

Project proposal

Preoperative fracture surgery using virtual reality

Tobias Eilertsen

12th October 2021

Supervisors

- Harald Soleim
- Atle Geitung
- Daniel Patel

Collaborator

- Haukeland Universitetssykehus, medisinsk teknisk avdeling

Before and during a surgery, it is important for medical personnel to have a good understanding of the anatomy of a patient. A better understanding can lead to a less invasive surgery with less risk of implications. The goal of this project is to create a better way for medical personnel to inspect 3d models, making surgeries easier and safer.

1 introduction

1.1 introduction

When a hospital receives a injured patient that needs orthopedic surgery, a CT scan is often performed. The CT images are then displayed as a set of images or a 3D model on a computer. This helps the medical personnel plan the surgery by inspecting bone mass. If a surgeon has a good understanding of the anatomy related to the fracture, it is possible to perform a surgery that has less risk of complications or requires less resources.

A problem with visualising the model in 2D the limited understanding of what the bone actually looks like, because of the lack of scale and depth. A possible solution is visualising the model in Augmented Reality or Virtual Reality to give medical personnel a good feel for what the problem area actually looks like.

1.2 Research Questions

VR has many potential benefits, and it is possible that the surgery planning process can use some of these. As the users are already looking at 3d models in 2d screens, visualising in VR could improve the surgeons overview and improve the patients safety. The entire planning process could also be more effective, by removing or reducing the need for 3D printed models, especially in cases with limited time. Therefore the possible research questions are as follows:

How Can VR technology improve surgery planning by making the process safer or more effective? How Can VR technology give some of the same benefits as 3D printing gives today at a lower cost?

1.3 Expected Results

The project should include a VR prototype of a standard where it is user friendly enough to test with non technical subjects and with functionality that is comparable to the use cases of a printed model. The prototype will be tested on medical personnel to investigate the impact on the users anatomical understanding, how it effects the surgery and the efficiency of the planning process. The application should be available for further development and/or study.

The resulting report will include interviews and a conclusion describing what the performance of the VR viewer is compared to existing solutions, and whether VR is a valuable tool for surgery planning.

1.4 Related works

There currently exists several alternatives to viewing medical data in VR, here are some of the alternatives:

Medical Holodeck [3] is made for surgeons to plan surgeries and education.

An Augmented reality viewer called Dicom Director also exists, but is not yet approved for clinical use.[2]

Other similar solutions are Materialise[4] and Ceevra[1].

Most current solutions are closed source premium services targeted at enterprise/medical institutions. Many of them are not yet approved for clinical use, and current solutions are difficult to use for people not used to Virtual Reality *cite needed*

Some free general purpose VR viewers for 3D models also exist, but I have not found any with features related to medical use, collaboration or planning.

A study in visualising Patient data with VR [6] implemented a VR viewer for DICOM data and tried to measure anatomical understanding compared to 2D images. The study did not investigate the efficiency of the planning phase (loading the model into the software took 1 hour), and it did not do a comparison to 3D printing.

2 background

2.1 existing solutions

2.1.1 3D printing

An alternative to digital representation is to print the 3d model to inspect it physically [5]. This has many advantages, such as the surgeon being able to physically hold the bodypart, measure the model, try out equipment and practice with it. The biggest drawback to 3D printing is that the printing process can take more than 24 hours depending on the model, which in some cases is too long. Another drawback is not having any digital tools such as transparency, displaying cross sections or being able to alter the model in any way. Having a physical model in plastic also means it needs support structures, which can get in the way or create an inaccurate representation of the fracture.

A possible future use case for this project is taking a quick look at a model in VR, and then deciding if a printed model is necessary, potentially saving time and resources.

2.1.2 2D viewer

There exists a wide range of computer programs to inspect CT images as 3D models, using the computer to interact with the model. The current solution used by Helse Vest is materialise [materialise]. Using a 2D viewer is fast and simple, but lacks the depth and scale of VR.

3 Literature and References

- Mini invasiv behandling av brudd i hælbeinet ved hjelp av 3D printing:
Norwegian presentation showing how 3d Printing is used to improve surgery planning

- Virtual preoperative planning and 3D printing are valuable for the management of complex orthopaedic trauma

Article describing how 3D printing in planning can reduce surgical morbidity

- A Virtual Reality Environment to Visualize Three-Dimensional Patient-Specific Models by a Mobile Head-Mounted Display

Article testing the usability of viewing models in VR for surgeons and interviewing participants.

- A collaborative virtual reality environment for liver surgery planning

Article using VR specifically for liver surgery planning.

- Using Virtual Reality (VR) Models for Preoperative Planning

Quantitative study with randomized participants from surgical field measuring the impact of VR in pre op phase based on surgery duration.

4 Research Method

Firstly, a prototype Vr viewer will be created with the help of related open-source frameworks/software and guidance from both orthopedic surgeons and developers with experience from medical technology.

To answer the research question, it is necessary to measure the performance of the final application. This thesis will use qualitative methods by interviewing related personnel to investigate the performance including anatomical understanding, cooperation, and the effectiveness of the planning process. This will also be put in context to the existing solutions, possibly by doing a direct comparison by using a 3D model, printed model and VR viewer on the same case.

5 Thesis Outline

- Introduction (7-9 pages)

short description of how vr can be used to plan surgery

- Background(10-12 pages)

Description of related medical processes, surgery and surgery planning.

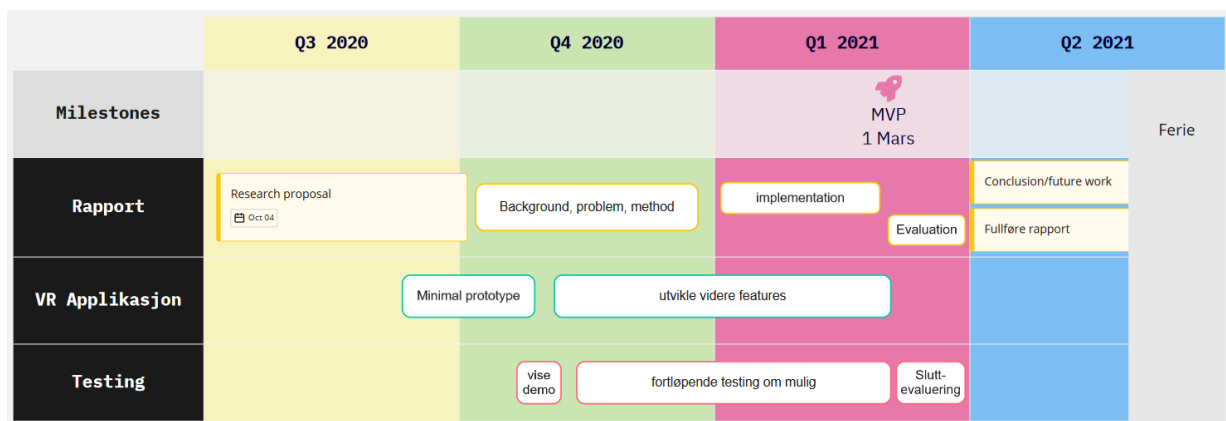
describe current state of 3D printing and Vr usage in medical field.

- problem(2-3 pages)

Describe what the application hopes to solve

- method(3-4 pages)
How the application is created and how final result will be measured
- Implementation(10-15 pages)
how the final application is designed
- Evaluation (10-12 pages)
results after final evaluation
- Conclusion and Future Work(5 pages)
if project was a success and how VR in pre op planning can be improved

6 Project Plan



7 Conclusions and Outlook

This report will hopefully answer some questions regarding the usability of Virtual Reality in surgeries, and bring more awareness and interest towards potential future uses of Virtual Reality.

To get an valid and interesting result it is necessary that the application is of a decent quality. The resulting application should be available for further development and study.

8 Literature and References

References

- [1] Ceevra, Inc. *Using Virtual Reality (VR) Models for Preoperative Planning*. Clinical trial registration NCT03334344. submitted: November 1, 2017. clinicaltrials.gov, June 2019. URL: <https://clinicaltrials.gov/ct2/show/NCT03334344> (visited on 03/10/2021).
- [2] dicomdirector.com. *Surgeons — Solutions For DICOM Done Better, Faster + 3D on every device*. en-US. URL: <https://www.dicomdirector.com/for-surgeons/> (visited on 01/09/2021).
- [3] Medical Holodeck. *Medicalholodeck. The Virtual Reality Platform for Medical Teamwork*. en. URL: <https://www.medicalholodeck.com/en/> (visited on 01/09/2021).
- [4] materialise. *Medical 3D Printing — 3D Printing In Medical Field — Materialise Medical*. en. URL: <https://www.materialise.com/en/medical> (visited on 01/09/2021).
- [5] Abhishek Mishra et al. ‘Virtual preoperative planning and 3D printing are valuable for the management of complex orthopaedic trauma’. eng. In: *Chinese Journal of Traumatology = Zhonghua Chuang Shang Za Zhi* 22.6 (Dec. 2019), pp. 350–355. ISSN: 1008-1275. DOI: 10.1016/j.cjtee.2019.07.006.
- [6] Maurizio Vertemati et al. ‘A Virtual Reality Environment to Visualize Three-Dimensional Patient-Specific Models by a Mobile Head-Mounted Display’. en. In: *Surgical Innovation* 26.3 (June 2019). Publisher: SAGE Publications Inc, pp. 359–370. ISSN: 1553-3506. DOI: 10.1177/1553350618822860. URL: <https://doi.org/10.1177/1553350618822860> (visited on 01/06/2021).