Hochschule Karlsruhe Technik und Wirtschaft
Fakultät für Informatik und Wirtschaftsinformatik

von

Betreuer:

Mai 2019

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Alina Jaud Karlsruhe, May 29, 2019

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1 Introduction and goals

show uni dropout rates and reasons from German statistics; point out missing knowledge about job rules; describe how it should be that less people quit uni

At one point of every students life, they have to make a decision about the specialization of their education. This decision is mostly due when applying for a course at a higher educational institute. For students, this decision can be challenging, because it has a great impact for their future but often less information is provided by the schools or universities. This results in high drop out rates, as seen in [H$^+$17], a study about dropout rates in Germany and their reasons:
In total, about one third (32%) left German universities without a degree in 2016. Most of the students quit their course because of too high requirements and difficulties in the exams (30%). The second important reasons were a lack of motivation (17%) and the missing of practical work and exercises (15%). The study also pointed out that within the group of university dropouts about 56% did not study their originally desired subject, whereas 76% of the successfully graduated students got a degree in their desired course. On of the results of the study was that courses with an admission restriction had less dropouts than courses without. Regarding to the researches, this is because prospective students occupy more intense with their subject when they have to pass several obstacles like writing a motivation letter for applying.
Looking at the second and third most important reasons for a university dropout together, it is with over one third a very large group, but could be avoidable. With missing imagination and information about the profession the students are later able to work in, the endurance might not be very high. As a conclusion, motivation lacks occur and it is harder for the students to get through more theoretical parts of their studies. As well, it is also shown in the study that occupying with the subject before applying for a course results in less amounts of university dropouts.
The question is now: How to provide prospective students suitable information for the profession of their desired course? And more important: How is it possible to engage students in getting to know their future job roles?

One possible answer to that questions could be an internship as a entry requirement for a course. There are schools and universities which already taken this idea and put an internship on their requirement list (TODO sources). However, for prospective students, this means a high effort and a significant amount of time they have to spend on finding an internship and carrying it out. There should be a solution which is less time consuming and yet provides prospective students a real experience of their future job roles.
Another idea is to use the concepts and technologies of virtual reality (VR). Virtual reality describes a computer generated 3D environment which can be experienced by the users. Mostly the user is wearing a special goggle through which they are fully shielded off from the real surroundings. It is possible to get an immerse and real experience of the virtual environment, and users feel as they are actually present in the virtual world. [Lin15]
The advantages of using VR to give information about future job roles are the less costs, less time consuming and yet a nearly real experience for users. This thesis will examine the idea of a VR job role simulation for prospective students. The aim of this thesis is not only to give a theoretical research but also to develop a prototype of a VR application for prospective students. The work will be limited to the information technology courses offered at Nanyang Polytechnic, a polytechnic located in Singapore. At first there will be a research in basic VR technologie and

current developements. Following, a storyline for the application will be designed, suitable hardware and software will be evaluated. The next step will be to implement the application on an agile approach. After that the application will be tested by some test persons to get feedback. In conclusion, the whole project will be evaluated under the aspect of fulfilling the purpose of helping prospective students.

1.1 What is virtual reality?

Definition; use; popularity; difference from AR

According to [Fuc11] virtual reality is a simulated virtual world, made with hardware and software. It provides a real time user interaction and the users feel the maximum amount of immersion when experiencing the computer generated world. The virtual world is mostly provided by a head mounted display (HMD) as seen in figure 1.1. This device splits the main scene into two different camera perspectives for each eye of the user. The two perspectives will then be merged into on three dimensional picture by the users brain.
The computation of the virtual world can be either done on a standalone desktop PC, on which

Figure 1.1: Head mounted display - by Maurizio Pesce - https://www.flickr.com/photos/pestoverde/17136177965, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=39894108

the HMD is connected with, or directly in the HMD, for example through a mobile phone which is inside some special HMDs.
Despite from augmented reality (AR), virtual reallity provides a fully self-contained environment and does not interact with elements of the real world. Argumented reality on the other hand embeds virtual content into the real environments. Thereby the borders between reality and simulation become blurry. AR is a closely related technology to VR, but this thesis will focus on a virtual reality application only.
The usages of virtual reality are very widespread. [Lin15] describes a variety of different areas in which virtual reality can be used: Especially the gaming industry stands out for one of the first industries to develop VR applications and hardware devices. This is because most of the modern computer games take place in a computer generated, first person, 3d environment. It is thereby obvious to develop the games further into virtual reality applications. Lately, non-gaming VR applications are becoming more and more important. Design and architecture is

a branch, where virtual reality is used to visualise prototypes in a new way to customers. In education, VR applications are used to train learners in a nearly real environment but without the cost and danger of a real life exercise. Military training or disaster management for example are a good showcase for the usage of virtual reality in education. Another area, in which virtual reality is used, is tourism. It is possible to visit a museum without actually travelling to the place, through a virtual reality application. VR can give more immerse insights of a travelling destination and yet can be an instrument of marketing for the tourist destinations.

1.2 NYP information technology courses

This thesis will investigate the usage of virtual reality in the area of student acquisition. The aim is to help students with their decision for their diploma courses, but it is also important to make the VR experience enjoyable for prospective students.
The prototype application will be focused on the information technology diploma courses offered at the Nanyang Polytechnic. In the following, the environment of the school and the courses will be described.

Nanyang Polytechnic (NYP) is a polytechnic located in Ang Mo Kio, Singapore. The school offers post-secondary education for students who successfully passed the GCE O-Level examination. The O-Level examination is an annually examination mainly for students who have visited a secondary school. [Sin18]
It allows the students to take courses either on a junior college, a technical institute or a polytechnic. In Singapore, a polytechnic offers students a more practical and industry based education than a junior college which has a more fundamental approach. In general, students study 3 years at a polytechnic until they get their diploma. After getting a diploma, students can continue their education at a university but they can also start to work in the industry. [Min18]
NYP offers a wide range of courses in different fields. One of the fields is information technology (IT). In the following the courses will be introduced briefly: [Nan18]

Information Technology This course offers students a broad range of the different fields in information technology. It focuses on an interdisciplinary education. By finishing the course, students are prepared to work in different areas, most commonly in software engineering. During the first year, the fundamental topics of information technology are educated. The second year deepens the knowledge in application programming, database management, software engineering, algorithms and several other topics. The third year will be for specialization. The students can choose elective courses in the fields of artificial intelligence, enterprise cloud computing, geospatial and mobile innovation and cybersecurity. As in all courses offered at the school of information technology, there is one practical industry project and an internship in the third year as well.

Infocomm and Security This course covers topics in IT infrastructure, network engineering and security and the internet of things (IoT). Students learn how to program, but also how to

secure applications in a connected environment. They also learn about managing connected infrastructures. During the first year there are basic classes in developing and infocomm to get a grounded knowledge in information technology. The second year will deepen the knowledge of network engineering, programming, and IT service management. There will be a practical IoT project for the students as well. In the third year there will be several elective courses in the areas of system and network security, enterprise infrastructure and infocomm solutions.

Cybersecurity and Digital Forensics The cybersecurity and digital forensic course focuses on IT security. This includes securing systems and data for unauthorized access as well as tracing criminals in case a security incident happened. After graduating, students can work as security analysts, network penetration tester, security engineer and similar jobs. During the first year students learn fundamental IT skills. The second year offers classes in forensics, network security, operating systems, security standards and more. Students will also complete an applications security and an infosecurity project. The last year offers specialization in the topics cybersecurity track and cyber forensics track. It is possible to choose crossdisciplinary classes from other IT courses.

Business Intelligence and Analytics The business intelligence and analytics course teaches analytics and interpretation of massive amounts of data. Therefore big data technologies, as well as artificial intelligence is needed. After graduating, it is possible to work as a data or business analyst, a social media strategist or a digital marketing executive. During the first year student will gain basic IT and business statistic knowledge. The second year offers classes in big data management, digital marketing, predictive modelling and similar topics. Students participate on a big data and a business analytics project. During the third year, students will do a data science project and can choose between several elective classes.

Business and Financial Technology This course focuses on information technology in the financial and business sector. After getting a diploma, students can work as IT or financial consultants, financial application specialists or business and financial analysts. From the beginning the focus lies on connecting business and financial topics with information technology. Therefore, in the first year students learn about economics, accounting and consumer banking as well as about basic programming skills. During the second year this knowledge is deepened through classes like software engineering or financial management. Besides the elective classes, the industry project and internship, students in the third year also collaborate in a fintech innovation project.

1.3 Advantages of VR for prospective students

Explain why VR and future professions work well together, point out immersion of VR, name examples of similar VR projects

The last chapter summed up the information about the information technology diploma courses in textual representation. Therefore the question occurs, why it is necessary to develop a VR application if the required information can be distributed to prospective students through other

media as well. Or to put it in other words: Can prospective students profit from experiencing their future profession through a virtual reality application?
The thesis will take a close look at two different groups: Prospective students, using virtual reality to inform themselves about their future job roles and prospective students, using traditional media (e.g. flyers, websites) as resource. The predicted outcome of this research is that there will be a difference between those groups. Students using the virtual reality application will have a clearer understanding of their profession and will be able to remember the provided information easier. They will get a more comprehensive idea of the different job roles in IT than the group with the traditional media for informing.

Despite the area of information keeping, virtual reality is a currently researched topic of information technology. Students are able to use technologies, which they later get into closer touch with. The idea is to arouse interest in the technology behind virtual reality and to make the students want to develop their own application. Prospective students can profit as well from the cheaper and less time consuming approach in getting to know a future job role, compared to an internship.

2 State of the art

In the introduction chapters, a overview and definition of VR was given. The reader was able to get a small insight in the world of virtual reality. The following chapter will deepen the knowledge in VR and related technologies. Some basic concept about virtual reality will be explained. Later on there will be a summary of the latest state of research. Current VR related hardware devices as well as software applications will be presented. It will also be pointed out, of what VR is not capable yet. The aim of this chapter is to get an overview about the topic of VR and the state of research as it is for now.

2.1 VR basic concepts

covering some history in this chapter too? E.g. explaining the first wave of VR in the 90s

[SC19] describe five core concepts for virtual reality. According to them, this concepts are the key elements when it comes to design a virtual reality. In the following, this concepts will be explained:

Participants A participant is a user of a VR application, who is actually wearing the HMD and experiencing the virtual world. Every participant has a different perception of the application, so every experience can be seen as a unique experience. This is because the several participants differ from their cultural background, their age, their expectations and their knowledge in technology. Therefore, it is a challenge for developers of VR applications to provide a virtual world in which various users can feel comfortable. The role of the participants is described as the most important role by [SC19], because all the experience is happening in their imagination. Developers or creators are only capable of creating the framework around the experience.

Creators Creators or developers design and implement a VR application for participants. As mentioned, the developers are not able to create the experience of the users. The core aim of their work is to develop the application, which is a collection of programming scripts, concept designs and data. Together with the participants the experience is created. The following chapters design and implementation (TODO ref) will take a look at the VR application from a creator's perspective, whilst chapter (TODO ref) will dive into the different experiences of participants using the VR application.

Virtual world In general, the term "virtual world" is defined as the content of a virtual reality application. The virtual world is the skeleton of the virtual experience. Precisely, it is a description of the objects inside the virtual space. TODO schwammig

Immersion Immersion in general describes, how deeply users connect to a virutal world. They experience something through a medium which they would not be able to experience without it. They see actions and things through a different point of view and can connect to it

in some way. The deeper a user can connect to the virtual environment and the objects inside it, the more immerse the VR experience is for them. In chapter **??** the term immersion will be explained in more detail.

Interaction Most of the time, interaction means a manipulation of a computer generated world. However, interaction can also happen in a non artificial environment. An example for this are interactive novels, or text based computer games. In this mediums/media?, computer graphics are not required and yet they provide a form of user interaction. When it comes to VR, interaction also means relocating a viewport inside a virutal world. Participants can move physically in the virtual environment. Another form of interaction is the collaborative interaction. In some VR applications it is not only possible to interact with the virtual world but also to share the space with other participants and interact with them. This can be in a virtual or physical way.

2.1.1 Different dimensions of reality

describe different states: reality, augmented reality, augmented virtuality, vr

Despites VR, there exist other technologies, which serve the purpose to create a virtual world for the user. They differ in the extend of intervention with the reality. [Tha18] show a spectrum of different types of technologies and their dimension of reality. A visual representation of this spectrum is displayed in 2.1.

Figure 2.1: Graphical representation of the dimensions of reality by [Lov18]

The reality describes the real world and using non digital devices to interact with it, such as a steering wheel for driving a car for example. As already mentioned in the indroduction, AR is a related technology to VR. In the spectrum of [Tha18] augmented reality covers the second level of reality dimensions. It describes computer generated elements, which are embedded into the reality. A famous example for a AR application is the game PokemonGo (TODO source), in which players search in the real environment for computer generated items, based on a phone's camera and location services. The next level of reality is the augmented virtuality. This preamble describes a virtual environment, in which users can interact through analogue methods. An example for this could be a video chat room where the participants are present in

a virtual room but communicate through analogue methods. As seen in figure 2.1, augmented reality and augmented virtuality can be summed up with the term m̈ixed realityẅhich describes the interaction between real life elements and the virtual environment. Finally, in the last stage is the virtual reality in which a user is fully surrounded by a computer generated environment. This environment is most likely a reproduction of a real-life environment. The user is not only surrounded by an artificial reality but can also interact with it. It might appear that the user actually feels present in the virtual reality. In the following, this phenomenon will be explained in more detail.

2.1.2 Immersion and storytelling

What is immersion and why so important for VR? What describes a good storytelling? Is there anything special when designing a story for a VR application?

The term immersion often comes up when talking about VR. As mentioned before, this term describes a experience which users would not be able to percieve without the use of a medium. In general, it describes a experience from a different point of view. This could be for example the story of a different character or the exploration of a unknown location. [Tha18]
When talking about immersion, it is important to distinguish between two types: mental and physical immersion. Mental immersion is when the participant feels deeply emotionally connected to the virtual world. Physical immersion on the other hand means that the user's physical interactions are transferred into the virtual environment with the use of technology. When talking about immersion in books, films or related media, it is often only referred to mental immersion, because these types of media are not able to provide the technology for interacting with their environments. VR on the other hand can create immersion through a physical way as well. That is why VR can provide a higher grade of immersion than other media. [Tha18]
Another term closely related to immersion is presence. Presence in the context of VR describes a subjective feeling of participants to actually exist in the virtual world. The feeling of presence is a mix between mental and physical immersion. The more presence user feel, the more they accept the virtual world as the reality. To gain the sense of presence, the participant's movements in the reality should match with the movements of the virtual world. With a higher grade of presence, participants act more natural in a virutal environment, such as they would in a real environment. Through this, their task performance increases. This is one reason why presence is an important factor when it comes to developing VR, especially in the field of education and learning. [SW97]

Since the terms immersion and presence are explained, it is now the question, how design the story of a VR application in order to gain a maximum grade of immersion. Storytelling is one of the most important elements for mental immersion in a virtual experience. Especially mental immersion can be influenced by the storyline, while physical immersion can be increased through hardware tools.
Storytelling in general is the art of telling a narrative to the user in a way that the user is not only consumer but actually feels immersed with the story.[Lou18]. Designing a storyline in VR opens a lot of possibilities in engaging the participant in the story. Therefore there are things to consider when it comes to storytelling in VR: [Kea18]

One thing to bear in mind is, that space and environment in a VR application are more important than in other media, like books or films. The creator designs a world in a 360 degree view, so there is a lot more space to show. The storyline not only happens in front of the users, but can be all around them. Because the user can walk freely around in the virtual world, it is very important to softly guide the user into a certain direction when necessary for the storyline. The guidance should not be conspicuous, but should attract the users curiosity. This can be achieved through light and sound effects or movements. Another aspect to consider is not to overwhelm the user with complex tasks. This could prevent the user in experiencing an immersed virtual world because their full attention would lie on completing the tasks.

2.1.3 Interaction: Selection and manipulation in VR

2.2 Hardware for VR

describe difference between mobile and desktop HMDs, show examples HTC Vive and Google Daydream, maybe also Google Cardboard. What possibilities of interaction do they provide?

2.3 Showcases of VR applications

2.4 Limits of VR

At current status, what is VR not able to achieve? What are the challenges VR researchers face currently?

3 Design

3.1 Target group

outlining target group: prospective students; creating persona

Before starting with the design of the application, a target group has to be defined. This makes developing of the application purpose easier and also helps not to loose the focus during the design process. A very important aspect of defining a target group is also, to develop the application directly to the needs of the future users. In the end this helps to increase the acceptance of the application.

The main target group of the virtual reality application will be prospective students, who are thinking of taking a diploma at NYP. As mentioned in the introduction, those students mostly come from a secondary school and have finished their O-Levels, which is an entry requirement for polytechnics. The secondary school educated the students on a very widespread basis, and the students can now decide their specialisation.
When the students leave their secondary school, the average age is ??. In this age, people are known to be open to new technologies and trends. Also, the people in the target group are in the stage to make independent decisions for themselves without influence of parents. The application will be designed for prospective student, which show an interest in information technology but yet have no experience or knowledge in that field.
In the following, a characteristic of a fictive person is displayed. This person stands as a representative for the target group of prospective students:

Characteristics

Name: Jessica Lee

Age: 16

Place of residence: Singapore

Education: Finished secondary school

Personal interests: Dancing, computer games, TV series, technology

Level of tech experience: Rich consumer, no programming skills

Expectation: Wants to experience a fun virtual reality application

Since the fictive person Jessica Lee's main expectation is to experience a joyful application, there will be the need of gamification elements in the application. Her interests in computer games and technology lead the application's scene setting into a futuristic environment with new technologies. She has experience in digital media as a consumer, but not as a professional (programmer). Therefore, common gestures for user interaction can be applied, but the difficulty level of tasks about information technology should be on a beginner level.

3.2 Main story concept

To gain the users attention and let them grow interest in the application it is important to have a good main story. The main story will create a bridge between the several IT courses displayed in the application.
The application will start in the so called “Smart City”. This is a futuristic urban environment in which the user can move around freely.There are five different buildings along the streets. Each building is interactive and represents a course offered by the NYP. By interacting with the buildings the user can enter laboratories, so called “labs”, and complete different tasks. Every successful completion of a task has an impact to the main story.
The main goal of the VR application is to create a delivery drone which will deliver orders from online shops, just like Amazon announced in a video of 2013 (source). This is still a vision of future for now, but it is a good showcase for the user to show them how they can impact the future with IT. During the completion of the labs several challenges will occur. Once the user started programming their first drone, a lot more drones will start flying around in Smart City. To avoid crashing and chaos, the next task is to provide a proper and stable internet connection to the drones, so they can communicate. But the connected drones have their advantages and disadvantages: At first they are flying normally and communicating to each other but then an unknown IoT-Hacker infiltrates a virus into the drone firmware, so they start to misbehave. Now the user has to trace the hacker with basic cyber security concepts. After the hacker was found, more and more inhabitants of Smart City start to use the drones and provide a lot of data. It is now the job of the user to analyse this data and optimise the drones.

3.3 Storyboard

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