



DIGITISING THE 20 METRE VISION TEST USING 3D IMAGE SCALING AND VOICE RECOGNITION SOFTWARE FOR USER INPUT

Abstract

This document is a proposal for the project to implement a piece of software for the DVLA that is a digital recreation of the minimum eyesight distance test. The document will provide an introduction to, and background research of, the main idea. Detailed in this report are the research and development methods, aims and objectives of the proposed research project.

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1. Introduction

The first section of this proposal will introduce the concept of the project and will discuss the different aspects of both implementation and research planned.

The working title of this project is “Digitising The 20 Metre Vision Test Using 3D Image Scaling and Voice Recognition Software for User Input” and the ultimate goal is to create a piece of software that can display a registration plate on the screen such that it appears 20 metres away to allow people to perform the minimum eyesight distance test from the comfort of their own homes.

This project is to provide research into the legal minimum eyesight distance test as stated by the Driver and Vehicle Licensing Agency (DVLA). When a person would like to drive a vehicle they must apply to the DVLA who are responsible for providing licences and regulating rules surrounding driving, including monitoring medical conditions of drivers.

There are many caveats put in place by the DVLA that must be met when a person applies for a driving licence in the United Kingdom. Whether it be someone’s first time applying for a licence, a renewal of a licence or reapplying for a licence after sometime without one, anyone wanting a driving licence must pass all of the following tests: a driving theory test, a practical driving test and a vision test [1]. It is the latter that this project will be focusing on.

There are multiple vision tests that potential drivers must satisfy including specific tests for people with visual defects and higher standard tests for bus and lorry drivers. However, there is one test that must be passed by all drivers under all circumstances. This is the minimum eyesight distance test.

The minimum eyesight distance test is a simple test that evaluates the distance the participant can see when they are asked to read a registration plate in good daylight, under the current printing standards, from 20 metres away [2]. There are two registration plate printing standards that participants must be able to read: those printed prior to 2001 and those after 2001, where the structure of the registration plate changed. Prior to 2001, the characters on a registration plate were 79mm high and 57mm wide but once the restructuring took place, the characters changed to 50mm wide while remaining at 79mm high [2]. The minimum distance required to read these different types of registration plates is different with pre 2001 being 20.5 metres and post 2001 being slightly closer at 20 metres. This test is usually completed at a driving test centre where the 20 metre distance is clearly marked.

This project will focus on the minimum eyesight distance test by aiming to recreate the test in a digital program. The program will display a registration plate on the screen and will scale the image so that it appears 20 metres away. Research into screen resolution detection will be conducted as different resolutions would affect the scaling of the registration plate image. This research will be reflected in the implementation to ensure that the registration plate is always the same distance for all users regardless of what screen is being used. Once the registration plate is displayed on the screen the user will need to enter what they can read and the input will be evaluated to determine if the user has passed the test. If the screen being used has a resolution such that the scaling is producing an image that is too small, the user will be asked to move further away from the screen. In this case the user may be too far away from the keyboard and therefore unable to enter the response without moving closer, which would corrupt the results. To prevent any false results, research into voice recognition software will be conducted to allow users to verbally input their response.

The implementation of this recreation will use the programming language C# [3] and the 3D modelling software Unity [4] while the research aspect will focus on the following: voice recognition software,

human vision, screen resolution detection and 3D image scaling. Voice recognition software will be researched to understand how users could vocalise a response if they are too far away from a keyboard. Human vision will be researched as each person's eyesight is different and this could affect how participants use the system. Some interesting questions arise here, namely for those who need corrective glasses, does the user always wear glasses while driving and will glasses affect the outcome of the test? Research will be conducted into screen resolution detection as different users would have different screen resolutions and this would affect how the image is displayed on the screen, particularly how many pixels the image takes up and the aspect ratio of the image. Detecting the screen resolution will allow the software to adjust the image to correctly display the registration plate at a distance of 20 metres from the user. Research into 3D image scaling will be conducted to understand and implement this.

This section has introduced the project, including the title, concept, scope and research topics. The next section is the literature review and background research which will take a deeper dive into the literature surrounding the research topics and project idea.

2. Background Research/Literature Review

In the United Kingdom, the DVLA requires all drivers to achieve the minimum eyesight distance test before applying for a driving licence. This is done on a self-declaration and it is up to the applicant to ensure they are complying with the law at all times while driving. The actual test is carried out before a person is taken on the road for the practical driving test at a Driving and Vehicle Standards Agency (DVSA) driving test centre [5]. This test is to be performed under good daylight conditions and the participant is asked to read a registration plate from 20 metres away, which can be equated to five car lengths [6]. The registration plate to be read must be of standard printing which sees the characters be 79mm high and 50mm wide, for those registered after 2001, and 79mm high but 57mm wide for those registered before 2001.

There are more specific tests that drivers must pass if they have visual impairments or require a licence to drive larger vehicles such as buses and lorries. However, for the average motorbike and car driver, the minimum eyesight distance test was the only requirement to be deemed visually fit to drive. The DVLA puts the onus on the driver to ensure they remain visually fit to drive. Should a driver notice their vision deteriorating they should visit their optometrist for an eyesight check and inform the DVLA if their doctor advises they should not drive.

In 2012, to bring UK standards in line with EU standards, the DVLA changed the regulations for being visually fit to drive by adding the need for visual acuity to be at least 6/12 on the Snellen scale with both eyes open [6], [7]. This addition does not necessitate the need for a certificate from an optometrist proving that a driver meets the requirement, but drivers must state that they have not been informed that their visual acuity is less than the requirement [7]. If a formal test is performed and it shows a driver does not meet the requirement, then their licence can be revoked or refused [7].

The Snellen chart is commonly used by optometrists to perform eyesight checks. The patient is asked to cover one eye and read letters on a chart positioned six metres away [8]. Each line of the chart increases the number of letters, while decreasing the size. Optometrists use the Snellen chart to evaluate visual acuity of patients [9].

There have been multiple studies conducted to prove the viability of the minimum eyesight distance test with some concluding that drivers should be required to undergo more frequent eyesight checks due to a lack of understanding about eyesight when driving [10], [11]. Other studies concluded that more care should be given to the weighting given to the Snellen test when compared to the minimum eyesight distance test [12], [13].

With regards to online vision tests, there are a number of options available which includes services provided by Personal Eyes [14] and Essilor [15]. The Personal Eyes service simulates the Snellen test by asking the user to take the test twice, covering a different eye for each test. The user is presented with eight random letters and is asked to enter what they see. Once they have entered their response, the process repeats five times with the letters decreasing in size each time. While this is a reasonable representation of the Snellen test, it requires the user to be positioned one metre away from the screen. Inputting a response while one metre away from the screen could cause the user to either pull a keyboard taut or ensure they have a wireless keyboard, which can reduce the usability of the system. If a user is too far away and therefore must move closer to input their response, the input could be corrupt as the letters may only become clear once the user is closer to the screen.

Essilor hosts multiple online versions of eyesight tests including visual acuity and colour vision tests. The visual acuity test is similar to the Snellen test and works by displaying a symbol facing one of four directions, and asks the user to click on the arrow it is facing. Each time the user clicks an arrow, the

symbol changes position and decreases in size. This system requires the user to perform the test twice, covering a different eye each time. Similar to the test supplied by Personal Eyes however, the user is required to ensure they are positioned one metre away from the screen to achieve the best results. Again this requirement reduces usability as a user might not be able to use a mouse to input the results without moving closer to the screen, particularly if they are using a laptop with a stationary track pad.

More closely related to this project is SeeDrive [16] by Vutest which attempts to recreate the minimum eyesight distance test. This software displays a registration plate of the current printing standards on the screen and asks the user to position themselves a certain distance away. To measure the correct distance, a yellow line is displayed on the screen that the user must measure. The user must then position themselves at a distance that is equivalent to the distance measured but converted from centimetres into metres, for example if the line is measured at 3.4cm then the user should be positioned 3.4m away from the screen. Unlike the previous two examples however, this test does not require the user to enter a response, a random registration plate is just displayed on the screen and is updated every ten seconds. This puts all the emphasis on the user to ensure that they are properly positioned and can read the registration plate correctly as there is no way for the system to confirm if the user has read the plate correctly.

This project will build upon the previous work of the SeeDrive system but will aim to incorporate screen resolution detection and image rescaling technologies to ensure the registration plate is displayed correctly without having the user to be positioned far away from the screen. The project will use voice recognition software to alleviate the need for the user to enter their response via a keyboard, as with the Personal Eyes and Essilor tests, therefore improving usability.

This literature review has analysed previous work from studies regarding the minimum eyesight distance test and has evaluated other pieces of software that aim to provide an online solution to eyesight tests. Other topics that will be critically analysed and evaluated in the literature review of the major project will be 3D image scaling transformations, screen resolution detection and voice recognition software. The next section will outline the overall aim for this project and will detail the specific objectives this project intends to complete to achieve the aim.

3. Aims and Objectives

3.1. Aims

- To evaluate the effectiveness of recreating the minimum eyesight distance test for UK drivers using 3D image scaling transformation and voice recognition software.

3.2. Objectives

- To critically assess different voice recognition software and 3D image scaling transformations to evaluate which would be best suited for implementation.
- To use the 3D modelling software Unity to render a registration plate at the correct distance and to use the knowledge gained from the research to implement image scaling transformations.
- To gather user responses via questionnaires and interviews with respect to the effectiveness of the software.
- To analyse user responses to using the software to understand how the general public would respond to this software.

This section has outlined the high level aim of this project and detailed the more specific objectives of how to achieve the aim. The next section will discuss the philosophy, approach and strategies planned for use during the project as well as highlighting the potential risks and limitations that the project could face.

4. Research Methods

4.1. Philosophy

The philosophy to be used for the research of this project is phenomenological. The phenomenological philosophy is a qualitative research paradigm that focuses on experience from a first-person point of view [17], [18]. This philosophy was chosen as the project will have a human interaction element and will subjectively evaluate the effectiveness of the program.

4.2. Approach

The approach to conducting the research in this project will be an inductive one. An inductive approach to research moves from specific details or experiences into general understandings of those details and provides qualitative results [19], [20].

4.3. Strategy

4.3.1. Literature Review

The major focus for the research portion of this project will be in the literature review. The literature review will delve into research that has been conducted by others in the same areas, such as screen resolution detection, image scaling and voice recognition software. This review will provide a detailed context to the project and the critical analysis of previous work will influence the path the implementation will follow.

4.3.2. Software Development

Software development will be used to aid the research aspect of this project. This will include the implementation of a program that displays a registration plate at an appropriate scale to achieve the same circumstances of the standard 20 metre vision test. While the software development will be focused on creating the simulation, it will be directed by the research gathered from the literature review.

An advantage of using the software development strategy is that it provides a physical representation of the idea which can then be tested by users. This can aid the research as the application of the idea moves from theoretical to tangible, therefore providing results that prove if the implementation is a feasible product in reality.

4.3.3. Survey/Questionnaire/Interview

Surveys, questionnaires and interviews will be used to gauge the general public's view on the creation of an online version of the minimum eyesight distance test. Surveys and questionnaires will be used to achieve quick responses to questions surrounding the concept of the project, while interviews will be used to obtain more in-depth responses.

A preliminary study will be conducted where users will use a system that is currently available, SeeDrive [16] that is produced by EyeLab [21]. During this preliminary study, participants will be observed to understand how they react to the current system. At the end of the study, participants will be given a questionnaire that will provide written feedback on how they interacted with the system and what their views on it were, including usability and effectiveness.

The feedback gathered from the preliminary study will reveal areas of interest from the general public which will hone the research in the literature review as well as the design of the implementation. Surveys, questionnaires and interviews conducted after the implementation will assess if the implementation is a product that people would willingly use as a substitute for the current standard physical test and the currently available application SeeDrive.

4.4. Risks & Limitations

There are many risks that could potentially arise throughout the course of this project, ranging from common issues, such as data loss, to more specific risks relating to human interaction.

A very real risk this project faces is that the implementation portion of the project could take up a significant period of time. To combat this, a Gantt chart has been produced (as shown in section 6.2. Gantt Chart) which outlines the time to be spent on certain sections of the project, including the implementation. During this time, the main goal of the implementation will be to create a minimum viable product (MVP). This MVP will contain the basic aspects of the implementation and should perform appropriately but may not have all the extra features of a fully implemented program.

As surveys, questionnaires and interviews will be used in this project, there is always a risk associated with human interaction. One such risk is that of personal and environmental effects affecting a participant's responses [22], [23]. To contend with this, the surveys, questionnaires and interviews will be conducted over different days and with a varying sample of participants to achieve a wide range of results.

A risk that is specific to this project is that users may not be the correct distance away from the screen when performing the test. While there will have to be some element of trust that the user will be the correct distance away from the screen, the 3D image scaling calculations will ensure the image is displayed at the correct distance. An extension of this is that users could use a zoom function that is built into many computer operating systems and web browsers. Research will also be conducted into these zoom and magnification functions to potentially disable them to prevent the user from cheating.

4.5. Data Evaluation

The data for this project will be supplied by the responses to the surveys, questionnaires and interviews conducted. While this data will be qualitative, as it is based on human experiences, it will be able to influence how the implementation is designed and the final outcomes of this project.

The results of the preliminary study will be compared to the results of the survey, questionnaires and interviews given to users after they have used the implemented software. This comparison will show the effectiveness of the software created for this project and will provide confirmation if the software would be welcomed by the general public.

4.6. Conclusion

This section has discussed the research philosophy and approach that will be used throughout this project. It has also defined the strategies to be implemented alongside the risks and limitations these strategies produce. The next section will discuss the development methodology to be utilised.

5. Development Methods

5.1. Feature Driven Development

Feature driven development is a software development methodology that could be utilised throughout this project. This methodology is beneficial for object-oriented programming as it focuses on designing and building specific features of a piece of software [24]. In particular, there are five defined steps: develop an overall model, build a features list, plan by feature, design by feature and build by feature [25]. The final two phases, design by feature and build by feature, are repeated iteratively to achieve the optimal implementation [26].

This methodology allows for focused building of a specific feature of the software before moving onto the next, which is beneficial as it allows for an iterative and structured implementation. However, as this methodology has a stronger focus on the implementation when compared to the waterfall methodology, less attention is given to the design of the software [27].

5.2. Waterfall Methodology

The waterfall methodology is one that could be used for this project and is one which has clearly defined stages for analysis/research, design, implementation and testing [28]. This methodology allows for effective and efficient planning as each stage can have specific tasks that must be completed before development can move onto the next stage. The separation of stages allows for efficient and early planning during the analysis and design stages while also providing time for implementation and testing.

The development methodology that will be used for this project will be feature driven development due to it being less time consuming than the waterfall methodology as there is a strong focus on the implementation.

This section has described potential software development methodologies that could be used in this project, including the choice to focus on feature driven development. The next section will discuss the resources and planning the project will need.

6. Resources & Planning

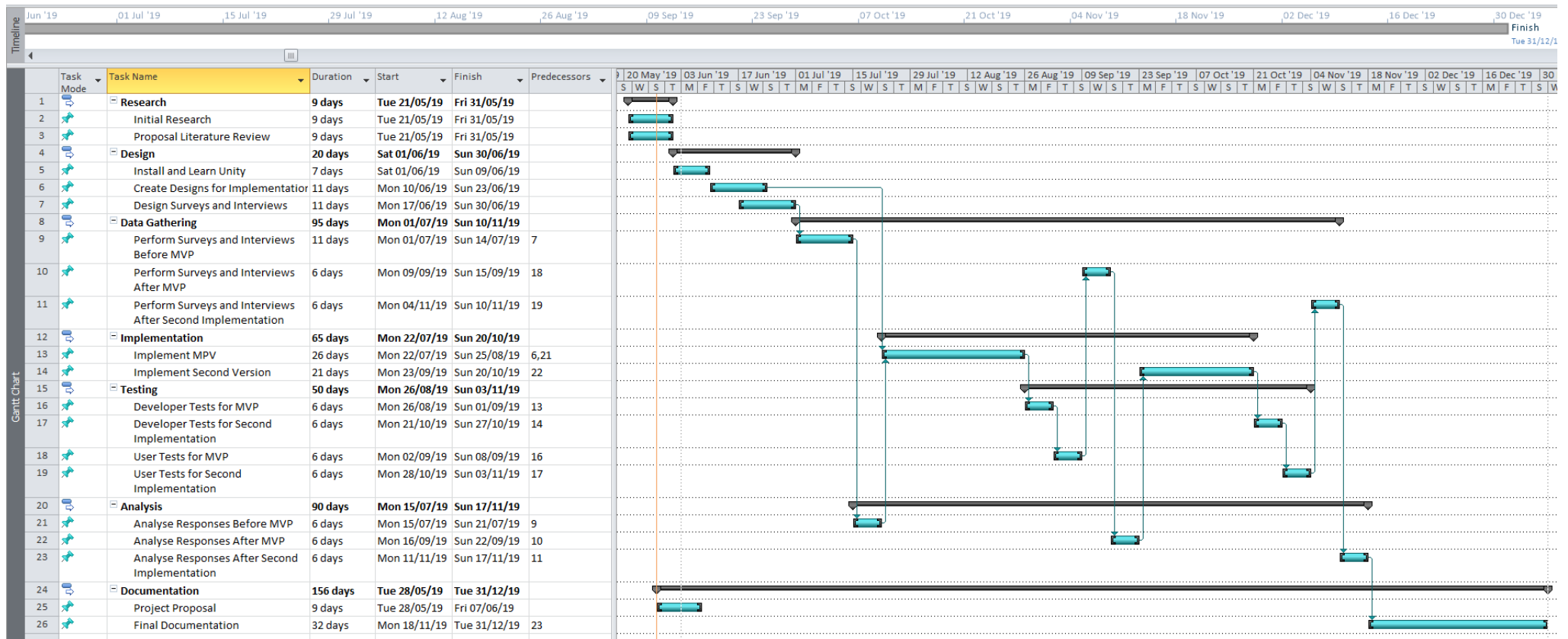
6.1. Resources Required

The project will need the following resources:

- Access to UWTSD Microsoft One Drive for backup storage.
- Personal Bitbucket account for code version control and backup.
- Unity Hub, which is a tool that manages resources related to Unity projects [29].
- Unity Editor, which is the main user interface for creating and editing Unity projects and assets [30].
- Visual Studio, which is the main user interface for creating and editing C# projects, including writing and editing code for Unity projects [31].
- University rooms to conduct interviews and experiments with general public, though the environment in which users test the program could change to expand potential results.

6.2. Gantt Chart

The below Gantt chart shows how time will be utilised throughout the duration of the project. Time has been dedicated to research, design of the program and surveys, gathering data from users and the general public, implementing the program, testing the program, analysing the responses from the surveys and interviews and finally time to write the final documentation.



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