram

Activity diagram is UML behaviour diagram which shows flow of control or object flow with emphasis on the sequence and conditions of the flow. The actions coordinated by activity models can be initiated because other actions finish executing, because objects and data become available, or because some events external to the flow occur.

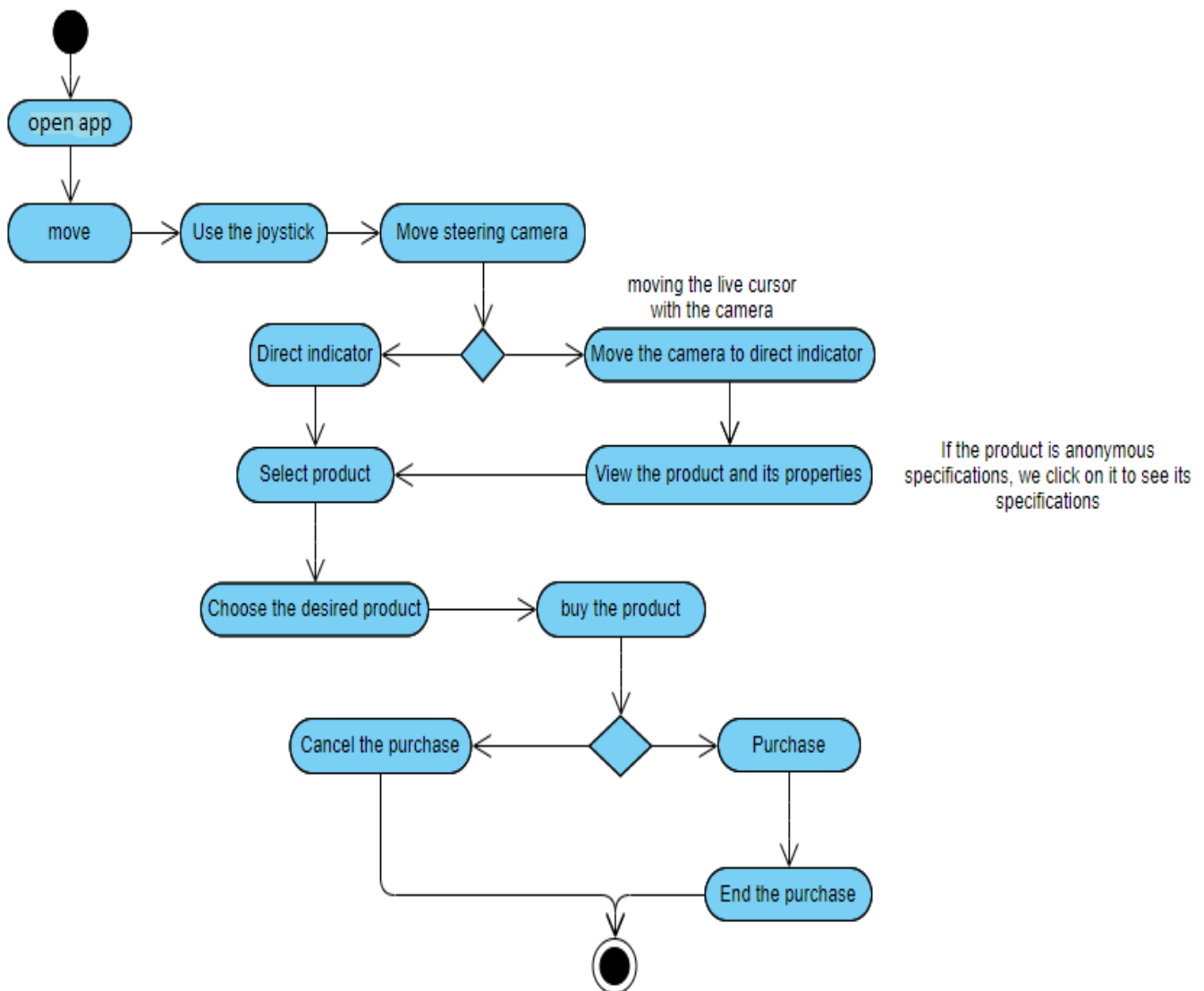


Figure 4-10 :describe the activity diagram for virtual reality store

4.11 Class Diagram

In software engineering, a class diagram in the Unified Modelling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects.

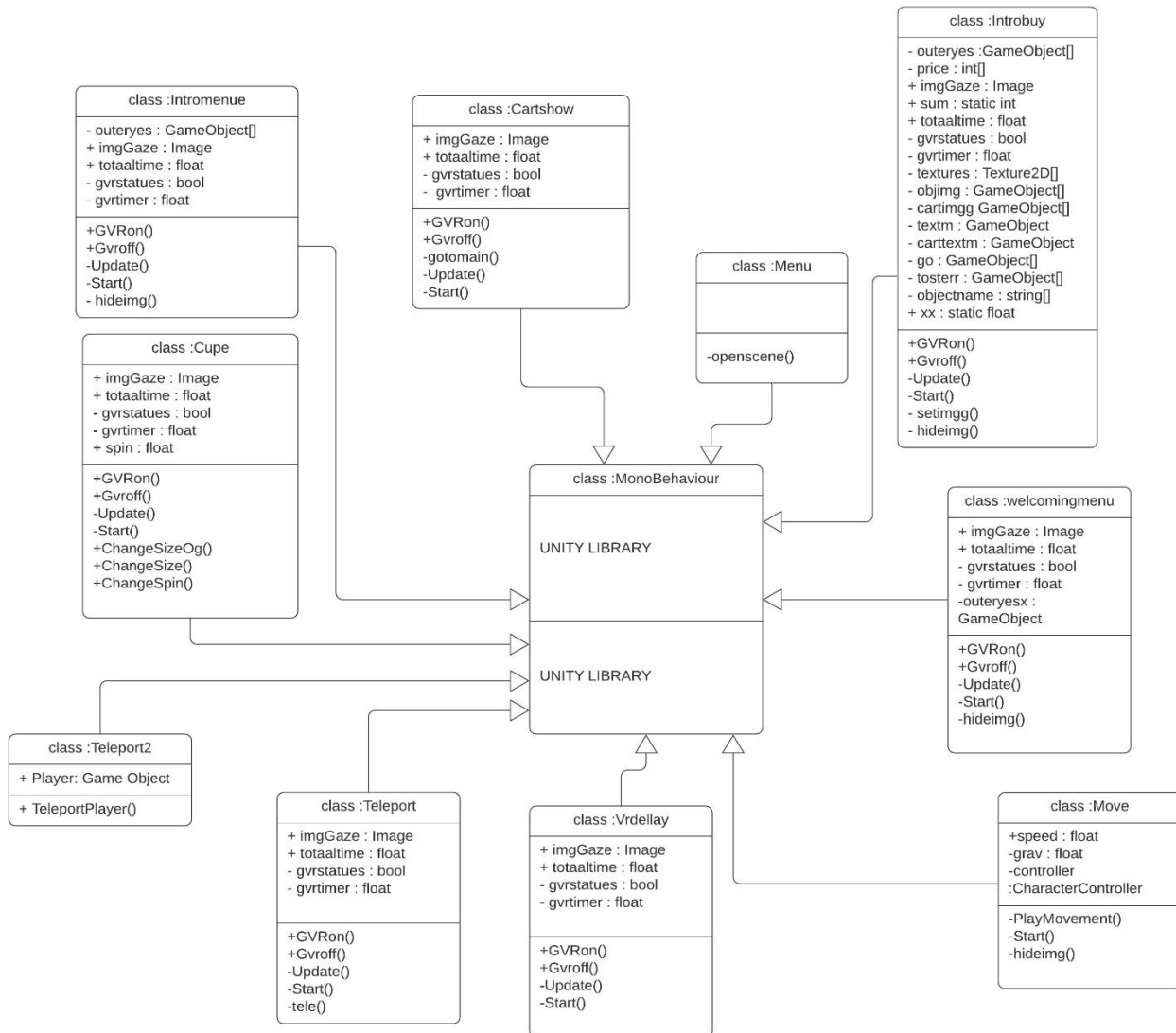


Figure 4-11 : describe the Class Diagram for virtual reality store

4.12 Physical Design

the physical design in our project is:

1. The displayed goods:

The offered goods are a piece or anthropomorphic that represents a specific product. The sizes of the goods differ from one product to another according to the required product.

Containing :

The product itself from all sides.

product name.

The price of the product.

2. Virtual reality glasses:

It is a device that is fixed to the head and covers the eyes, such as its usual glasses, but it differs in the hosts and the external structure. This specification provides an environment similar to reality, widely used with games and video, It includes a stereoscopic screen attached to the head, sensors that track head movement and provide separate images for each eye and sound. [53]

3. The smartphone:

A smartphone is a device that allows you to perform many operations including (phone calls, messaging, etc.)The smartphone can browse through the internet and run programs, the smartphone contains a touch screen to allow Customers to interact with them, there are many smart phone applications including games, educational applications, social networking applications and programs used in business, there are many types of phones Smart.[54]

4. A Bluetooth controller :

The movement can be done using a Bluetooth remote with a one-hand remote specification using Bluetooth communication that can control the screen of a smartphone device and a digital engineering laboratory virtual application.[55]

CHAPTER 5

FINDINGS

5.1 Introduction

In this chapter we will define what is the interface and the type of interfaces, also what is customer interface and the type of customer interface at last the tips of designing Customer interfaces, and how we implemented it with our virtual reality application and we will discuss about it and what it has and what every button does.

5.2 Project Interfaces and their Description

5.2.1 Main menu

The application main menu, it includes a welcoming message and different collection of shops, what is currently activated is the small shop and it includes basic items of any store, the Customer in this scene choses a store then transfer to the actual store



Figure 5-1 : virtual reality store Main menu Screen shot

5.2.2 Welcoming message and store front

This is the first thing a Customer look at, this scene includes a welcoming message and the cart of the Customer in the store, the Customer here interact with the welcoming message and then the message disappear



Figure 5-2 : virtual reality store Welcoming Message Screen Shot

5.2.3 Store Map

This is a map of the store items, it helps the user to get to the wanted section easily, the colored tiles have a name and if the user has no controller, he can point on the tiles and he will be teleported to tile location



Figure 5-3 : virtual reality store items map Screen Shot

5.2.4 First look inside the store

This is the first look inside the store where the user will go around the store and items to his cart



Figure 5-4 : virtual reality store inside of store Screen Shot

5.2.5 Items display and functions

these scene includes some items where every item change size (bigger) and will rotate with 360 degree on Customer interaction and a pop up menu that includes the item discription, price, buy(add to cart), close menu (remove item) .



Figure 5-5 : virtual reality store Purchasing Items 1 Screen Shot



Figure 5-6 : virtual reality store Purchasing Items 2 Screen Shot

5.2.6 Menu of item

This menu includes an image of the product and its description of the item and its price and two functions buy(add to cart), close menu (remove item) .



Figure 5-7: virtual reality store menu item Screen Shot

5.2.7 Adding to cart and cash out

After pointing on adding icon the item will be added to cart with its price and will be cloned to cash register



Figure 5-8 : Virtual Reality store adding to cart and cash out

CHAPTER 6

CONCLUSION

6.1 Conclusion

We have developed the e-shopping system with virtual reality technology, as this gives you the impression that you are inside the store while you are in your home or in your office, and it also allows you to see the product and preview it and look at its specifications as well.

6.2 Limitations

By working on this application, we encountered some limitations, including:

- The process of finding pictures of products was not an easy thing, because every product that was or will be placed inside the store must have a picture of it.
- The size of the application on Customer device is big .
- Finding 3d models of the exact product .
- This application is limited to the youth category, as it was difficult to program it to suit all age groups.

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- The size of the application on Customer device is big .
- Finding 3d models of the exact product .
- This application is limited to the youth category, as it was difficult to program it to suit all age groups.

6.3 Future Works

In the end, we succeeded in building the application that changes the shopping process to the best and easiest, but we have some points and ideas that we will implement in the future, and we must tell you:

- We will activate the application on huge and global e-commerce sites and local shops
- We will add more than one language in the application, so that it is suitable for everyone who will use it
- We will develop the application to suit all age groups
- Developing the application on different platforms
- Using 360 cameras to solve the problem of finding a 3d model

REFERENCES

- [1] 'British inventor of online shopping on his inspiration ' . 2013 BBC News Magazine: BBC videoclip of Michael Aldrich.
- [2]<http://www.aldricharchive.com/papers/1982/Videotex%20Communications%20Dec'82.pdf> 1982 Videotex Communications, Collected Papers Aldrich Archive University of Brighton December 1982 .
- [3] Berners-Lee, T. (2010). "Long Live the Web". Scientific American 303 (6): 80–85. doi:10.1038/scientificamerican1210-80. PMID 21141362.
- [4] Swartz, Jon. "Company takes browser war to Netscape's lawn." San Francisco Chronicle. Thursday October 2, 1997.
- [5] T. Dierks, E. Rescorla (2008). "The Transport Layer Security (TLS) Protocol, Version 1.2".
- [6] Ives, B, and Junglas, I., 2008. APC Forum: Business Implications of Virtual Worlds and Serious Gaming. MIS Quarterly Executive, 7 (3), p.151-156.
- [7] Lee, K., C., Chung, N., 2008. Empirical analysis of consumer reaction to the VR shopping mall. In Computers in Human Behavior, 24 (1), p. 88-104.
- [8] What is VR? Virtual reality explained. retrieved from: <https://www.pocket-lint.com/ar-vr/news/136540-what-is-vr-virtual-reality-explained>(21-04-2020)
- [9] What is AR or augmented reality technology . retrieved from: <https://smartercx.com/what-is-ar-or-augmented-reality-technology/>(22-04-2020).
- [10] Virtual reality in retail: the future of shopping is virtual [Blog post]. retrieved from: <https://www.antycipsimulation.com/blogs/future-of-retail-is-virtual/> (18-03-2020).

- [11] VR in ecommerce: how to offer a virtual reality shopping experience[Blog post]: retrieved from: blog.linnworks.com/virtual-reality-ecommerce (25-03-2020).
- [12] Marco Speicher, Sebastian Cucerca, and Antonio Krüger. (2017). VRShop: A Mobile Interactive Virtual Reality Shopping Environment Combining the Benefits of On- and Offline Shopping. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 1, 3.
- [13] Gantt.com (2016), What is a Gantt chart? retrieved from:<http://www.gantt.com>.
- [14] James M. Wilson (2003), Gantt charts: A centenary appreciation, *European Journal of Operational Research*, Volume 149, Issue 2, Pages 430-437, ISSN 0377-2217".
- [15] M. Buffa and J. C. Lafon. 2000. 3D virtual warehouse on the Web. In *Information Visualization, 2000. Proceedings. IEEE International Conference on*. 479–484. <https://doi.org/10.1109/IV.2000.859800>.
- [16] Nah, F., F., Eschenbrenner, B., DeWester, D., 2011. Enhancing brand equity through Flow and Telepresence: A comparison of 2D and 3D Virtual Worlds. *MIS Quarterly*, 35 (3), p.731-747.
- [17] Ibáñez, M. B., García, J. J., Galán, S., Maroto, D., Morillo, D., & Kloos, C. D., (2011) . Design and Implementation of a 3D Multi- User Virtual World for Language Learning. *Educational Technology and Society*, 14 (4), p. 2–10.
- [18] Zhao, Y., Guo, L., Wang, X., Pan, Z., 2003. A 3D Virtual Shopping Mall That Has the Intelligent Virtual Purchasing Guider and Cooperative Purchasing Functionalities. *The 8th International Conference on Computer Supported Cooperative Work in Design Proceedings*, p. 381- 385.
- [19] Masaya Ohta, Shunsuke Nagano, Seiya Takahashi, Hiroki Abe, and Katsumi Yamashita. 2015. Mixed-reality shopping system using HMD and smartwatch. In *Adjunct Proceedings of the 2015 ACM International Joint Conference on Pervasive*

and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers (UbiComp/ISWC'15 Adjunct). ACM, New York, NY, USA, 125–128.

[20] Schmandt C. (1983). Interactive three-dimensional computer space. Proc. SPIE Int. Soc. Opt. Eng. 367, p. 155–159.

[21] Fisher S. S., McGreevy M., Humphries J., Robinett W. (1986). Virtual environment display system. In Proc. 1986 ACM Workshop on Interactive 3D Graphics (Chapel Hill, NC, Oct. 1986), p. 77–87.

[22] Raja V., Calvo P. (2017). Augmented reality: An ecological blend. Cognitive Systems Research, No. 42, 2017, p. 58–72.

[23] Coates, G. (1992). Program from invisible site — a virtual shop, a multimedia performance. San Francisco, CA: Performance Works.

[24] Akçayır M., Akçayır G., Pektas H. M., Ocak M. A. (2016). Augmented reality in science laboratories: The effects of augmented reality on university students' laboratory skills and attitudes toward science laboratories, Computers in Human Behavior, No. 57, p. 334–342.

[25] Huang H., Liaw S., Lai C. (2016). Exploring learner acceptance of the use of virtual reality in medical education. Interactive Learning Environments, No. 24 (1), 2016, p. 3–19.

[26] Arslan, R. (2017). New Facilities in International Competition, Virtual Reality, Augmented Reality and Hologram, Gölle Bölgesi Aylık Hakemli ekonomi ve kultur dergisi ,49,22-26.

[27] Deléglise, E., Paul, D., Field, M., 2009. 2D/3D WEB Transitions: Methods and Techniques. In Proceedings of WEBIST. P. 294-298.

- [28] Nah, F., F., Eschenbrenner, B., DeWester, D., 2011. Enhancing brand equity through Flow and Telepresence: A comparison of 2D and 3D Virtual Worlds. *MIS Quarterly*, 35 (3), p.731-747.
- [29] <https://www.antycipsimulation.com/blogs/future-of-retail-is-virtual/>,"Book ANTICIP".
- [30] M. Speicher, "Shopping in Virtual Reality," 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), Reutlingen, 2018, pp. 1-2.
- [31] Barnes, Stuart, Understanding Virtual Reality in Marketing: Nature, Implications and Potential (November 3, 2016). Available at SSRN: <https://ssrn.com/abstract=2909100>
- [32] WaterFall Model , retrieved from: <https://www.toolsqa.com/software-testing/waterfall-model/> (27-4-2020).
- [33] SDLC - WaterFall Model , retrieved from: https://www.tutorialspoint.com/sdlc/pdf/sdlc_waterfall_model.pdf (27-4-2020).
- [34] Gunnerson E. A Programmer's Introduction to C# (2nd edn). Apress: Berkeley, CA, 2001.
- [35] Platt DS. Introducing Microsoft .NET (2nd edn). Microsoft Press: Redmond, WA, 2002.
- [36] Lindholm T, Yellin F. The Java Virtual Machine Specification (2nd edn). Addison-Wesley: Palo Alto, CA, 1999.
- [37] Introduction to C#. retrieved from: <https://www.geeksforgeeks.org/introduction-to-c-sharp/>(26-4-2020).
- [38] [statista.com/statistics/426469/active-virtual-reality-users-worldwide/](https://www.statista.com/statistics/426469/active-virtual-reality-users-worldwide/)(13-3-2020)

- [39] <https://www.toptal.com/insights/innovation/3-ways-virtual-reality-transforms-ecommerce> (13-3-2020).
- [40] Ieee standard glossary of software engineering terminology, 1990. IEEE Std 610.12-1990.
- [41] Rosziati ibrahim and siow yen yen(2010) . Formalization of the data flow diagram rules for consistency check , international journal of software engineering & applications (ijsea), vol.1, no.4, october 2010 doi : 10.5121/ijsea.2010.1406 95.
- [42] Arabization of Scientific Terms" - The Caravan Magazine, a copy saved on September 12, 2017 on the Wayback Machine.
- [43] Computers in Human Behaviour Volume 24, Issue 1, January 2008, Pages 88-104.
- [44] Deléglise, E., Paul, D., Field, M., 2009. 2D/3D WEB Transitions: Methods and Techniques. In Proceedings of WEBIST. P. 294-298.
- [45] Nah, F., F., Eschenbrenner, B., DeWester, D., 2011. Enhancing brand equity through Flow and Telepresence: A comparison of 2D and 3D Virtual Worlds. MIS Quarterly, 35 (3), p.731-747.
- [46] https://www.researchgate.net/publication/336323274_Will_the_use_of_Virtual_Reality_Lead_to_a_Revolution_in_Marketing_Communication.(27-3-2020)
- [47]https://www.researchgate.net/publication/314949464_Understanding_Virtual_Reality_in_Marketing_Nature_Implications_and_Potential.(27-3-2020)
- [48]https://www.researchgate.net/publication/271076109_Importance_ratings_of_grocery_store_attributes.(5-4-2020)
- [49]https://www.researchgate.net/publication/324705917_THE_DEVELOPMENT_OF_VIRTUAL_REALITY_MARKET.(4-4-2020)
- [50] <https://www.expandcart.com/ar/30766>. VR technology and future in e-stores.(16-3-2020)
- [51] <https://acquire.io/blog/problems-solutions-ecommerce-faces/>.(12-3-2020)

[52] Gartner. (2016). Gartner's 2016 hype cycle for emerging technologies identifies three key trends that organizations must track to gain competitive advantage. <https://www.gartner.com/newsroom/id/3412017> (22.06.2019).

[53] https://www.researchgate.net/publication/304703961_A_Study_of_Virtual_Reality_Headsets_and_Physiological_Extension_Possibilities (16-6-2017)

[54] https://www.researchgate.net/publication/236669025_Impact_of_Smartphone's_on_Society (2-2013)

[55] https://www.researchgate.net/figure/VR-box-and-VR-controller_fig4_332334751 (iJIM – Vol. 13, No. 4, 2019)