NUST COLLEGE OF

ELECTRICAL AND MECHANICAL ENGINEERING

VRAM – Virtual Reality for Amblyopia

A PROJECT REPORT

DE-40 (DC&SE)

Submitted by

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BACHELORS

IN

COMPUTER ENGINEERING

YEAR

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PROJECT SUPERVISOR

DR. USMAN AKRAM

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Primarily, Alhamdulillah, our FYP has finally been completed, and I am grateful to Allah for providing me with the strength and willpower to continue pushing on for supporting me along the road.

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Finally, we would want to express our gratitude to my parents and friends, without whom we would not have been able to accomplish our final year project due to their unwavering support and ongoing drive. They played a crucial role in our trip, and we will be eternally grateful to them.

ABSTRACT

Our study employs virtual reality gear to present a variety of visuals to patients suffering from amblyopia. Begin with a virtual reality scenario and divide it into two images: one for the strong eye and one for the weak eye. To make it simpler for them to operate together, reduce the signal strength of objects in the strong eye and enhance it in the weak eye. Each week, the patient requires less assistance, and the gap between the eyes continues to narrow. The two eyes learn to cooperate and team up with experience. As the patient improves, the objective is to eliminate the requirement for picture manipulation to integrate them and see in detail.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

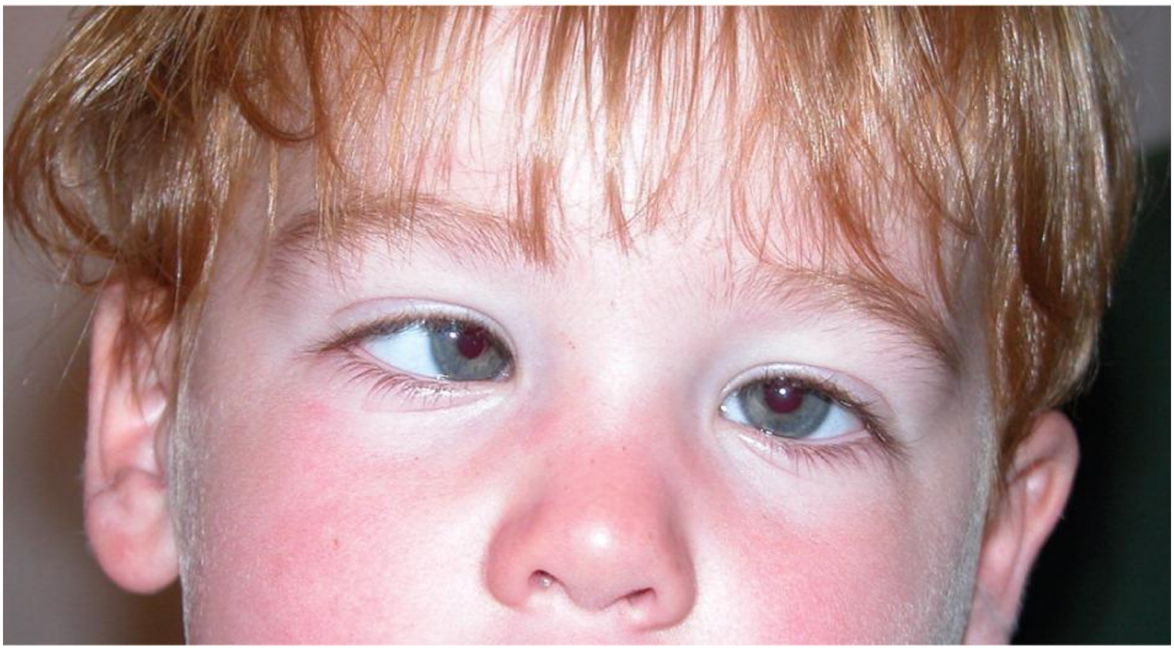
. 

Figure 1 Amblyopia

Amblyopia is a visual disorder that impairs children's development. It is caused by a childhood ocular illness that impairs the development of the cortical visual system in one or both eyes. Amblyopia is commonly referred to as "lazy eye" by the general population. Even if the ocular illness is cured later in life, amblyopia causes chronic vision loss in the troublesome eye if it is not addressed early enough. In children and younger individuals, it is the most common cause of single-eye vision loss.

Amblyopia can be caused by media opacities, cataracts, strabismus, or anisometropic refractive defects, that places one eye at a growth deficit to the other. Amblyopia is usually unilateral; however, if both eyes have cataracts or significant refractive abnormalities, it can be bilateral. How we perceive as adults is influenced by our visual experiences as infants and youngsters.

When one or both eyes have impaired vision that is out of proportion to the anatomical defect of the eye, and no other visual disorders are recognised as the underlying cause, amblyopia is diagnosed. When the refractive error is repaired, it is defined as an acuity difference of two lines or more between the eyes. Eyesight in children is hard to observe, but it is still discovered by observing the child's responses and ability to follow things with one eye covered.

Deprivation, strabismus, and refractive error are the three main causes of amblyopia. Any condition that blocks the visual pathway causes deprivation amblyopia. There is a chance you will have a cataract, corneal opacity, retinal damage, or optic nerve disease. A lack of visual input, such as shutting one eye or living in t can also be caused by full darkness. The most severe kind of amblyopia is caused by deprivation. Strabismus is a condition in which both eyes are not aligned. Diplopia is prevented by the paediatric brain limiting visual information in one eye, resulting in poor that eye's visual development Although strabismus can be cured with surgery or prism glasses, even after the underlying strabismus is addressed, amblyopia usually persists. Astigmatism, hyperopia, and astigmatism create blurred visual input., or Vmyopia causes refractive amblyopia. An eye with hyperopia or astigmatism is more likely to develop amblyopia than one with myopia, because a myopic eye can still focus on close objects.

The more severe the visual loss, the more severe the amblyopia that develops as a result. The first seven years of life are vital for visual development, The first few years, if not months, are the most critical. The longer amblyopia therapy is given, the more difficult it is to reverse clinically. Early-onset visual deprivation causes permanent anatomic changes in the magnocellular (M) and parvocellular (P) visual pathways. As a result, surgeons may need to operate on congenital monocular cataracts that are substantial as soon as they are identified., frequently within a week. A congenital cataract can cause irreparable amblyopia in as little as a few months. There is a bit more leeway with binocular, similarly dense congenital cataracts, usually a few weeks.

1.2 Problem Statement

Vision disorders can have a considerable influence on an infant's or child's development, limiting involvement in social, athletic, and educational activities, as well as eventual job chances. Squint, amblyopia, ptosis, corneal opacity, chalazion, epiphora (blocked tear duct), and refractive errors are examples of these conditions. Uncorrected refractive error and ocular misalignment or strabismus are the top two problems, which are easily identified by families for aesthetic reasons and hence receive early management. The most prevalent cause of amblyopia, known as anisometropic amblyopia, is refractive error, which is difficult to detect without an ocular examination. The frequency of amblyopia in the West is between 1 and 5%, thanks to intensive screening techniques. Amblyopia is undiagnosed and untreated in Pakistan and other poor nations with inadequate screening programmes and many children who do not attend school. When most individuals are diagnosed, they are past the age of therapy, therefore treatment is useless. Furthermore, there are no procedures in place for screening and rehab of amblyopia patients in rural places as well as big cities, as well as real-time data storage and patient database administration. Such therapies will be replaced by our proposed system. According to our research, VR treatment is non-surgical, non-invasive, low-cost, and phenomenally successful.

As previously said, the fundamental issue is that there is now no proven therapy for amblyopia in adults in Pakistan. Furthermore, the absence of software and hardware use in rural locations creates a communication gap between patients in remote places and doctors in big cities. Our goal is to close the gap between the patient and the physician. To develop a therapy that is both effective and affordable, with no negative side effects. Below are some data about the prevalence of amblyopia.

1.3 Scope

The goal of the project is to create a virtual reality-based treatment system that can treat children with amblyopia by changing interocular contrast. The VR application will be portable in the sense that it can be readily loaded on any smartphone and utilised at home, eliminating the need to travel to a hospital to use it. The doctor will also be able to view the patient's previous treatment history and adjust the device for the patient based on his or her exact condition, ensuring that the experience is tailored to each individual patient. There will be an online database that will allow the device's makers to track trends, view use statistics, age groupings, and other information related to the VR therapy's functioning and impact.

The following objectives can be used to determine the project's scope:

Creating an integrated VR experience with customised games and a virtual environment to replicate and enhance amblyopia therapy concepts.

To increase, augment, and accelerate the visual function recovery in patients with amblyopia, test the system created on patients with amblyopia in a controlled setting.

Adapt the created method to a less expensive alternative utilising a mobile phone and a Google cardboard gadget.

1.4 Structure

The structure of report ahead:

Chapter 2, It primarily focuses on the explanation of vision issues as well as a on the historical background and causes and effects of this disease.

Chapter 3, It focuses on the treatments and the some other ologies related to Amblyopia.

Chapter 4, It explains the basic theory of operation and system integration as well as the design and development of a VR-based mobile application and database and the software used in the development of the project.

Chapter 5, It is concerned with future prospective and awareness of Amblyopia

CHAPTER 2: VISION DISORDERS

2.1 Amblyopia

Literature Background

Amblyopia is a major health problem in today's world. Our study employs tearing virtual reality gear to present a variety of visuals to patients suffering from amblyopia. Begin with a virtual reality scenario and divide it into two images: one for the strong eye and one for the weak eye. To make it simpler for them to operate together, reduce the signal strength of objects in the strong eye and enhance it in the weak eye. Each week, the patient requires less assistance, and the gap between the eyes continues to narrow. The two eyes learn to cooperate and team up with experience. As the patient improves, the objective is to eliminate the requirement for picture manipulation to integrate them and see in detail.

SETTING: Study was conducted in Alshifa Eye Trust Rawalpindi.

DURATION: From February 2022 to June 2022.

STUDY POPULATION: Study population covered overall the world is in between 1.6% to 3.6% in various parts of the world in children it is 3.0% and in the adults is 4% and the untreated old is 2.9%.

METHODOLOGY: The goal of this research is to use virtual reality technology to help with amblyopia rehabilitation activities. Interactive games are used to combat the Lazy Eye Syndrome. Because it is based on a basic game, it gives an enjoyable approach for the impaired eye to exercise. Our idea employs innovative virtual reality gear to provide various visuals to the patient's amblyopia-affected eye. Begin with a virtual reality scenario and divide it into two views, one for the strong eye and the other for the weak eye. To make it simpler for them to operate together, decrease the signal strength of objects in the strong eye and raise it in the weak eye. Each week, the patient needs a bit less assistance, as a result, the gap between the eyes becomes smaller and smaller. The two eyes learn to cooperate and team up with experience. As the patient's condition improves, the objective is to eliminate the requirement for picture manipulation to integrate them and see in detail all the time,

2.2 Causes of Amblyopia:

An abnormal visual experience early in childhood alters the neural connections between a little layer of tissue at the back of the eye (retina) and the brain, resulting in lazy eye. When compared to the stronger eye, the weaker eye receives less visual information. When the eyes' capacity to work together deteriorates, the brain suppresses or rejects information from the weaker eye.

Anything that hinders a child's vision or causes the eyes to cross or turn out might induce lazy eye. The following are some of the most common causes of the condition:

Rrefractive amblyopia:

A wide gap in prescriptions in each eye, produced by farsightedness, near-sightedness, or an uneven surface curvature of the eye, causes lazy eye (astigmatism). Glasses or contact lenses are commonly used to correct refractive difficulties. In certain youngsters, a combination of strabismus and refractive problems causes lazy eye.

amblyopia:

The most common cause of lazy eye is an imbalance in the muscles that position the eyes. The eyes may cross in or out of alignment because of this imbalance, making it difficult for them to work together.

Deprivation.

A problem in one eye, such as a cloudy area in the lens (cataract), may make it ddifficult to see well in one eye. Deprivation amblyopia in youngsters must be addressed very as to avoid irreparable vision loss. Amblyopia of this kind is the most prevalent.

Risk factors

The following factors have been linked to an increased incidence of lazy eye:

An untimely birth

Small size at birth

Lazy eye in the family

Developmental disabilities

System Level Diagram:

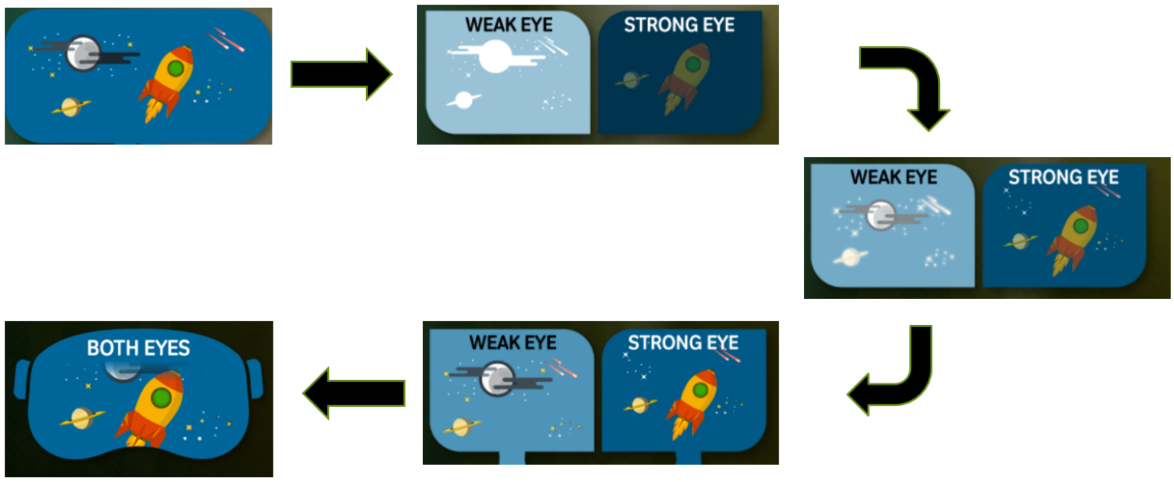


Figure 2 System Level Diagram

Effects of Amblyopia:

•Eye wanders inward or outward.

•Eyes appear to not work together.

•Temporary or permanent loss of vision

2.3 Aims & objectives

The aim is to provide such a solution based on virtual reality-based therapy by which the poor people across the globe can easily afford this. Beside this there numerous amounts of medications and therapies provided in the various facilities that are expensive and in under developed countries like Pakistan not all classes of people can afford such treatments basically it as a new kind of treatment which we have developed in this solution the patient will be able to see clearly the object and patient's eye-alignment will be corrected, as clear as 6/6. The treatment will take 2 to 3 sessions of therapy through which the patient's vision will be clear, this treatment is being implement.

•**Vergence**: The ability of the eyes to diverge and converge is important for things like switching gaze from a whiteboard to a textbook. Our work deals with the flexibility of the vergence system.

•**Stereopsis / “3D”:** 3D vision allows you to perceive the distance between objects. It is important in tasks such as catching a ball or parking a car. We will control the 3D environment.

•**Artificial Intelligence:** AI refers to simulation of human intelligence in machine. All the games, within this project, will be designed with AI. Moreover, assessing the improvements will be done with AI.

•**Perceptual Learning:** Practicing visual and other sensory tasks result in an improvement in performance. Our Project combines this with games to increase visual skills.

•**Anti-Suppression:** Amblyopic patients suppress vision in the weak eye to avoid visual confusion. Our Project uses image blur and brightness to help balance vision between the eyes and showing us positive results in majority of the cases.

General aim

To correct the amblyopia using virtual reality-based therapy and to help people throughout the world at cheaper rates.

Specific Objectives

There are four different games build on the virtual reality.

Each game is divided into two visions one for strong eye and one for lazy eye.

Strong eye will take less effect and the Lazy eye will take more effect to balance the eye vision in both the eyes.

The treatment will take 2 to 3 sessions of therapy.

CHAPTER 3: RELATED TREATMENTS AND FACTORS RELATED TO AMBLOPIYA

3.1 Treatment:

The underlying cause of amblyopia determines the initial treatment. The obstructive pathology should be removed first to treat deprivation amblyopia. Cataract surgery, retinal detachment repair, corneal surgery, and therapy for a range of other visual disorders are all possibilities. The most treatable kind of amblyopia is refractory amblyopia. Corrective lenses to correct the patient's full refractive defect may be adequate to reverse the amblyopia. Although strabismus correction can help to straighten the eyes in strabismic amblyopia, it is rarely enough to entirely reverse the condition.

Visual penalization of the non-amblyopic eye is frequently required to force visual development in the amblyopic eye in all forms of amblyopia. Patching the non-amblyopic eye is the most common visual penalization. Patching the non-amblyopic eye is the most common visual penalization. The length of time the non-amblyopic eye is patched each day is determined by the severity of the amblyopia. Patching is commonly done for two hours, six hours, or even all day. While patching, visual activities such as reading, watching TV, or playing video games may be beneficial since the patient will be forced to utilise the amblyopic eye and may be more cooperative with the patching if it is coupled with a fun activity. Amblyopia was first treated in the 16th century by patching the non-amblyopic eye. It is still the cornerstone of therapy today.

If patching therapy does not work for the patient, pharmaceutical amblyopia treatment is an alternative. In the non-amblyopic eye, a cycloplegic medication (typically atropine) can be administered to prevent accommodation. The convenience of using one drop per day as opposed to wearing a patch over the eye for hours at a time is one of the advantages of this therapy. In the right patients, this therapy has been demonstrated to be as successful as patching. Patients who are myopic or emmetropic in the non-amblyopic eye, on the other hand, may not benefit from pharmacologic therapy since their eyes will keep objects in focus at specific distances.

Patients who are myopic or emmetropic in the non-amblyopic eye, on the other hand, may not benefit from pharmacologic therapy since their eyes will keep objects in focus at specific distances.

3.2 Differential Diagnosis:

Amblyopia is an exclusionary diagnosis, which means that it can only be diagnosed after all other ocular or brain pathologies have been ruled out as the reason of diminished visual acuity. Refractive error, cataract, corneal disease, retinal pathology, and optic nerve pathology are all common reasons of diminished visual acuity. A comprehensive eye exam can rule out most of these disorders. Visual impairment caused by the brain and functional (non-organic) vision loss should both be examined.

3.3 Prognosis:

The degree of amblyopia and whether it is treated at an early age determine the prognosis. Amblyopia has a high morbidity rate and is a prevalent cause of monocular vision loss. At least 75% of children who get occlusion therapy have a significant improvement in their eyesight. However, there is a modest decline in visual acuity in at least 50% of youngsters over time. Children who are referred early in life have the greatest outcomes. However, the actual real-life images of many youngsters may be altered as they develop. If treated, however, more than 70% of individuals see considerable visual improvement in less than a year. Even after therapy, there may be some visual loss in the years ahead.

The age at which therapy for the disorder began (later treatment has a poorer prognosis), deprivation amblyopia, and low initial visual acuity are all risk factors for failure to recover eyesight.

3.4 Complications:

The most serious side effect of amblyopia is an irreversible, permanent visual loss. Reduced visual acuity, contrast sensitivity, vernier acuity, spatial distortion, aberrant spatial interactions, and reduced contour identification are among the visual functional disorders. Binocular abnormalities in amblyopia patients include poor stereoscopic acuity and improper binocular summation. Monocular vision impairments are limited to the amblyopic eye. However, non-amblyopic eyes have been shown to exhibit subclinical impairments.

Amblyopia makes it harder for people to view three-dimensional pictures hidden in stereoscopic displays like auto stereograms. The non-amblyopic eye's perception of depth from monocular signals such as size, perspective, and motion parallax, on the other hand, is usually normal.

Children with amblyopia may have difficulty learning. Children with amblyopia read and respond to multiple-choice questions more slowly than children without amblyopia. Another potential consequence of amblyopia is increasing strabismus because of poor binocular fusion.

3.5 Deterrence and Patient Education:

Parents should be informed about the necessity of having their children's vision checked at an early age. Amblyopia may be discovered for the first-time during school vision tests. If a kid has been diagnosed with amblyopia, parents should be informed that the visual loss caused by amblyopia is usually permanent if left untreated. Parents should be reminded of the need of therapy. Parents must ensure that their children complete the treatment, even if they do not want to wear glasses or patches. Providers should encourage parents to maintain therapy at every appointment, since amblyopia treatment may be required for a long time.

3.6 Pearls and Other Issues:

Amblyopia, often known as lazy eye, is a vision problem caused by the eye and brain not cooperating. It causes a reduction in vision in a normal eye. It is the most prevalent cause of single-eye visual loss in children and younger people. In actuality, the earlier the sensitive phase begins, the more severe the visual deprivation and amblyopia that results. The most treatable kind of amblyopia is refractive amblyopia, specifically astigmatic amblyopia. Sometimes, all that is required for therapy is refractive correction. If the amblyopia does not improve, the non-amblyopic eye should be patched.

3.7 Enhancing Healthcare Outcomes:

Amblyopia is primarily treated by paediatric ophthalmologists, while optometrists have familiarity with the condition as well. Because mishandling of this illness can result in irreversible vision loss, it is crucial that patients be directed to a practitioner who is trained in amblyopia therapy. Often, an ophthalmologist or optometrist will not be the first to detect amblyopia. A paediatrician, family doctor, nurse, or medical assistant might be the person in charge. Family members spend more time with the patients and may be the first to detect the non-amblyopic eye's preferred fixation. During vision screenings, many incidences of amblyopia will be detected. These screening programmes are crucial for early detection of amblyopia.

The youngster is at danger of irreversible visual loss unless he or she receives the proper referral. The longer the problem goes undiscovered and untreated, the worse the consequences will be. To avoid irreparable vision loss from this disorder, health care practitioners must communicate efficiently with other clinicians as well as parents.

3.8 Aetiology:

Deprivation, strabismus, and refractive error are the three major causes of amblyopia. Any condition that blocks the visual pathway causes deprivation amblyopia. A cataract, corneal opacity, retinal injury, or optic nerve disease are all possibilities. It can also be brought on by a lack of visual stimulus, such as closing one eye or living in utter darkness. The most severe kind of amblyopia is caused by deprivation. When both eyes are not aligned, this is known as strabismus. Diplopia is prevented by the juvenile brain limiting visual information in one eye, resulting in poor visual development in that eye.

Although strabismus can be corrected with surgery or prism glasses, amblyopia lingers even when the underlying strabismus is corrected. The blurred visual input caused by hyperopia, astigmatism, or myopia causes refractive amblyopia. An eye with hyperopia or astigmatism is more likely to develop amblyopia than one with myopia, because a myopic eye can still focus on close objects.

The more severe the visual loss, the more severe the amblyopia that develops as a result. The first seven years of life are vital for visual development, with the first few years and even months being the most crucial. The longer amblyopia therapy begins, the more difficult clinically it is to reverse. This is due to irreversible anatomic alterations in the magnocellular (M) and parvocellular (P) visual pathways caused by early-onset visual deprivation. As a result, surgeons may need to operate on extensive congenital monocular cataracts very soon after they are discovered, frequently within a week. A congenital cataract can cause irreparable amblyopia in as little as a few months. There is a bit more freedom with binocular, similarly thick congenital cataracts, generally a few weeks.

3.9 Epidemiology:

Amblyopia has been estimated to afflict up to 3% of the population in various forms, with a 1.2 percent lifetime risk of vision loss due to this disorder. The global prevalence of amblyopia has lately been estimated to be 1.75 percent. The most prevalent cause of amblyopia was anisometropia, which was followed by combined anisometropia and strabismus, strabismus, and visual deprivation. Mixed and strabismic amblyopia are usually diagnosed at a younger age (7.4) than anisometropic amblyopia (12.7). Amblyopia is equally prevalent in both the right and left eyes. There is no evidence of a sex preference.

3.10 Pathophysiology:

When monocular visual deprivation occurs during visual development, the neural networks of the two eyes compete for influence on cortical neurons. Distinct components of neuronal selectivity, including as synaptic plasticity, activity dependency, and neuronal network learning, have different sensitivity periods and are thus influenced differently by the different forms of visual deprivation.

Amblyopia is determined by the anatomic interactions between photoreceptors and ganglion cell receptor fields, ganglion cell receptor fields and the layers of the lateral geniculate, and the lateral geniculate and the layers of the visual cortex. The severity of the handicap is determined by the age at when it began and the length of time it has been present. Amblyopia is more difficult to fix the sooner it appears and the longer it remains untreated.

3.11 Evaluation:

Formal visual field testing, optical coherence tomography (OCT), fundus photography, and an electroretinogram are among tests that should be explored while examining for amblyopia (ERG). If a compressive lesion in the visual system is suspected, brain and orbit imaging may be considered. Additional patient testing should only be done to assess for other ocular pathologies causing impaired vision because amblyopia is a clinical diagnosis. In studies, brain magnetic resonance imaging (MRI) revealed that people with amblyopia had a smaller visual cortex. However, as a diagnostic test for amblyopia, MRI is not advised.

CHAPTER 4: TECHNOLOGY AND SOFTWARES

4.1 Game engine: Unity: -

Unity is a cross-platform game engine created by Unity Technologies. It was initially unveiled and distributed as a Mac OS X game engine at the Apple Worldwide Developers Conference in June 2005. Since then, the engine has been continuously expanded to accommodate a wide range of platforms, including PC, mobile, console, and virtual reality. It is popular for independent game production and is especially popular for iOS and Android mobile game development. It is also straightforward to use for newbie developers. The engine may be used to make 3D and 2D games, as well as interactive simulations and other experiences. Outside of video games, the engine has been utilised by the film, automotive, architectural, engineering, and construction sectors, as well as the US Armed Forces. Unity allows users to build 2D and 3D games and experiences, and the engine includes a major scripting API written in C# and Mono for both the Unity editor and the games themselves, as well as drag-and-drop capability. Prior to C# becoming the engine's principal programming language, it supported Boo, which was discontinued in August 2017 following the release of Unity 2017.1, and a Boo-based implementation of JavaScript called Unity Script, which was deprecated in August 2017 after the release of Unity 2017.1. Unity supports the loading of sprites and has a powerful 2D environment renderer for 2D games. Unity allows developers to specify texture compression, mipmaps, and resolution settings for each platform supported by the game engine, as well as support for bump mapping, reflection mapping, parallax mapping, screen space ambient occlusion (SSAO), dynamic shadows using shadow maps, render-to-texture, and full-screen post-processing effects for 3D games. In addition to the classic built-in pipeline, the High-Definition Render Pipeline (HDRP) and Universal Render Pipeline (URP) render pipelines are available. [a secondary source is required] All three render pipelines are mutually incompatible. Shaders utilising the old renderer may be upgraded to URP or HDRP using a tool provided by Unity. According to the Financial Times, the engine is utilised in games such as Pokémon Go, Monument Valley, Call of Duty: Mobile, Beat Sabre, and Cuphead. Unity had been used to develop almost half of all mobile games and 60% of augmented reality and virtual reality content as of 2018,[89], including approximately 90% on emerging augmented reality platforms like Microsoft HoloLens and 90% of Samsung Gear VR content. Most virtual reality and augmented reality experiences are built on Unity technology, according to Fortune, and Unity "dominates the virtual reality market." Unity Machine Learning Agents is open-source software that connects the Unity platform to machine learning tools such as TensorFlow from Google. Virtual characters employ reinforcement learning to generate inventive tactics in lifelike virtual settings via trial and error in Unity Machine Learning Agents. The software is used to create self-driving automobiles and robotics.

4.2 Graphic Designing Suit:

Blender: -

Blender is a free and open-source 3D computer graphics software toolkit that may be used to make animated films, visual effects, art, 3D-printed models, motion graphics, interactive 3D apps, virtual reality, and, formerly, video games. 3D modelling, UV mapping, texturing, digital drawing, raster graphics editing, rigging, and skinning, fluid and smoke simulation, particle simulation, soft body simulation, sculpting, animation, match moving, rendering, motion graphics, video editing, and compositing are some of the features available in Blender.

Modelling: Polygon meshes, Beziers curves, NURBS surfaces, meatballs, ecospheres, text, and an n-goon modelling method called B-mesh are among the geometric primitives supported by Blender. An extensive polygonal modelling system is also available, which may be accessed via an edit mode. Extrusion, bevelling, and subdividing are among the characteristics it offers.

Modifiers: Modifiers, such as subdivision surfaces, impart non-destructive effects that can be added during rendering or exporting.

Sculpting: Multi-resolution digital sculpting in Blender includes dynamic topology, "baking," remeshing, re-symmetrisation, and decimation, among other features. The latter is employed to make models easier to export (an example being game assets).

Geometry nodes: Blender offers a geometry node system for building and manipulating geometry in a procedural and non-destructive manner. Blender 2.92 was the first version to have it, and it focuses on object dispersion and instancing. Because it takes the form of a modifier, it can be layered on top of other modifiers. Object properties are used in the system, which may be changed and overridden using string inputs. Positions, normal, and UV maps are examples of attributes. In an attribute spreadsheet editor, you may see all the attributes. Primitive meshes can also be created with the Geometry Nodes function. Geometry Nodes in

Blender 3.0 now facilitate the creation and modification of curve objects. The Geometry Nodes process in Blender 3.0 was fully overhauled with fields to make the system more intuitive and function how it should.

Simulation: Smoke, rain, dust, fabric, fluids, hair, and stiff bodies may all be simulated with Blender.

Animation: Inverse kinematics, armatures, hooks, curve- and lattice-based deformations, shape keys, non-linear animation, restrictions, and vertex weighting are among Blender's keyframed animation features. Furthermore, its Grease Pencil tools enable 2D animation within a complete 3D workflow.

Rendering: Internal render engine featuring scanline rendering, indirect lighting, and ambient occlusion that exports to several formats; Cycles is a route tracer render engine that can take advantage of the GPU for rendering. Since Blender 2.65, Cycles has supported the Open Shading Language. Optic Version 2.92 allows for Cycles Hybrid Rendering. The GPU is used in conjunction with the CPU to compute the tiles. EEVEE is a novel real-time renderer that is physically based. It serves as a renderer for final frames as well as the engine that powers Blender's real-time viewport for asset creation.

File format: Blender features an internal file system that can pack multiple scenes into a single ". blend" file.

Commands: Most of the commands may be accessed via hotkeys. There are also extensive graphical menus available. Numeric buttons may be "dragged" to alter their value without having to aim at a specific widget, and they can also be adjusted via the keyboard. With modifiers like the Ctrl and Shift keys, both sliders and number buttons may be restricted to different step sizes. Mathematical expressions can also be entered directly into number entry fields, allowing them to designate values.

Modes: The two most common modes for dealing with objects in Blender are Object Mode and Edit Mode, both of which are toggled with the Tab key. Edit mode is used to modify the actual object data, whereas Object mode is used to manipulate individual objects as a unit. An Object Mode, for example, may be used to move, scale, and rotate complete polygon meshes, while an Edit Mode can be used to alter individual vertices of a single mesh. Vertex Paint, Weight Paint, and Sculpt Mode are among the additional modes available.

Workspaces: The Blender GUI uses one or more windows given by the underlying platform to create its tiled windowing system. One platform window (typically large enough to fill the screen) is separated into sections and subsections, each of which can include any of Blender's views or window kinds. The user may create numerous displays, or layouts, using these Blender windows and navigate between them fast by selecting from a menu or using keyboard shortcuts. The same tools that alter the 3D view may be used to control the GUI components of each window type. For example, similar controls may be used to zoom in and out of GUI buttons, just as they can be used to zoom in and out of the 3D viewport. The GUI viewport and screen layout may be personalised by the user. By hiding components that are not needed for the activity, you may adapt the layout for specific activities like video editing, UV mapping, or texturing.

Workbench: Using the default 3D viewport drawing system for modelling, texturing, etc

Figure 3 Workbench 1

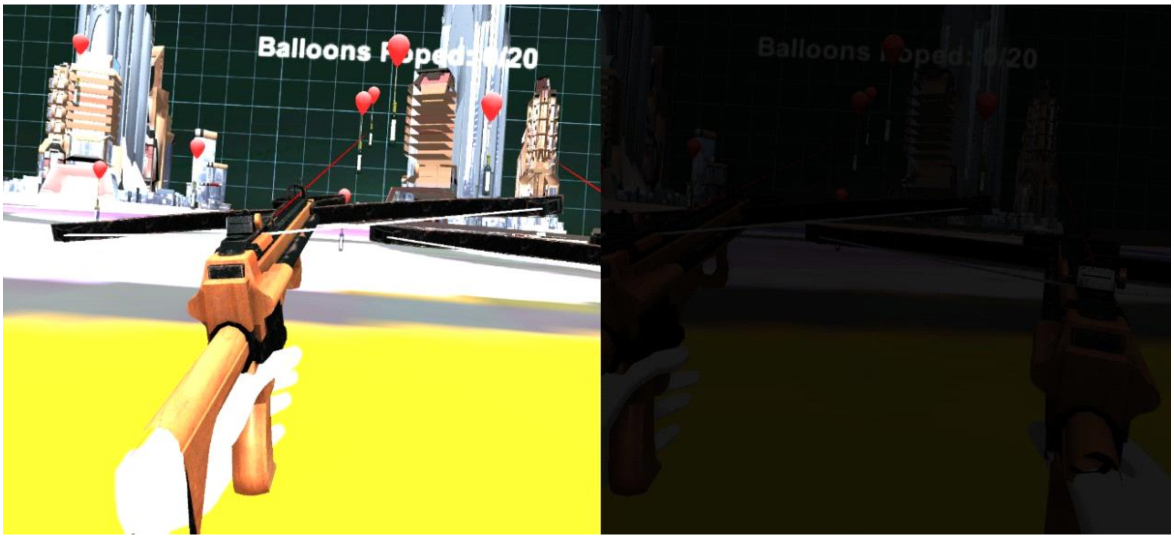


Figure 4 Workbench 2

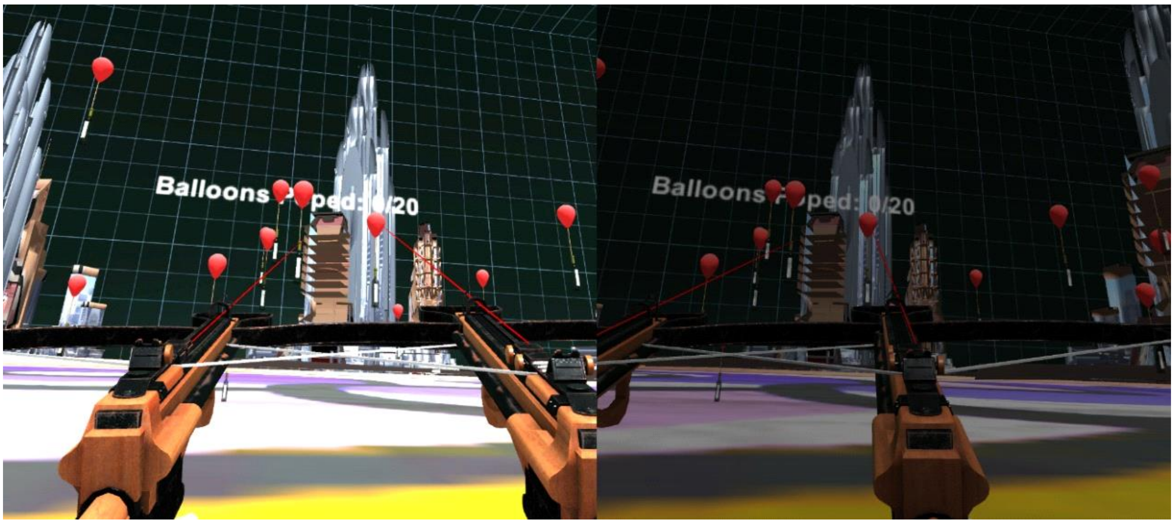


Figure 5 Workbench 3

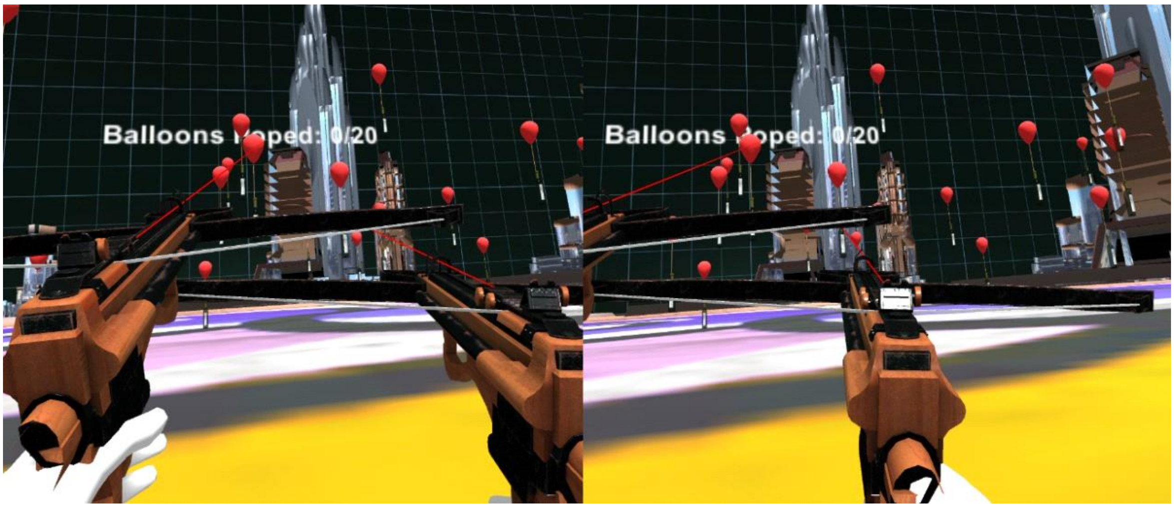


Figure 6 Workbench 4

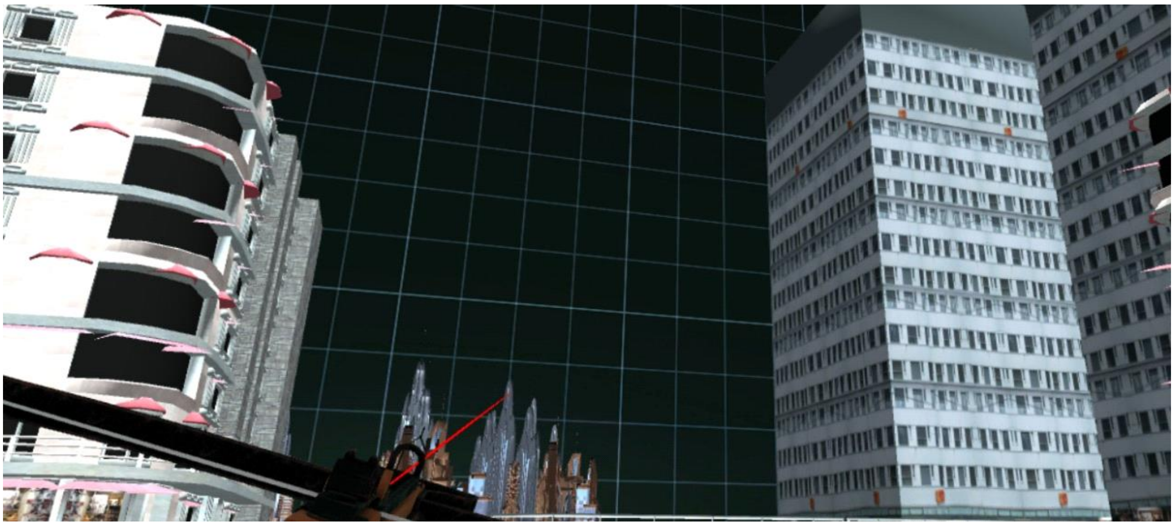


Figure 7 Workbench 5

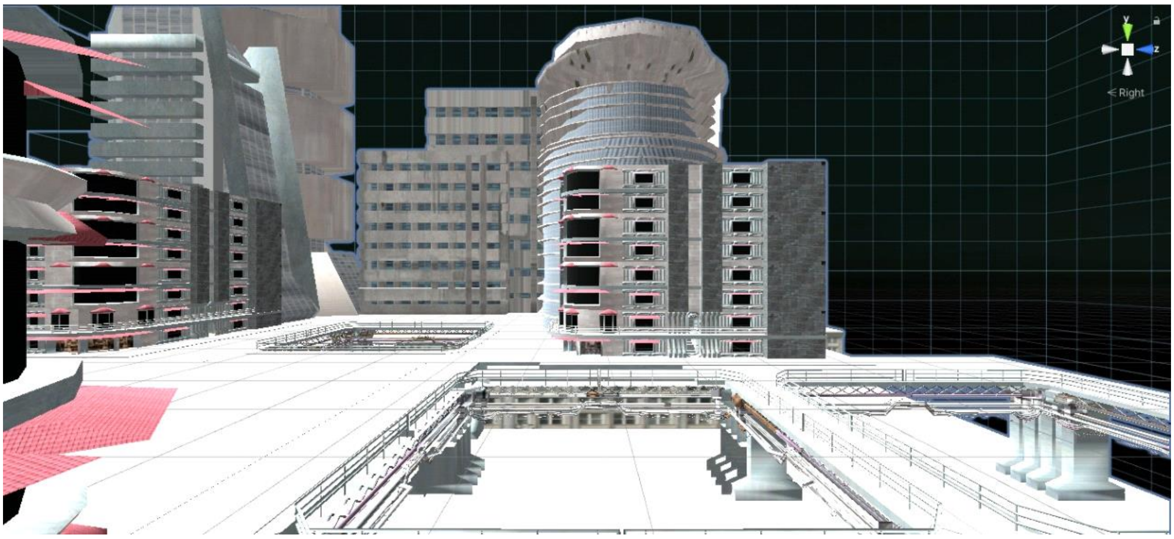


Figure 8 Workbench 6

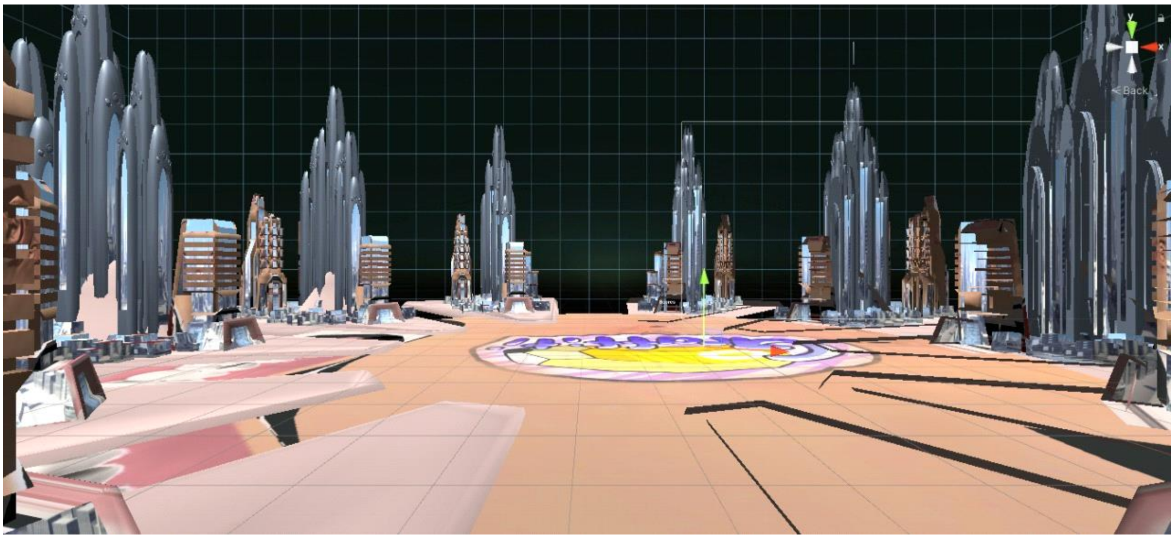


Figure 9 Workbench 7

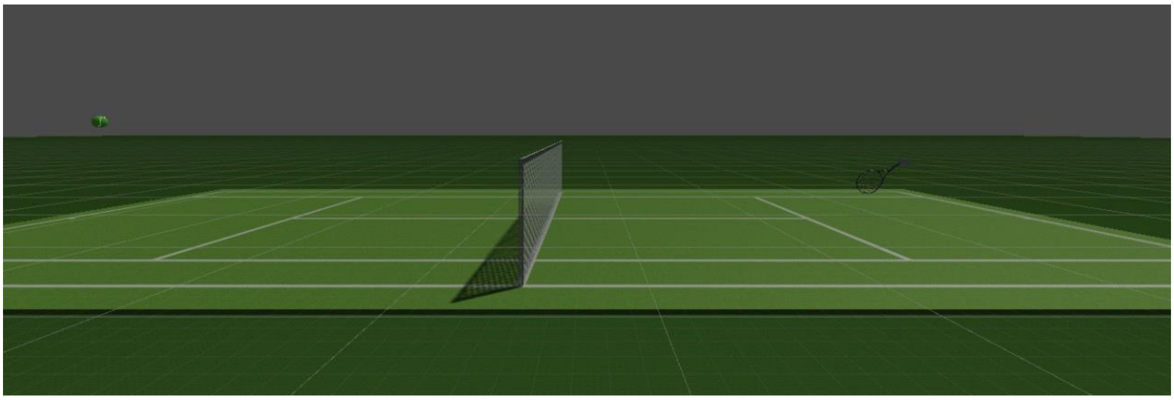


Figure 10 Workbench 8

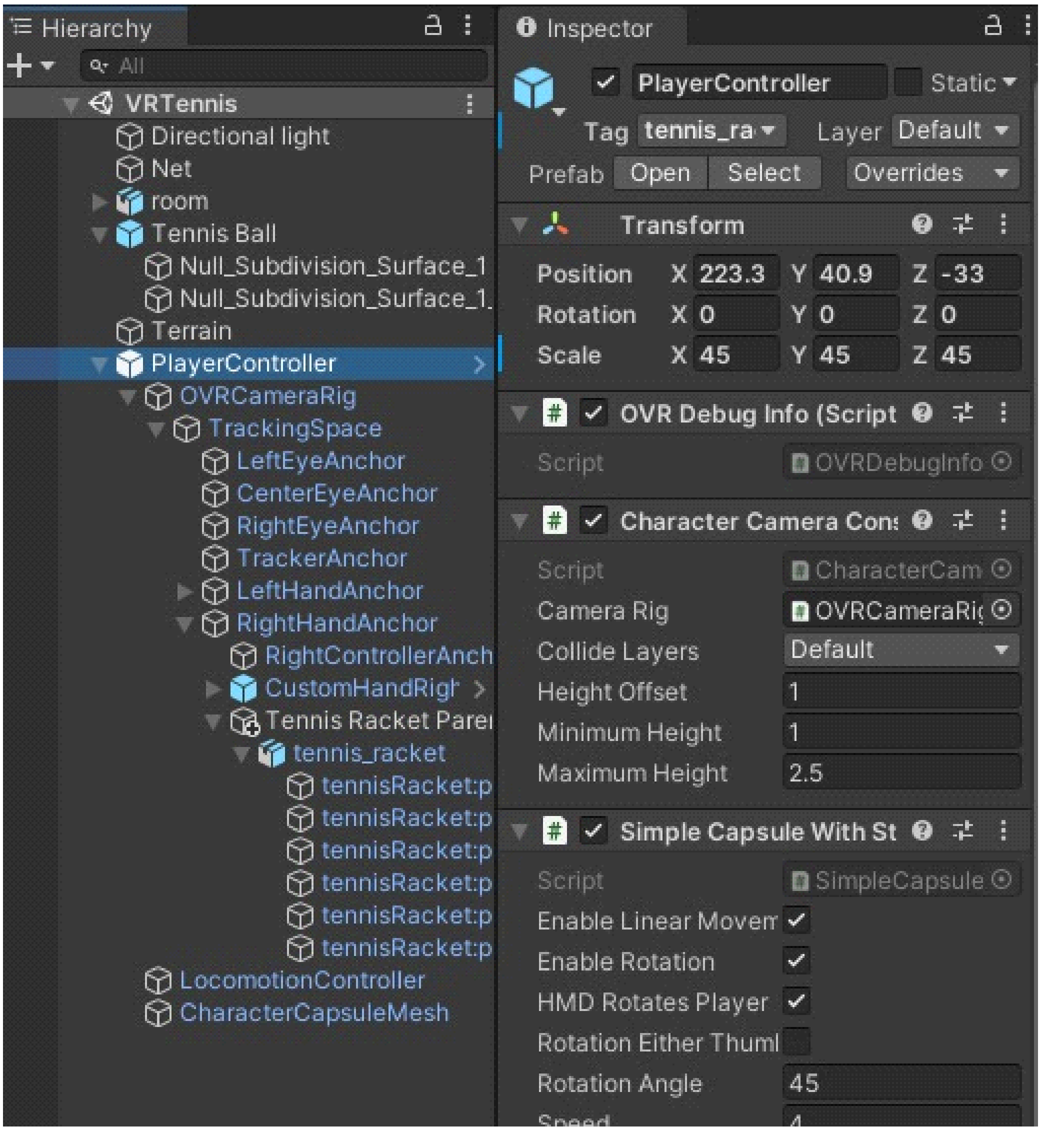


Figure 11 Workbench 9

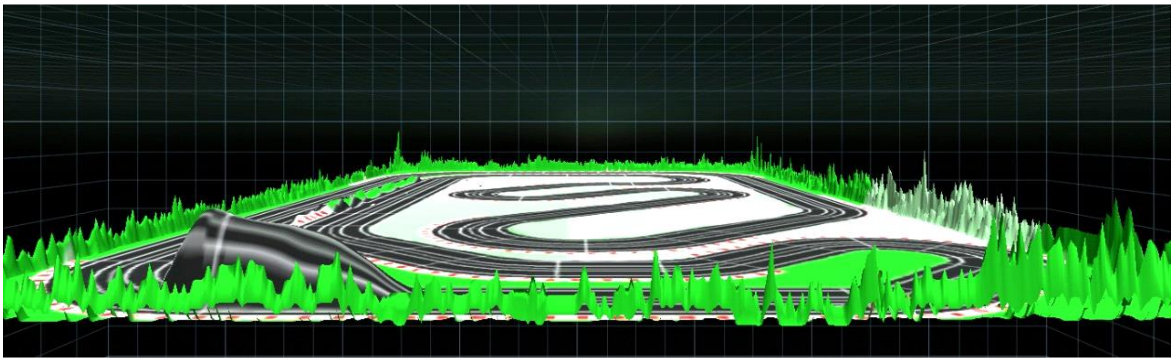


Figure 12 Workbench 10

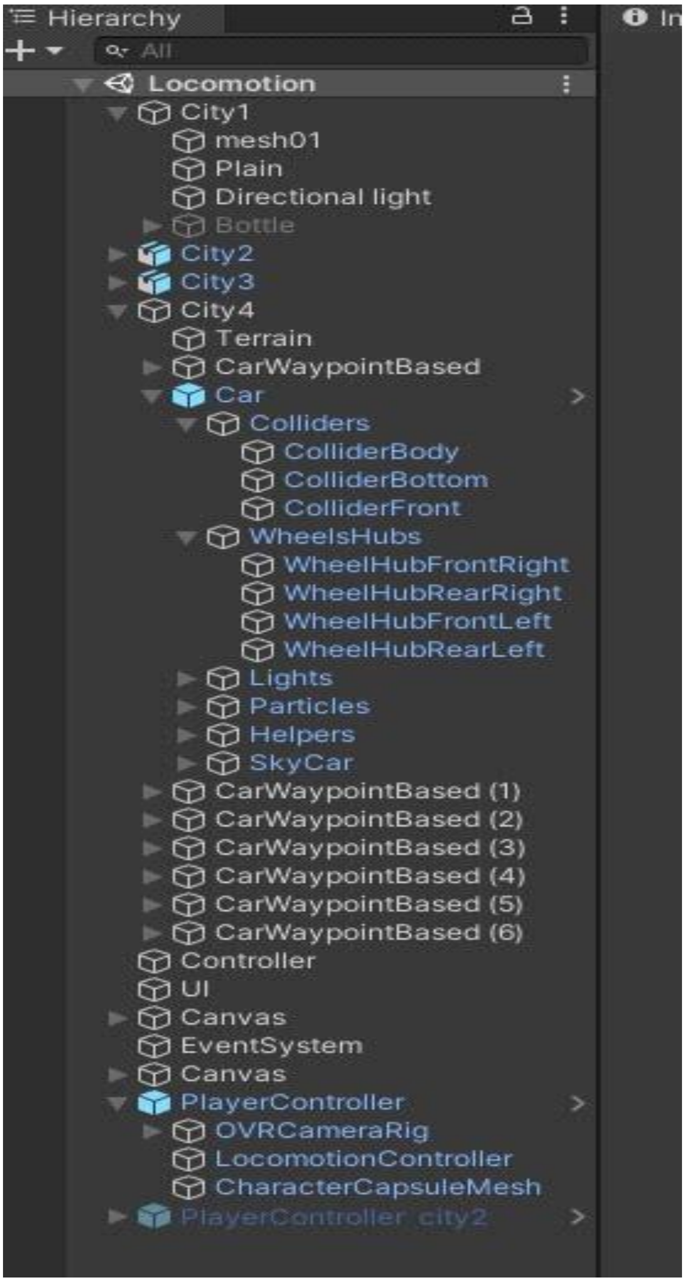


Figure 13 Workbench 11

4.3 Programming Language: C++: -

C++ is a general-purpose programming language developed by Bjarne Stroustrup, a Danish computer scientist, as an expansion of the C programming language, sometimes known as "C with Classes." The language has evolved over time, and current C++ now includes object-oriented, generic, and functional features, as well as memory management capabilities. It is commonly implemented as a compiled language, and several manufacturers, such as the Free

Software Foundation, LLVM, Microsoft, Intel, Oracle, and IBM, supply C++ compilers, making it available on a wide range of systems.

Standard library: There are two elements to the C++ standard: the core language and the standard library. Every major implementation of C++[clarify] includes aggregate types (vectors, lists, maps, sets, queues, stacks, arrays, tuples), algorithms (find, for each, binary search, random shuffle, etc.), input/output facilities (iostream, for reading from and writing to the console and files), filesystem library, localisation support, smart pointers for automatic memory management, regular expression support, multi-threading library, atom support, and so (measurement, getting current time, etc.).The Standard Template Library underpins a substantial portion of the C++ library (STL). Containers as collections of objects (such as vectors and lists), iterators that give array-like access to containers, and algorithms that perform actions such as searching, and sorting are all useful tools supplied by the ST. Also included are (multi)maps (associative arrays) and (multi)sets, which all output comparable interfaces. As a result, using templates, it is feasible to create generic algorithms that operate with any container or iterator sequence. The library's functionalities are accessed via the #include directive to include a standard header, much as in C. There are 105 standard headers in the C++ Standard Library, twenty-seven of which are deprecated. The standard includes the STL, which was created by Alexander Stepanov, who spent years experimenting with generic algorithms and containers. Thanks to C++ features like inclining and compile-time binding instead of function pointers, he was eventually able to design generic algorithms (e.g., STL sort) that perform even better than the C standard library sort. Because it is simply a component of the standard library, the name "STL" is not used in the standard, although it is frequently used to distinguish it from the remainder of the standard library (input/output streams, internationalisation, diagnostics, the C library subset, and so on). Most C++ compilers, and all major ones, provide a standards-conforming implementation of the C++ standard library.

4.4 HMD: Oculus Rift: -

Figure 14 oculus

The Oculus Rift is a virtual reality headset that was created and manufactured by Oculus VR, a branch of Meta Platforms, and was released on March 28, 2016.

Runtime: Microsoft Windows, macOS, and Linux are all officially supported by the Oculus Rift runtime. The headset driver (which contains Oculus Display and controller drivers), Positional Tracking Sensor driver, Oculus Service, and Oculus Home Application are all included in the installation package. The runtime service uses a variety of processing approaches to reduce latency and increase the smoothness of VR apps on less powerful hardware. Direct mode, asynchronous time warp, and asynchronous space warp are among them.

Oculus Home: The user is greeted with Oculus Home when they put on the Rift and no other material is being broadcast to the headset. This is the Rift's default environment, which has a loft atmosphere and a floating menu that allows users to open VR applications they own, see if their friends are using the headset, and purchase virtual reality stuff from the Oculus Home shop directly from the headset. Core 2.0, a software upgrade, featured a more interactive default environment that allowed users to traverse and alter it with imported 3D objects.

Features: The register includes the following entries: Ratings based on age and content “Comfortable," "moderate," and "intense" are the comfort levels (assigned by Oculus) User reviews and ratings: users can provide a 5-star rating and write a review**.**

SDK: The Oculus PC SDK, a free proprietary SDK for Microsoft Windows, is used to create content for the Rift (OSX and Linux support is planned). This is a feature-rich SDK that takes care of all elements of creating virtual reality content for the developer, including optical distortion and sophisticated rendering techniques. The prominent game engines Unity 5, Unreal Engine 4, and CryEngine are all natively connected with the Oculus SDK. This enables developers who are already familiar with these engines to produce VR content with minimal VR-specific code. Developers do not require clearance or verification to create, distribute, or sell content for the Rift, and they do not have to pay any licence costs because it is an open platform. However, without authorization, the SDK cannot be updated or utilised for other applications or devices. Material created with the Development Kit 2 and SDK version 0.8 or higher is compatible with the Rift; however, content created with the Development Kit 1 or previous SDK versions must be recompiled with the newest SDK version to be compatible.

CHAPTER 5: CONCLUSION AND FUTURE WORK:

- Identification of the main causes of Amblyopia.

- People should be educated about the Amblyopia and their risk factors so that its prevalence can be reduced as much as possible

- Increase the socioeconomic conditions of public.

- Awareness seminars should be arranged through different platforms.

- Health facility should be improved.

- Social media should play role.

- Permanent check of Amblyopia status.

- Public should be educated about the importance of physical activities

- Treatment should be aimed to achieve optimal values of eye disorder Ness.

BIBLOGRAPHY:

Serinette K, Level CN. Amblyopia: The Thalamus Is a No-Go Area for Visual Acuity. Cur Biol. 2018 Jun 18;28(12): R709-R712. [PubMed]

Hunter D, Cotter S. Early diagnosis of amblyopia. Vis Neurosis. 2018 Jan;35: E013. [PubMed]

Bangerter A. Treatment of amblyopia: Part 3 Apparatus, exercise equipment and games (continued). Strabismus. 2018 Jun;26(2):106-109. [PubMed]

Najem K, Margolin E. Stat Pearls [Internet]. Stat Pearls Publishing; Treasure Island (FL): Aug 22, 2021. Diplopia. [PubMed]

de Zárate BR, Tejedor J. Current concepts in the management of amblyopia. Clin Ophthalmic. 2007 Dec;1(4):403-14. [PMC free article] [PubMed]

Holmes JM, Levi DM. Treatment of amblyopia as a function of age. Vis Neurosis. 2018 Jan;35: E015. [PubMed]

Kiores L, Daw N. Cortical correlates of amblyopia. Vis Neurosis. 2018 Jan;35: E016. [PubMed]

Webber AL, Wood J. Amblyopia: prevalence, natural history, functional effects, and treatment. Clin Exp Optima. 2005 Nov;88(6):365-75. [PubMed]

Hashemi H, Pakzad R, Yekta A, Costanza P, Gairsain M, Sardari S, Valadao M, Pekin M, Heydar Ian S, Halakhos M. Global and regional estimates of prevalence of amblyopia: A systematic review and meta-analysis. Strabismus. 2018 Dec;26(4):168-183. [PubMed]

ATECO K, Mitchell P, Cumming R, Smith W, Jolly N, Sparkes R. Prevalence and causes of amblyopia in an adult population. Ophthalmology. 1998 Jan;105(1):154-9. [PubMed]

Choi MY, Lee KM, Hwang JM, Choi DG, Lee DS, Park KH, Yu YS. Comparison between anisometropic and strabismic amblyopia using functional magnetic resonance imaging. Br J Ophthalmic. 2001 Sep;85(9):1052-6. [PMC free article] [PubMed]

Chen AM, Cotter SA. The Amblyopia Treatment Studies: Implications for Clinical Practice. Adv Ophthalmic Optima. 2016 Aug;1(1):287-305. [PMC free article] [PubMed]

Petersilia MMW, Rhodes RS, Patel RN, Wilson ME, Edmondson LE, Logan SA, Cheeseman EW, Shortridge E, Trivedi RH. Effectiveness of the Go Check Kids Vision Screener in Detecting Amblyopia Risk Factors. Am J Ophthalmic. 2018 Mar; 187:87-91. [PubMed]

US Preventive Services Task Force. Grossman DC, Curry SJ, Owens DK, Barry MJ, Davidson KW, Roubini CA, Epling JW, Kemper AR, Krist AH, Kurth AE, Landefeld CS, Mangione CM, Phipps MG, Silverstein M, Simon MA, Tseng CW. Vision Screening in Children Aged 6 Months to 5 Years: US Preventive Services Task Force Recommendation Statement. JAMA. 2017 Sep 05;318(9):836-844. [PubMed]

Scheiman MM, Hertle RW, Kraker RT, Beck RW, Birch EE, Felis J, Holmes JM, Kund art J, Morrison DG, Repka MX, Tomkins SM., Paediatric Eye Disease Investigator Group. Patching vs atropine to treat amblyopia in children aged 7 to 12 years: a randomized trial. Arch Ophthalmic. 2008 Dec;126(12):1634-42. [PMC free article] [PubMed]

Scheiman MM, Hertle RW, Beck RW, Edwards AR, Birch E, Cotter SA, Crouch ER, Cruz OA, Davitt BV, Donahue S, Holmes JM, Lyon DW, Repka MX, Sala NA, Silbert DI, Suh DW, Tomkins SM., Paediatric Eye Disease Investigator Group. Randomized trial of treatment of amblyopia in children aged 7 to 17 years. Arch Ophthalmic. 2005 Apr;123(4):437-47. [PubMed]

Sarkar S, Tripathy K. Stat Pearls [Internet]. Stat Pearls Publishing; Treasure Island (FL): Feb 21, 2022. Cortical Blindness. [PubMed]

Kraus CL, Coolican SM. New advances in amblyopia therapy II: refractive therapies. Br J Ophthalmic. 2018 Dec;102(12):1611-1614. [PMC free article] [PubMed]

Kelly KR, Jost RM, Wang YZ, Dao L, Beauchamp CL, Leffler JN, Birch EE. Improved Binocular Outcomes Following Binocular Treatment for Childhood Amblyopia. Invest Ophthalmic Vis Sci. 2018 Mar 01;59(3):1221-1228. [PMC free article] [PubMed]

Kelly KR, Jost RM, De La Cruz A, Dao L, Beauchamp CL, Stager D, Birch EE. Slow reading in children with anisometropic amblyopia is associated with fixation instability and increased saccades. J AAPOS. 2017 Dec;21(6):447-451.e1. [PMC free article] [PubMed]

Kelly KR, Jost RM, De La Cruz A, Birch EE. Multiple-Choice Answer Form Completion Time in Children with Amblyopia and Strabismus. JAMA Ophthalmic. 2018 Aug 01;136(8):938-941. [PMC free article] [PubMed]

Ostendorf GM. [Vision screening of children: rational and cost effective]. Versicherungsmedizin. 2013 Dec 01;65(4):207. [PubMed]

Von Noorden GK, Campos EC. Binocular Vision and Ocular Motility: Theory and Management of Strabismus. 6th ed. St. Louis, Mo.: Mosby; 2002.

ATECO K, Mitchell P, Cumming R, Smith W, Jolly N, Sparkes R. Prevalence and causes of amblyopia in an adult population. Ophthalmology. 1998;105(1):154-159.

Scheiman MM, Hertle RW, Kraker RT, et al; Paediatric Eye Disease Investigator Group; Patching vs atropine to treat amblyopia in children aged 7 to 12 years: a randomized trial. Arch Ophthalmic. 2008;126(12):1634-1642.

Wallace DK, Edwards AR, Cotter SA, et al; Paediatric Eye Disease Investigator Group; A randomized trial to evaluate 2 hours of daily patching for strabismic and anisometropic amblyopia in children. Ophthalmology. 2006;113(6):904-912.

Repka MX, Cotter SA, Beck RW, et al; Paediatric Eye Disease Investigator Group; A randomized trial of atropine regimens for treatment of moderate amblyopia in children. Ophthalmology. 2004;111(11):2076-2085.

Holmes JM, Clarke MP. Amblyopia. Lancet. 2006;367(9519):1343-1351.

Committee on Practice and Ambulatory Medicine, Section on Ophthalmology, American Association of Certified Orthoptists; American Association for Paediatric Ophthalmology and Strabismus; American Academy of Ophthalmology; Eye examination in infants, children, and young adults by paediatricians. Paediatrics. 2003;111(4 pt. 1):902-907.

Policy statement. Vision screening in infants and children. A joint statement of the American Association for Paediatric Ophthalmology and Strabismus and the American Academy of Ophthalmology. http://www.aapos.org//client_data/files/2011/337_visionscreeningforinfantsandchildren2011.pdf. Accessed November 29, 2012.

Matta NS, Arnold RW, Singman EL, Silbert DI. Comparison between the pulsate and MTI photo screeners. Arch Ophthalmic. 2009;127(12):1591-1595.

Donahue SP, Baker JD, Scott WE, et al.; Lions Clubs International Foundation Core Four Photo screening: results from seventeen programs and 400,000 preschool children. J AAPOS. 2006;10(1):44-48.

Matta NS, Singman EL, Silbert DI. Evidenced-based medicine: treatment for amblyopia. Does Orth opt J. 2010; 60:17-22.

Holmes JM, Melia M, Bradfield YS, Cruz OA, Forbes B; Paediatric Eye Disease Investigator Group; Factors associated with recurrence of amblyopia on cessation of patching. Ophthalmology. 2007;114(8):1427-1432.

Repka MX, Beck RW, Holmes JM, et al; Paediatric Eye Disease Investigator Group; A randomized trial of patching regimens for treatment of moderate amblyopia in children. Arch Ophthalmic. 2003;121(5):603-611.

Paediatric Eye Disease Investigator Group: A randomized trial of near versus distance activities while patching for amblyopia in children aged three to less than 7 years. Ophthalmology. 2008;115(11):2071-2078.

Paediatric Eye Disease Investigator Group; A randomized trial of atropine vs. patching for treatment of moderate amblyopia in children. Arch Ophthalmic. 2002;120(3):268-278.

Lang, Ben (2019-03-20). "Oculus Rift S Revealed with Inside-out Tracking, Resolution Bump, & New Ergonomics". Road to VR. Retrieved 2019-03-20.

"Oculus Rift: Step into the Game". Kickstarter. Retrieved June 17, 2015.

Facebook purchases VR headset maker Oculus for $2 billion Ars Technical, March 25, 2014

Pleasure, R., & Feller, J. (2016). A Rift in the Ground: Theorizing the Evolution of Anchor Values in Crowdfunding Communities through the Oculus Rift Case Study. Journal of the Association for Information Systems, 17(10), 708-736.

"Iribe: Over 100,000 Oculus Rift DK2s Shipped". Overfocus. February 16, 2015. Retrieved September 7, 2015.

Mitchell, Nate (March 20, 2019). "Oculus Rift S Hands-On and Impressions!". YouTube. Whale rock Industries. Archived from the original on 2021-11-17. Retrieved 23 May 2019. So, Rift S is going to replace Rift. We are in the process of phasing out Rift right now.

Robertson, Adi (March 20, 2019). "The Oculus Rift is out of stock almost everywhere, still shipping 'while supplies last'". The Verge. Vox Media, Inc. Retrieved 23 May 2019. While we do not comment on specific shipment windows or allocations, [we] can confirm [the] original Rift is still available for sale at Oculus.com and from our retail partners while supplies last.

"Announcing Oculus Rift S, Our New PC VR Headset Launching Spring 2019 for $399". Oculus.com. Facebook Technologies, LLC. March 20, 2019. Retrieved 23 May 2019. Rift S replaces the original Rift with an upgrade to a higher resolution display, improved optics, and a feature called Passthrough+ … Because Rift and Rift S share the same core platform experience, current Rift owners will be able to take advantage of our continued software updates.

"Meant to be Seen – View topic – Oculus "Rift": An open-source HMD for Kickstarter". Mtbs3d.com. Retrieved September 9, 2013.

Don Colagrossi (2013-11-05). "Neil Traces the History of Oculus Rift and Vireo Perception". Tom's Hardware.

"The Inside Story of Oculus Rift and How Virtual Reality Became Reality". Wired. 2014-05-20.

Neil Schneider. "The #1 Stereoscopic 3D Gaming (VR Gaming, 3D Gaming) and VR Resource - Meant to be Seen - John Carmack Talks VR at Quake on 2012". mtbs3d.com.

"Carmack Makes Virtual Reality Actually Cool".

Welsh, Oli (June 7, 2012). "John Carmack and the Virtual Reality Dream". Eurogamer. Retrieved August 1, 2012.

Rosenberg, Adam (June 14, 2012). "Hands-On With Oculus Rift, John Carmack's Virtual Reality Goggles". G4TV. Archived from the original on February 3, 2016. Retrieved January 28, 2019.

"A Brief History of Oculus". TechCrunch. March 26, 2014. Retrieved July 17, 2015.

"Update on Developer Kit Technology, Shipping Details". Oculus VR. November 28, 2012. Retrieved March 20, 2014.

"Oculus Rift pre-order open now". Mtbs3d.com. Retrieved September 9, 2013.

"Oculus Rift: Step into the Game". Kickstarter.com. Retrieved 11 March 2017.

"Oculus Rift: Step into the Game by Oculus » Online Pre-Orders Live! – Kickstarter". Kickstarter.com. Retrieved September 9, 2013.

"Oculus/RiftDK1". github.com. Retrieved 29 September 2014.

"E3 2013: New 1080p Oculus Rift with Unreal Engine 4". IGN. 2013-06-11. Retrieved November 1, 2013.

"Oculus reveals Crystal Cove prototype virtual reality headset with intriguing OLED display". The Verge. 2014-01-07. Retrieved January 7, 2014.

"Announcing the Oculus Rift Development Kit 2 (DK2)". Oculus VR. March 19, 2014. Archived from the original on February 3, 2016. Retrieved Aug 31, 2018.

Stroustrup, Bjarne (1996). "A history of C++: 1979-1991". History of programming languages---II. ACM. pp. 699–769. doi:10.1145/234286.1057836.

Stroustrup, Bjarne (16 December 2021). "C++20: Reaching for the Aims of C++ - Bjarne Stroustrup - Copco 2021". Copco.

Naugler, David (May 2007). "C# 2.0 for C++ and Java programmer: conference workshop". Journal of Computing Sciences in Colleges. 22 (5). Although Java has strongly influenced C# it has also been strongly influenced by C++ and is best viewed as a descendant of both C++ and Java.

"Chapel spec (Acknowledgements)" (PDF). Cray Inc. 1 October 2015. Archived (PDF) from the original on 24 June 2018. Retrieved 14 January 2016.

"Rich Hickey Q&A by Michael Fogus". Archived from the original on 11 January 2017. Retrieved 11 January 2017.

Harry. H. Chaudhary (28 July 2014). "Cracking The Java Programming Interview: 2000+ Java Interview Que/Ans". Archived from the original on 27 May 2021. Retrieved 29 May 2016.

Roger Poon (1 May 2017). "Scaling JS++: Abstraction, Performance, and Readability". Archived from the original on 11 May 2020. Retrieved 21 April 2020.

"FAQ Nim Programming Language". Archived from the original on 11 July 2017. Retrieved 21 April 2020.

Blender's 25th birthday!"]. blender.org. January 2, 2019. Retrieved January 7, 2019. {{cite web}}: Check |URL= value (help) https://git.blender.org/gitweb/gitweb.cgi/blender.git/tag/0e427e082ca9615f6547059cf2fe187020243883; publication date: 1 April 2022; retrieved: 8 April 2022.

"Index of /demo/android/". download.blender.org. Retrieved 2020-09-23.

"Fresh Ports -- graphics/blender: 3D modelling/rendering/animation/gaming package". www.freshports.org.

"OpenPorts.se | The OpenBSD package collection". openports.se.

"pkgsrc.se | The NetBSD package collection". pkgsrc.se.

"The dedicated application build system for DragonFly BSD: Dragonfly BSD/Deports". July 23, 2019 – via GitHub.

"GitHub - haiku ports/haiku ports: Software ports for the Haiku operating system". July 27, 2019 – via GitHub.

"Blender 2.92 Release Index". blender.org. February 25, 2021. Retrieved February 26, 2021.

"Blender 2.92 Download Page". blender.org. Retrieved April 23, 2021.

"License - blender.org". Retrieved May 17, 2014.

"How Blender started, twenty years ago…". Blender Developers Blog. Blender Foundation. Retrieved 2019-01-10.

"Dock/2.6/Manual - Bednarik". Blender.org. Retrieved 2019-01-11.

"Ton Roosendaal Reveals the Origin of Blender's name". Blender Nation. 2021-10-19. Retrieved 2021-10-20.

Archived at Ghost archive and the Way back Machine: "Neoga — Blender". YouTube.com. 2011-10-28. Retrieved 2019-06-11.

Wassenaar, Joeri (2006-07-20). "Brief history of the Blender logo — Traces". Archived from the original on 2010-01-22. Retrieved 2010-01-22.

"Blender's prehistory - Traces on Commodore Amiga (1987-1991)". zgodzinski.com.

"Blender History". Blender.org. Retrieved March 29, 2018.

"Blender Foundation Launches Campaign to Open Blender Source". Linux Today. Retrieved 2017-01-22.

"Free Blender campaign". 2002-10-10. Archived from the original on 2002-10-10. Retrieved 2017-01-22.

"members". 2002-10-10. Archived from the original on 2002-10-10. Retrieved 2017-01-22.

"Blender.org About". Amsterdam. Retrieved 2021-02-01.

Roosendaal, Ton (June 2005). "Blender License". Archived from the original on March 4, 2016. Retrieved January 19, 2007.

Propounding, Alexandre (26 January 2012). "What's up with DWG adoption in free software?". libregraphicsworld.org. Archived from the original on 9 November 2016. Retrieved 2015-12-05. [Blender's Ton Roosendaal:] "Blender is also still "GPLv2 or later". For the time being we stick to that, moving to GPL 3 has no evident benefits I know of. My advice for Libre: if you make a library, choosing a widely compatible license (MIT, BSD, or LGPL) is an incredibly positive choice."

"rB159806140fd3". developer.blender.org. Retrieved 2019-02-28.

"Blender 2.80 release". blender.org. Retrieved 2020-01-16.

https://conference.blender.org/2019/festival/

"Index of /source/". blender.org. Retrieved October 13, 2010.

Foundation, Blender. "Blender's History".

"Blender 2.40". blender.org. Archived from the original on March 4, 2007. Retrieved December 23, 2005.

"3D-Software Blender 2.46 zoom Download freibergite". heise.de (in German). Retrieved May 20, 2008.

"Blender 2.48". blender.org. Archived from the original on January 20, 2009. Retrieved December 25, 2008.

"Blender 2.49". blender.org. Archived from the original on June 11, 2009. Retrieved June 21, 2009.

"Blender 2.57". blender.org. Archived from the original on October 30, 2013. Retrieved April 13, 2011.

blender foundation (2011-07-09). "Blender 2.58 release notes". blender.org. Retrieved 2019-01-14.

blender foundation (2011-07-09). "Blender 2.58a update log". blender.org. Retrieved 2019-01-14.

"DeVere/Release Notes/2.61 - Bednarik". archive.blender.org. Retrieved 2020-11-26.

"DeVere/Release Notes/2.68 - Bednarik". blender.org. Retrieved 2019-01-14.

"Past Releases". blender.org. Retrieved November 13, 2015.

"Blender 2.77". blender.org. March 19, 2016. Retrieved March 29, 2016.

"Blender 2.78b Release Logs". blender.org. February 16, 2017. Retrieved September 30, 2016.

"Reference/Release Notes/2.79 - Blender Developer Wiki". wiki.blender.org.

"Reference/Release Notes/2.80/UI - Blender Developer Wiki". Blender Developer Wiki. 26 June 2019. Retrieved 11 July 2019.

"Reference/Release Notes/2.80/EEVEE - Blender Developer Wiki". Blender Developer Wiki. 9 July 2019. Retrieved 11 July 2019.,

"Ton Roosendaal on Twitter". Twitter. Retrieved May 24, 2018.

"Drawing 2D Animation in Blender 2.8 - Blender Developers Blog". Blender Developers Blog - Developer musings on Blender. 12 December 2017. Retrieved 11 July 2019.

"2.80 - Blender.org". blender.org - Home of the Blender project - Free and Open 3D Creation Software. 11 July 2019. Retrieved 11 July 2019.

"2.81 blender.org". 18 August 2019. Retrieved 19 August 2019.

"2.82". Retrieved 15 February 2020.

Foundation, Blender. "2.83 LTS". blender.org. Retrieved 2020-06-10.

Failes, Ian (May 1, 2014). "Captain America: The Winter Soldier – reaching new heights". fxguide.com. Retrieved October 7, 2019.

Karon, Pavla. "Max Pulpier: "I Use Blender Because It is Powerful, Not Because It is Free"". CG Cookie. Retrieved 2019-06-11.

Archived at Ghost archive and the Way back Machine: "Death Grips - Inanimate Sensation - YouTube". www.youtube.com. Retrieved 2020-07-17.

Archived at Ghost archive and the Way back Machine: Blender used at VFX studio, retrieved 2021-10-09

"The Man in the High Castle, Season 2 VFX". Barnstorm VFX.

"We produced the Visual Effects for Man in the High Castle Season 2". Reddit. 3 February 2017.

"New Online Exploring Tools Bring NASA's Journey to Mars to New Generation". NASA. 5 August 2015. Retrieved 2015-08-07.

"Experience Curiosity". NASA's Eyes. Retrieved 2015-08-07.

"Internet 3D: Take the Curiosity Rover for a Spin Right on the NASA Website". Technology.Org. 11 August 2015. Retrieved 2015-08-12.

"Khronos Events – 2015 SIGGRAPH". Khronos. 10 August 2015. Retrieved 2015-08-13.

"Hardcore Henry – using Blender for VFX". Blender News.

"Feature length film: Sabogal". Blender Nation. May 1, 2015. Retrieved October 7, 2019.

Richard, Kennedy (July 7, 2016). "Blender Used in Warcraft (2016) Feature Film". Blender Nation. Retrieved October 7, 2019.

Archived at Ghost archive and the Way back Machine: Sandberg, David F. (November 20, 2016). "The Homemade VFX in Lights Out". YouTube. Retrieved October 7, 2019.

Archived at Ghost archive and the Way back Machine: Sandberg, David F. (April 4, 2017). "Annabelle Creation Trailer - Behind the Scenes". YouTube. Retrieved October 7, 2019.

"Interview With David F. Sandberg". openvisualfx.com. June 6, 2017. Retrieved October 7, 2019.

"Wonder Woman (2017)". artofthetitle.com. 2017-06-21. Retrieved 2017-09-11.

"Cinderella the Cat, Interview: Alessandro Rack - Director". cineuropa.org. 2017-07-09. Retrieved 2017-09-11.

World Building in Blender - Ian Hubert, retrieved 2022-03-09

""Next Gen" - Blender Production by Tangent Animation soon on Netflix! - Blender Nation". Blender Nation. 2018-08-20. Retrieved 2018-09-12.

Archived at Ghost archive and the Way back Machine: "Blender and Next Gen: a Netflix Original - Jeff Bell - Blender Conference 2018". 2018-11-04. Retrieved 2018-11-08.

Ian Failes (2019-11-30). "How the 'I Lost My Body' filmmakers used Blender to create their startling, animated feature". before & afters. Retrieved 2021-10-04.

"Ubisoft Joins Blender Development Fund to Support Open-Source Animation". Ubisoft. 2019-07-22. Archived from the original on 2019-07-23. Retrieved 2019-07-29.

Blender [@blender_org] (2019-07-24). "The Japanese Anime studios Khara and its child company Project Studio Q sign up as Corporate Silver and Bronze members of Development Fund. They are working on the Evangelion feature animation movie. www.khara.co.jp studio-q.co.jp #b3d" (Tweet). Retrieved 2019-08-15 – via Twitter.

Foundation, Blender. "Japanese anime studio Khara moving to Blender".

Foundation, Blender. ""2D Is not Dead, It Just Became Something Different": Using Blender for Wolf walkers". blender.org. Retrieved 2021-03-06.

"Award Winning SPA Studios Looking for Blender TA's and TDs in Madrid, Spain". Blender Nation. 2021-03-24. Retrieved 2021-03-28.

FAST GREASE PENCIL - Blender. Today LIVE #182, retrieved 2022-05-06

"New "Maya and the Three" Made with Blender Series Images Released". Blender Nation. 2021-06-16. Retrieved 2021-10-28.

"Warner Bros. Animation on LinkedIn: #hiring #cganimation #warnerbrosanimation". www.linkedin.com. Retrieved 2022-02-15.

"Blender — Open Projects". Blender.org. Retrieved 2019-06-11.

"Blender Cloud — Open Projects". Cloud.blender.org. Retrieved 2019-06-11.

"Peach.blender.org". 2008-10-03. Retrieved 2012-07-06.

"Big Buck Bunny set to make the hop to Nintendo Video". Nintendo UK. 26 April 2012. Retrieved 15 May 2022.

"You Frankie! – About". Apricot Open Game. Blender Foundation. Retrieved August 18, 2008.

"Durian.blender.org". Retrieved 2012-07-06.

"How long is the movie?". Durian.blender.org. 2010-04-15. Retrieved 2012-07-06.

"Sintel Official Premiere". Durian.blender.org. 2010-08-16. Retrieved 2012-07-06.

"Sintel The Game announcement". Blenderartists.org. Archived from the original on 2010-06-10. Retrieved 2012-07-06.