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Enhancing Sustainable Development with the Development of a Virtual Driving License Testing System in Mabopane, South Africa

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Abstract: It was observed that obtaining drivers' license from most drivers' license testing centers in South Africa involves queueing for the whole day or two consecutive days to book for a learner's license test date as these centers receive more applications whereas the space and other resources are limited. Due to lack of using relevant technologies, the centers are decorated with long queues and applicants experience delays in scheduling of tests' dates. This is not in line with the goals of sustainable development. Applicants travel to the centers for bookings, something that can be done remotely using self-service online methods. The travel alone degrades environmental sustainable development. Money spent on the travel degrades financial sustainability. And time wasted on the queue (sometimes for days) also degrades financial sustainability. Upon such realization, the researchers were keen to find out about how the current trends especially focusing on Virtual Reality in Computer Science could be utilized to ease up the processes in acquiring the driving licenses. The purpose of this study therefore is to investigate and find out how Virtual Reality could be employed for prospective licensed drivers to be evaluated using the Virtual Reality tools, focusing on South African driver's evaluation. A driving simulator can be considered as a vehicle operated in such a way that enables the production of sensory stimuli (i.e., visual, auditory, and haptic) so as to generate a virtual environment (VE) equivalent to driving. This simulated environment therefore acts on the driver at both a cognitive as well as at perceptive level. We thus proposed a driving simulator system modeled on a computer with the aim of creating a simulation system. A survey was used in validating the system for modeling approach for a Virtual Reality driver testing system. We believe that this study can encourage the South African government to use the technologies and methods including online systems and Virtual Reality, in order to eliminate the problems and the frustrations that the majority of the public face including the cases of bribery and corruption during the process of acquiring the licenses. We believe that this study could constitute the foundation of more innovations that can benefit South Africa and the research community as well.

Keywords: Virtual Reality (VR), Virtual Environment (VE), Testing System, Testing centre.

Introduction

Development has always been having positive impact on many societies. Major efforts in recent years have been more focused on further ensuring the sustainability of such development. Brown (2017) explains that sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". But the development that came with the use of vehicles have now been attributed to vehicle accidents some of which are as a result of inadequacies in drivers' license testing. This has now got to the present point compromising the ability of future generations to meet their own needs. Technology in general has been playing major role as starting point in achieving development that meets the needs of the present. Furthering on such starting point in recent years is made possible with one of the possible tools at our disposal today involving using Information Technology and Information Systems to enhance development. Mansell and Wehn (1998, p.11) support the above assertion with the explanation that "the former United Nations Secretary General Kofi Annan emphasises the enormous potential of information and communication technologies (ICTs) for development in his remarks to the first meeting of the United Nations Working Group on Informatics".

Subsequently, Malapela, Mabunda and Dehinbo (2022) observes that Information Systems development as the engine of information and communication technologies (ICTs) has been known to be capable of leading to development which can be in simple terms be understood to refer to a state of improvement. This research focuses further on how a specific aspect of information technology namely virtual reality can help influence the drive towards the growth of information systems development in solving some problems in drivers' license testing towards sustainable development.

The context of the research problem

Research problems according to Terre-Blanche, Durrheim and Painter (2006) can generally be derived from various sources including personal experience, from a reading of the literature, or from an array of issues considered relevant and important by communities or organizations. The researcher is engaged in this study after noticing that, like in most centres in South Africa, in Ipeleng traffic department at Mabopane, Pretoria, the researcher queued the whole day for two consecutive days, to book for a learner's license test date; these centres receive more applications whereas the space and other resources are limited. Upon such realization, the researcher was keener to find out about how the current trends especially focusing on Virtual Reality, in Computer Science could be utilized to ease up the processes in acquiring the driving licenses. Due to lack of use of relevant technologies, the centres are filled with long queues and applicants experience delays in scheduling of tests' dates. Applicants travel to the centres for bookings, while such that can be done remotely using self-service online methods. There is a wide gap in the current testing strategies used at the testing centres.

Furthermore, according to gov.za (2016) the Festive Seasons period in South Africa (including Christmas, new year and easter periods) are often the leading critical periods to me monitored and policed by road traffic management and metropolitan traffic authorities. Road traffic problems and fatalities are without doubt still among the major causes of death and disabilities in South Africa. The consequences of these include the loss of family members, especially the loss of family's bread winners which could leave behind traumatized families. Up till now, the South African road accidents and/or fatalities has for some years continuously remain unacceptably high at about at least 40 road related fatalities and deaths a day, costing the country over R3 billion annually, and diverting scarce resources away from other important social and economic needs and requirements of the country (gov.za, 2016).

The analysis of fatal crashes as indicated by gov.za (2016) for the country for recent festive seasons and the crash trends in recent few months have portrayed the fact that road crashes are caused by various factors including excessive speeding, overtaking, drinking and driving, lack of pedestrian safety, fatigue and lack driver fitness etc. The Accident Report by South African national department of transport (gov.za, 2016) contains the following breakdown among many other contributory factors:

Human factor:

Caused by human errors including speeding too high or higher than road limits, pedestrian jay walking on major roads and highways, overtaking when and where unsafe to do so, driver fatigue, hit and run cases, close follow-on distances etc.

Vehicle factor:

Tire burst prior and leading to the crash, faulty brakes and low brake oils, faulty steering wheels, etc.

Road factor:

Sharp corner bend, poor visibility especially during rain, poor condition of road surface including potholes, road surface being slippery or wet etc.

Furthermore, with bribery recognized as one of the world's most maladies and destructive issues with way over amount of US$ 1 trillion annually paid in bribes, the consequences can be at terrible and catastrophic levels, affecting and reducing quality of life of citizens, increasing poverty while eroding public trust. Thus, recognizing this, the International Standards Organization (ISO) is currently assisting by developing a new standard to assist societies and organizations in fighting and reducing bribery and promote an ethical business culture (ISO, 2016). The researcher assumes this study to use the VR will reduce channels of bribery in process of being tested for driving skills.

Lots and lots of research in recent years has been done concentrating on the development of VR- research techniques even as virtual reality is only recently just taking off (Berneburg, 2008). This continues to be the situation today in 2024 and so we sought to use Virtual Reality to address the research problem. The gap is that to the best of our knowledge and available information in literature and in practice at the South African licensing stations, Virtual

Reality has never been researched and proposed to tackle the South African licensing processes. This leads us to the objective and the premises of this study.

Main objective and Premises of the Research

The main objective of this study was to investigate the strategies that can be used to employ Virtual Reality in South African driver's license testing system. The researcher therefore compiled 3D – Virtual Reality product which adhered to the rules of design. The ease of use of 3D VR computer model which was used in this study were the priority scope in the development and implementation.

The main research questions then is: How can Virtual Reality be employed for driver's license testing system in South Africa? To address this question, the researcher used a modelled driving simulator on a PC for the yard test scenario. The assumption is that it should be safer to use a simulator than driving a real vehicle for assessments.

Current system

It is no longer news that computers are now being more and more widely used today in almost all major aspects of our lives and daily activities (Muhanna, 2015). A learner's licence is required prior to obtaining driving license and the learner's permit proves that you have basic knowledge of components of a motor vehicle and know the rules of the road. The learner's licence obtainable is usually valid for six months and cannot be extended. The system which is currently being used to test people for learner's licence works fairly well:

After arriving at a testing centre, and producing identification documents and confirming the test date, participants are requested to be seated and they are taken through a tutorial, until they are ready to begin the test. Participants would then enter their ID or Passport numbers into the system and choose a language of their choice. The participant would then be scored by the system. Upon completion of the test on the same day of the test, they will know whether they have passed or failed.

Proposed system

We recall that a driving simulator can be considered akin to a vehicle operated in such a way that enables the production of sensory stimuli which could be visual, auditory, and/or haptic, so as to generate a seemingly virtual environment (VE) equivalent. This VE environment therefore is desirable as it can be acted upon by the driver on both a cognitive as well as at perceptive level (Milleville-Pennel and Charron, 2015). In this study the researcher proposed a driving simulator, which the researcher modelled on a computer. The aim was to create a simulation system. The figure 1 below shows the interface of the virtual yard test (the model used in this study).

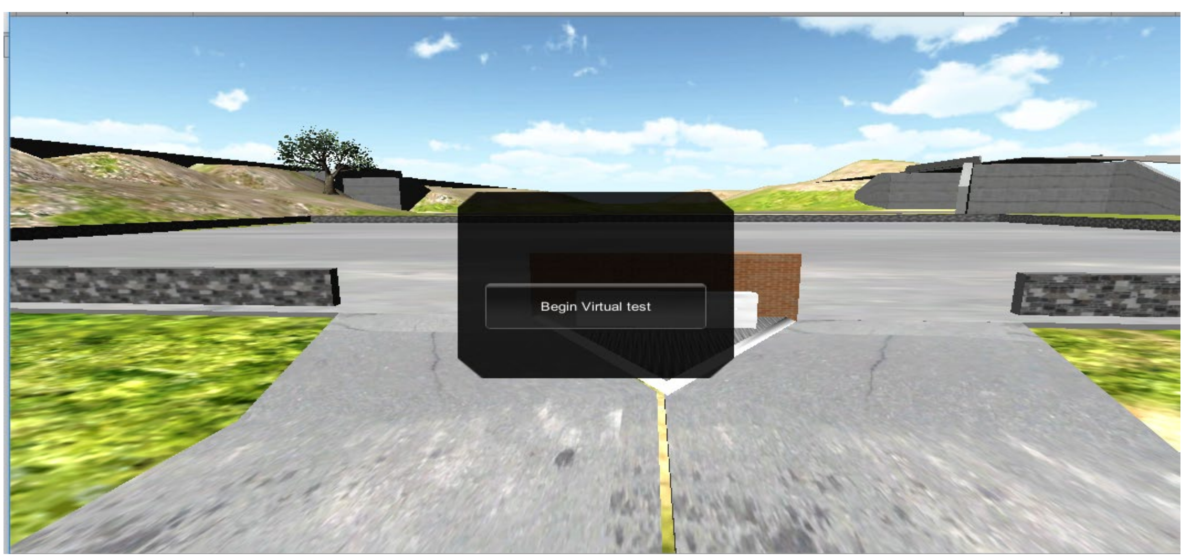

Figure 1. Interface of a driving license system

Beginning the virtual test

Merchant et al., (2012) cited in Merchant (2014) declared that “the assumption for the rapid rise in the application and use of desktop-based virtual reality technology in educational instruction is the unique enablement and affordances that it offers with limited mishaps in enhancing learners’ cognitive skills”. Virtual reality as proposed part of solution is further supported by (Milleville-Pennel & Charron, 2015), as they explain that this form of technology seems particularly well suited to people who are considered to be particularly ‘‘risky,’’ such as in mining underground situations or in those suffering from brain injury or in the vulnerable group of people such as the elderly. Thus, when assessing driving capabilities and abilities in such dynamic conditions with risks such as accidents, a driving simulator can according to Merchant (2014) be a good alternative to using a personal car where accidents can be costly. This is because such can be seen as too risky in cases of errors or potentially unfit reactive behaviour by a driver. Thus, driving school car can be often at risk and seen as more stressful for users and more expensive to maintain.

Literature Review

Terre-Blanche, Durrheim and Painter (2006) explains that “a literature or information review puts your research project into context by showing how it fits into a particular field”. We reviewed some previously published literature from books and academic journal related to Virtual Reality.

Virtual Reality (VR) is “an imitation of the real space and human activities in it, using computer equipment. It consists of a computer model of a 3D environment and the participant of virtual reality in this environment seems actually moving. It aims as much as possible to bring computing environment to simulate reality while avoiding the pitfalls and mishaps of reality (ie circumstances in real life e.g. accidents in enclosures such as gold mines) that is difficult for humans to physically monitor (Tůma et al., 2014)”. Tůma et al. (2014) goes on to state that companies can solve production systems problems using a variety of software solutions, and one possibility involves the use of augmented virtual reality, virtual reality and/or virtual environment.

Next, we look into the previous studies on desired Features of virtual reality systems.

Features of virtual reality systems

According to (vrs.org.uk, 2016) “there are many different types of virtual reality systems but they all share the same characteristics such as the ability to allow the person to view three-dimensional images. These images appear life-sized to the person”. In addition, vrs.org.uk (2016) indicates that “the images change as the person moves around their environment which corresponds with the change in their field of vision”. Thus, the aim is for a free-flowing natural form of interaction between the potential driver and the car as well as the environment which will result in a memorable experience.

Behavioral validity

Milleville-Pennel and Charron (2015) explains that “behavioral validity refers to the extent to which a driver behaves the same in both a simulator and in a real car. Behavioral validity is made up of two components: absolute validity and relative validity. Absolute validity is the extent to which the numerical values obtained under simulation and in reality are identical for specific variables”. For example, Milleville-Pennel and Charron (2015) showed that “simulated driving tests correlate with on-road tests with regard to both driving errors and hazard anticipation” (Milleville-Pennel and Charron, 2015). Milleville-Pennel and Charron (2015) further indicates that “more and more resources in the form of time and money are being devoted to the designing and developing desktop-based virtual reality instruction for teaching K-12 and higher education curriculum. Deploying desktop-based virtual reality instruction in schools and colleges not only involves financial cost but also the efforts to train the teachers to use them effectively”. Therefore, it is critical and important that instructional designers and system developers in the design and development of instructional materials make careful decisions in utilizing desktop-based virtual reality (VR) technologies (Merchant, 2014). However, Pantelidis (2010) observed that “the disadvantages of using virtual reality are primarily related to cost, time necessary for learning how to use hardware and software, possible health and safety effects, and dealing with possible reluctance to use and integrate new technology into a course or curriculum. As with all new technology, each of these issues may fade as time goes by and virtual reality becomes more commonly used”.

What has been done

Muhanna (2015) observes that “many attempts have been done to survey the current literature of virtual reality systems. Each of these reviews discusses and outlines the status of virtual reality from a specific perspective”. According to Muhanna (2015) the main objective was “to provide a comprehensive review of the current status of virtual reality systems and the CAVE, in particular”. The word “CAVE” according to Muhanna (2015) has been defined as “an acronym meaning or standing for (Cave Automatic Virtual Environment) which is a virtual reality (VR) environment consisting of a cube-shaped VR room or a room-scale area in which the walls, floors and ceilings are projection screens”. Muhanna (2015) proposed “a taxonomy of virtual reality systems with examples to give a visual insight of current trends of virtual reality systems”:

Muhanna (2015) based their classification on two factors. The first factor was the type of technology used in building the system. In particular, the need for having special devices for input and output hardware (such as the one shown on the figure below) in order to experience the virtual reality system. Muhanna (2015) highlights that systems that do not use such facilities are said to be ‘basic’ virtual reality systems. ‘Enhanced’ virtual reality systems, on the other hand according to Muhanna (2015), require special hardware facilities and devices as part of their systems.

The second factor highlighted by (Muhanna, 2015), is that basing their classification on the level of mental immersion. And according to (Muhanna, 2015), “a virtual reality system does not have to be fully immersive. Rather, Virtual Reality systems vary on the level of immersion introduced to the participant and are still considered to provide a virtual reality experience”.

Muhanna (2015) is “constructed around four main aspects: (i) virtual reality and elements of a virtual reality system, (ii) a taxonomy of virtual reality systems, (iii) the CAVE, and (iv) interaction styles used, challenges faced, and research directions in building software applications for virtual reality systems and the CAVE” (Muhanna, 2015). Heim (2007) cited in (Muhanna, 2015) further highlights that basic virtual reality systems do not need special input or output devices to display a virtual reality environment.

Based on the mental immersion factor, Muhanna (2015) explains that “enhanced virtual reality systems can be partially or fully immersive. Partially immersive virtual reality systems use a single projector to display a virtual world on a large screen. Muhanna (2015) stresses that when a participant moves inside the CAVE, rotates his or her head, pushes a button on the wand, or maybe speaks, the computer system that controls these devices will receive the input signals and provide feedback accordingly. And when it comes to costs, VR systems are highly charged. Muhanna (2015) highlights this fact by stating that although the financial requirements to build and install a CAVE are much higher than that of a desktop computer, simulators and emulators can be enhanced to imitate the real CAVE in desktop applications”.

Pantelidis (2010) highlights that “educators and trainers make use of many instructional aids in teaching courses, such as textbooks, videotapes, films, computer software, and, increasingly, the Internet and the World Wide Web with podcasts, blogs, and virtual environments. The educator or trainer must decide when and where to use VR. A model for determining when to use VR in any one course can help in making these decisions. Deciding when to use VR leads to decisions on where to use VR”. As a result, (Pantelidis, 2010) proposed such a model.

Immersion: According to Milleville-Pennel and Charron (2015), “all the measures used to assess simulator validity indicate that this technology can be a useful tool for the initial resumption of driving. Presence has been defined by Slater (2009) as a subjective phenomenon that is linked to the user’s feeling of being there in the virtual environment (VE)”. In this regard, (Muhanna, 2015) suggests that “in terms of psychology, immersion refers to being completely involved in something while in action. In other words, it is a state in which a participant becomes attracted and involved in a virtual space of an activity to an extension that his or her mind is separated from the physical space he or she is being active in. We can experience immersion in several types of daily activities. Many novels, for example, take the readers to a new non-existent world where they feel themselves part of it, empathize with its characters, and forget their real world and surroundings”.

Muhanna (2015) continues to highlight that “mental immersion, on the other hand, has different levels of immersion in a virtual reality experience. Such an experience can have a partial mental immersing or a complete one, although it is worthwhile noting that reaching a completely mental immersion in a virtual reality experience is still an active challenge for research”. When considering the implication of cognitive functions, one indicator should come to mind: mental workload. Mental workload can be seen as the difference between the capacities of the information processing system that are required to perform a task and satisfy performance expectations, and the capacity available at any given time (Gopher & Donchin, 1986) cited in (Milleville-Pennel and Charron, 2015). Muhanna (2015) believes that mental immersion exists in those systems (low level systems such as desktop VR system) but "with a lower level than enhanced systems. Muhanna (2015) also believes that a system that does not provide any level of mental immersion should not be considered a virtual reality system in the first place". Figure 2 below presents typical scenarios in which virtual reality is commonly relevant.

Figure 2. Possible VR scenario adapted from (Anon, 2016)

Challenges

Muhanna (2015) observes that "many challenges can be encountered when developing applications for CAVE-based virtual reality applications, which need to be more investigated and studied by interested researchers. Simulations are typically expensive to build and tend to be application-specific with a commensurate low level of reusability" (Chaturvedi, 2011). According to Lacrama (2007) "the Virtual Reality is a recent research domain, but the progresses made in the last few years by companies developing VR systems prove that in the next future this technology will be high-quality and cheap enough to become common good. VR's applications seem to grow in number and diversity covering very different domains from research to entertainment. Thus, the interest in its development is quite high. Giving participants the highest possible degrees of freedom in a CAVE has a great impact on the interactivity element. If the head rotation is constrained, for example, the participant would not be completely satisfied, nor immersed, in his or her virtual reality experience" (Muhanna, 2015).

Research Strategy and Approach

A careful analysis of the problem to be solved will often give an indication of the applicable methods (Olivier 2009, p.7). Techniques and methods are sometimes distinguished. Techniques tend to involve the application of scientific, mathematical or logical principles to solve a particular kind of problem. Methods often involve the creation of models. A model is a representation of a system which abstracts certain features but ignores others (Hughes and Cotterell, 2009). Models are often used to propose a new idea. Using a model for this is simpler for the researcher, than constructing the complete modeled system or implementing the complete modeled process. A model of something is constructed because it is easier to comprehend or manipulate than the real thing. The model therefore contains all aspects of 'something' that are relevant to your problem, but excludes other aspects (Olivier 2009, p.8). The development of the prototype system is detailed below in this section.

Prototyping: Functional Requirements

Prototyping is a software development methodology aimed at developing a small working model of a system that can be presented to the user for evaluations, giving the user an overview of the final deliverable. There are several variants of software prototypes; however, all of them are based on two main types of prototyping, namely: throwaway prototype and evolutionary prototype. Throwaway prototype is based on the principle called "do-it-twice" since the first model is only used to gather all the preliminary requirements required to accomplish the final system. After the developers get feedback from the users and the new requirements have been clearly stated, the developers devise a new system (Chaudhary, 2018).

Evolutionary prototyping is based on the development of a robust prototype in a structured manner that keeps on evolving up until all the software specifications are met. This type of a prototype is used as the heart of a new system and all the improvements and additional requirements are going to be built as the additional objects or components (Chaudhary, 2018). The prototype methodology can be used to develop a system which seeks to gather more information or requirements from the users (Sommerville, 2010). The selected prototyping method adopted in this study is throwaway prototype since we are currently seeking a demonstration tool as a proof of concept. In future studies where we would seek to use the prototype to study behaviours based on the system such as sustainable development enhanced by the use of the system, then we would be adapting the method as evolutionary prototyping.

Quantitative research approach in the form of prototyping is used because a prototype is developed to investigate further. A computer model of 3D virtual testing system was developed as a model or prototype of what could be.

System Results

The system output results begin with the system user interface which is the visual part of application or system through which a user interacts with the system.

The Yard Test for and Trucks

The purpose of the yard test is to check how well you handle your vehicle in the time allowed. Some testing centres allow learner drivers to practice the maneuvers after working hours in the yard where the official test is conducted. Ask your driving instructor to arrange for you to use the yard if this is permitted in your area. This will give you the opportunity to become familiar with the test area. Driving schools also sometimes have their own lots or organized ones to use - make sure to check this before beginning your driving lessons with a particular driving school or instructor. Even though you will not be out on the open road during the Yard Test, you still need to follow the K53 method of driving (Melo, 2016).

What the Test Covers

During this part of the driving test, which is done in an area that is closed to normal traffic, stopping will be permitted at any stage during certain maneuvers. Should the test be terminated at any stage, the full test must be repeated. Touching any obstacle or mounting a kerb is not allowed. The examiner will give you the instructions for each maneuver. The test includes the following:

Heavy Motor Vehicles or Trailer

Thirty 30 minutes for the pre-trip inspection and test; Signaling and observing, as if on a public road, is required; Wearing seat belts is not necessary; All traffic signs, signals and markings must be obeyed; No uncontrolled or dangerous actions may be made; The principles of defensive driving must be applied; The push-pull steering method is not required; Alley docking is to the right (2 attempts); A left turn (1 attempt); Parallel parking without a trailer from the left and the right (2 attempts each) code EB only; Revering in a straight line (1 attempt); An incline start (1 attemp.

Immediate Failures

All of the following are immediate fails; Exceeding the time limit allowed for the yard test; Not being able to perform a hand signal;

- Exceeding the maximum number of attempts allowed to perform a driving manoeuvre correctly Allowing your vehicle to roll (backwards OR forwards)
- If your vehicle fails during the test
- Using a vehicle that is unroadworthy
- Using a vehicle that does not have a licence
- Violating any rules of the road, road signs, or road markings
- Performing a dangerous action
- Having an avoidable collision
- Mounting the kerb, bumping any obstacles, or touching boundary lines
- Accumulating more than 50 penalty points during the yard test

Road Layout

In order to learn and practise the various manoeuvres the practice area must provide for the following:

Heavy Motor Vehicles or Trailer

- For Alley Docking (from left only) – A level road with a curve into an alley.
- For a left turn – A level road with a curve.
- For reversing in a straight line – An area 40m long and 4m wide.
- For the incline start – A gradient of at least 1 in 15 but not steeper than 1 in 10, with a Stop sign and a Stop line on the gradient.

Example: A truck reversing in a straight line

The Maneuvers

Positioning for a Manoeuvre

- In the yard test you must position the vehicle in preparation for each manoeuvre.
- Stop where instructed.
- Cancel the signal if applicable.
- Apply the handbrake.
- Select neutral or park

Leaving an Area after a Maneuver

- When you have completed a manoeuvre, you must drive out of the demarcated area without touching any obstacles, and follow the examiner's instructions.
- Check the mirrors.
- Check the blind spot.
- Signal your intention.
- Select the correct gear.
- Obtain clutch control (manual vehicles).
- Observe 360 degrees (Rear-view mirrors and blind spot if applicable).
- Release the handbrake.
- Steer out of the area.
- Cancel the signal.

Starting Procedure

You will be asked to start the vehicle to begin the yard test.

- Ensure the parking brake is applied.
- Ensure you are in Neutral or Park.
- Ensure the gauges and warning lights (instruments) are in non-function position.
- Turn the ignition key to "on" without starting the engine.
- Check the instruments for any malfunction.
- Apply the choke if necessary or ensure choke is cancelled.
- Start the engine and release the key.
- Check the instruments for any malfunction.
- Build up air pressure (HMV only).
- Cancel the choke where applicable.

Moving Off

When moving off, you must be able to do so smoothly and without rolling (which could pose a danger to other road users). Whenever you finish a manoeuvre, you should follow this moving off procedure.

- Observe 360 degrees (Rear-view mirrors and blind spot if applicable).
- Signal intention, if applicable.
- Ensure that there Is a clear space beyond the intersection before entering.
- Ensure the intersection is clear before entering.

- Maintain a clear space behind the vehicle ahead before moving off (approximately 4 – 5m).
- Select the gear.
- Obtain clutch control (manual).
- Observe 360 degrees (Rear-view mirrors and blind spot if applicable).
- Release the handbrake if applicable.
- Move off (make sure not to spin the wheels).
- Accelerate as necessary.
- Cancel the signal, if applicable

Incline Start

You must start your vehicle on an incline and move off smoothly without rolling backwards, stalling, jerking or spinning the wheels. You only get 1 attempt.

- Stop where the instructor indicates without allowing the vehicle to move backwards.
- Apply the handbrake.
- Select the neutral (manual).
- Check the mirrors and the blind spot.
- Signal intention, if applicable.
- Select gear.
- Obtain clutch control (manual).
- Observe 360 degrees (Rear-view mirrors and blind spot if applicable)..
- Release the handbrake.
- Move off without rolling back.
- Cancel the signal.
- With an incline start, you will likely need to accelerate as well as obtaining clutch control in order to achieve enough revs to stop the car from stalling or rolling backwards.

Alley Docking

LMV from the left and right; HMV from the right only)

Alley docking is reversing into a demarcated parking bay and then driving out again. You have 2 attempts, and you must not hit any obstacles including the kerb. Only combination vehicles (like a truck pulling a trailer) are allowed any forward movements (one). Touching a line with a wheel will result in the end of the test. You will need to perform alley docking to the left and to the right.

- Check the mirrors and the blind spot.
- Signal intention.
- Select gear.
- Obtain clutch control (manual).
- Observe 360 degrees (Rear-view mirrors and blind spot if applicable) 6.
- Release the handbrake.
- Move off.
- Check the blind spot (right blind spot if alley docking to the left; left blind spot if alley docking to the right).
- Steer into the area without touching any obstacles.
- Stop within the demarcated area.
- Apply the handbrake.
- Select neutral or park.
- Cancel the signal carefully drive out without hitting any obstacles using the Moving Off procedure. Make sure you steer properly out of the demarcated area.

Three-Point Turn in the Road (LMV only)

You must complete the three-point turn in three movements only, without bumping any kerbs, and your vehicles should end up facing in the opposite direction, on the opposite side of the road. You have 1 attempt.

- Check rear-view mirrors and the blind spots.
- Signal intention (right turn).
- Select the correct gear.
- Obtain clutch control (manual).

- Observe 360 degrees (Rear-view mirrors and blind spot if applicable).
- Release the handbrake.
- Move off driving forwards and turn the steering wheel as far right as possible.
- Counter-steer in the other direction as you stop.
- Stop.
- Apply the handbrake.
- Check the rear-view mirrors and the blind spot to the left.
- Signal intention.
- Select reverse gear.
- Obtain clutch control (manual).
- Observe 360 degrees (Rear-view mirrors and blind spot if applicable).
- Release handbrake.
- Move off in a backward direction and turn the steering wheel to the left.
- Counter steer to straighten out the wheels.
- Stop.
- Apply handbrake.
- Check the rear-view mirrors and the blind spot to the left.
- Signal intension.
- Select gear.
- Obtain clutch control (manual).Observe 360 degrees (Rear-view mirrors and blind spot if applicable).
- Release handbrake.
- Move off driving forwards, and keep left.
- Cancel signal.

Left turn (HMV and code EB)
For the left turn, you will need to steer your vehicle around a left curve without stopping or touching any obstacles, including mounting the kerb. Code C1 licences may not touch the centre line. You only get 1 attempt, and stopping and starting again counts as a second attempt.

- Check the mirrors and the left blind spot.
- Signal intention.
- Check blind spot to the left.
- Steer to and position the vehicle in the appropriate lane.
- Check the rear-view mirrors.
- Decelerate.
- Select the correct gear.
- Check blind spot to the left.
- Steer into the appropriate lane.
- Check the left mirror while turning to ensure safe follow-through of the vehicle around the bend.
- Accelerate smoothly.
- Cancel the signal.
- Check the mirrors again.

Figure 3. Developed Virtual model

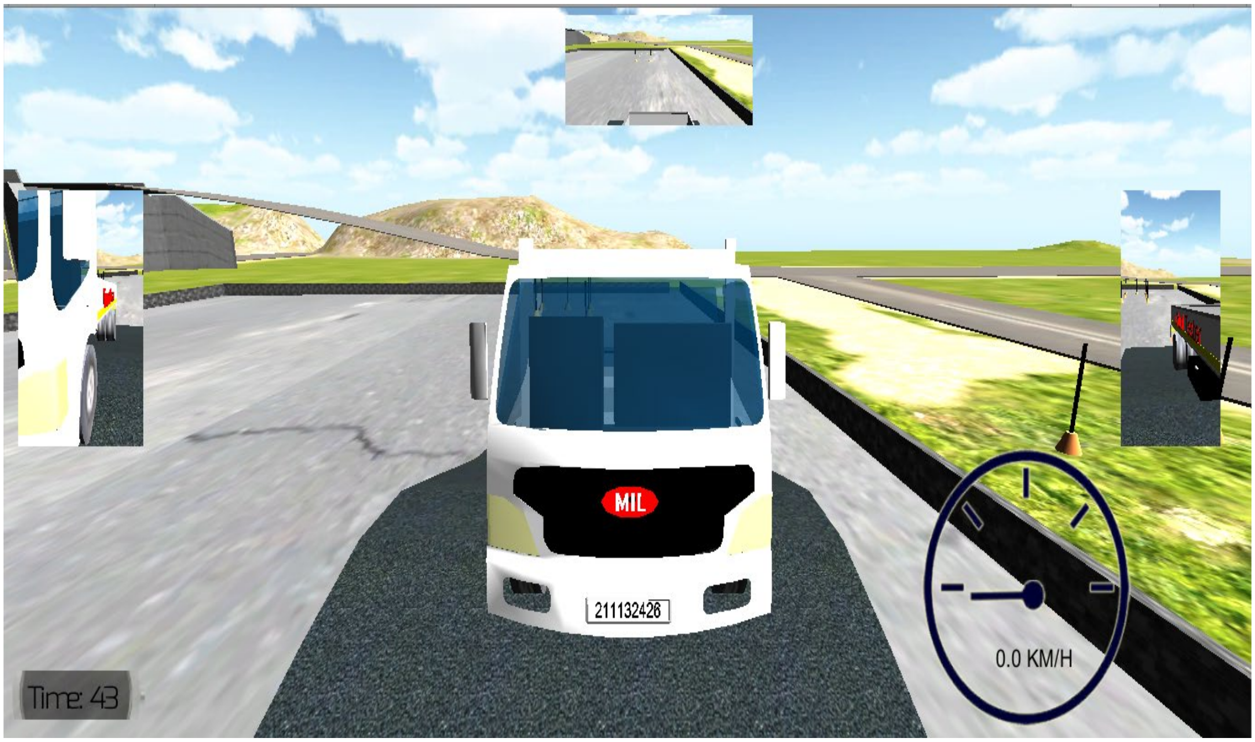

*Figure **4**. Developed Virtual model continued.*

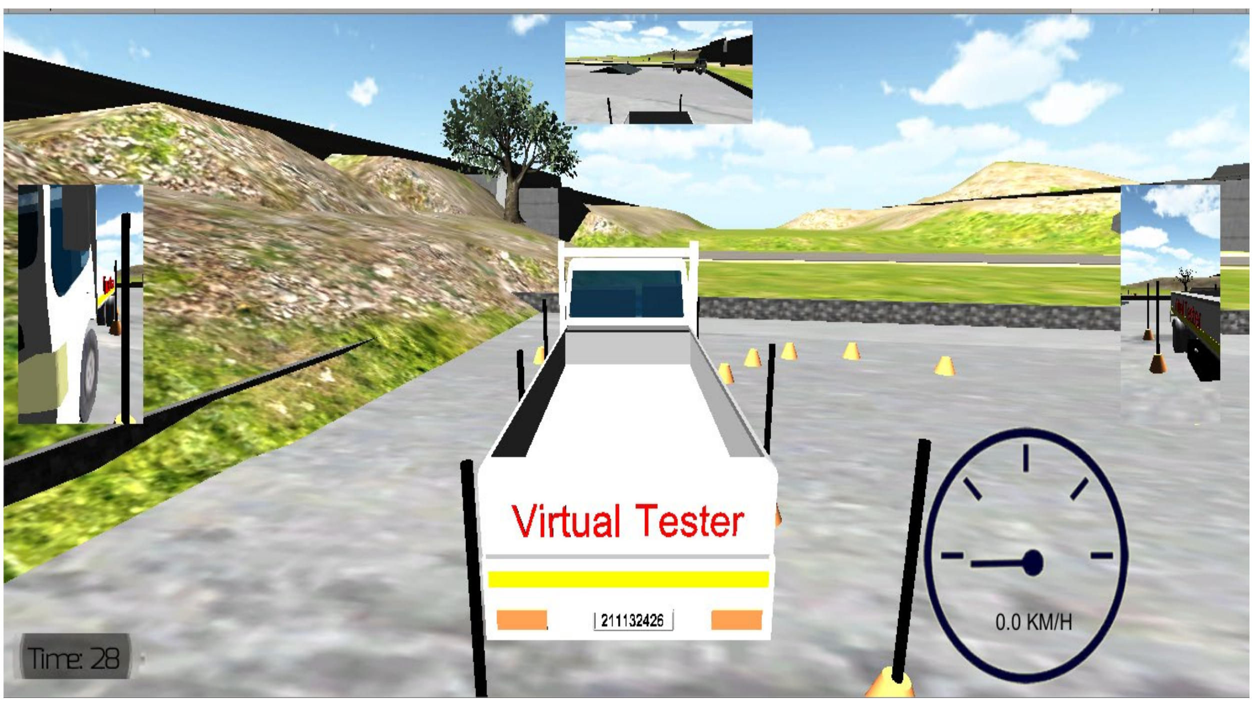

Figure 5. Virtual model showing a truck reversing in a straight line.

Figure 5 shows a truck reversing in a straight line is modelled in figure above. This is in addition to other situations in other figures.

Conclusions

Evidence-based virtual reality (VR) training programmes have been used successfully in training novice surgeons in other fields of surgery. Some smaller ophthalmology studies have established construct validity for a limited number of tasks on the VR simulator, mostly comparing novices with experienced surgeons (Spiteri, 2013).

But the development that came with the use of vehicles have now been attributed to vehicle accidents some of which are as a result of inadequacies in drivers' license testing. This has now got to the present point compromising the ability of future generations to meet their own needs. Technology in general has been playing major role as starting point in achieving development that meets the needs of the present.

Further, obtaining drivers' license from most drivers' license testing centres in South Africa involves queueing for the whole day or two consecutive days to book for a learner's license test date as these centres receive more applications whereas the space and other resources are limited. Due to lack of using relevant technologies, the centres are decorated with long queues and applicants experience delays in scheduling of tests' dates. Applicants travel to the centres for bookings, while such that can be done remotely using self-service online methods. There is a wide gap in the current testing strategies used at the testing centres. This is not in line with the goals of sustainable development. Applicants travel to the centres for bookings, something that can be done remotely using self-service online methods. The travel alone degrades environmental sustainable development. Money spent on the travel degrades financial sustainability. And time wasted on the queue (sometimes for days) also degrades financial sustainability.

In this study, the researcher presented a study on virtual reality systems. The researcher proposes the following framework, for the implementation of virtual reality in the South African process for driver testing. The purpose of this study therefore is to investigate and find out how Virtual Reality could be employed for prospective licensed drivers to be evaluated using the Virtual Reality tools, focusing on South African driver's evaluation. A driving simulator can be considered as a vehicle operated in such a way that enables the production of sensory stimuli (i.e., visual, auditory, and haptic) so as to generate a virtual environment (VE) equivalent to driving. This simulated environment therefore acts on the driver at both a cognitive as well as at perceptive level. We thus proposed a driving simulator system modelled on a computer with the aim of creating a simulation system. A survey was used in validating the system for modelling approach for a Virtual Reality driver testing system. We believe that this study can encourage the South African government to use the technologies and methods including online systems and Virtual Reality, in order to eliminate the problems and the frustrations that the majority of the public face including the cases of bribery and corruption during the process of acquiring the licenses. We believe that this study could constitute the foundation of more innovations that can benefit South Africa and the research community as well. This would be in a form that avoids the travels degrading environmentally sustainable development and also avoids the travel costs and time wasted on the queues degrading financial sustainability. The enhanced sustainable development would thus enhance the ability of future generations to meet their own needs.

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