Project proposal

Preoperative fracture surgery using virtual reality

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Client

- 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 recieves an injured patient that needs surgery, a CT scan is performed. The CT images are displayed as a 3D model on a computer. This helps the medical personnel plan the surgery by visualising bone mass or other tissue. If a surgeon has a good understanding of a problem, it can be possible to perform a surgery that has less risk of complications or requires less resources.

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

2 background

2.1 existing solutions

There exists several alternatives to viewing a CT scan in VR, such as Medical Holodeck [3] which is made for surgeons to plan surgeries and education. Current solutions are difficult to use for people not used to Virtual Reality *cite needed*

An Augumented reality viewer called Dicom Director also exists, but is not approved for clinical use. [1] Most current solutions are also closed source premium services.

A study in visualising Patient data with VR [**vertemati˙virtual˙2019**] implemented a VR viewer for DICOM data and tried to measure anatomical uderstanding 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.

2.1.1 3D printing

An alternative to digital representation is to print the 3d model to inspect it physically [4]. 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 a inaccurate representation of the fracture.

A possible future usecase 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 [2]. Using a 2D viewer is fast and simple, but lacks the depth and scale of VR.

3 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. Therefore the possible research questions are as follows:

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

4 Expected Results

To test the theory, this thesis will include developing a VR/AR application and doing qualitative testing on cases with relevant personnel. The final application 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.

5 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

- A collaborative virtual reality environment for liver surgery planning

  Article using VR specifically for liver surgery planning.

6 Research Method

Firstly, a prototype Vr viewer will be created with the help of related open-source frameworks/software and guidance from medical personnel.

To answer the research question, it is necessary to somehow 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.

7 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

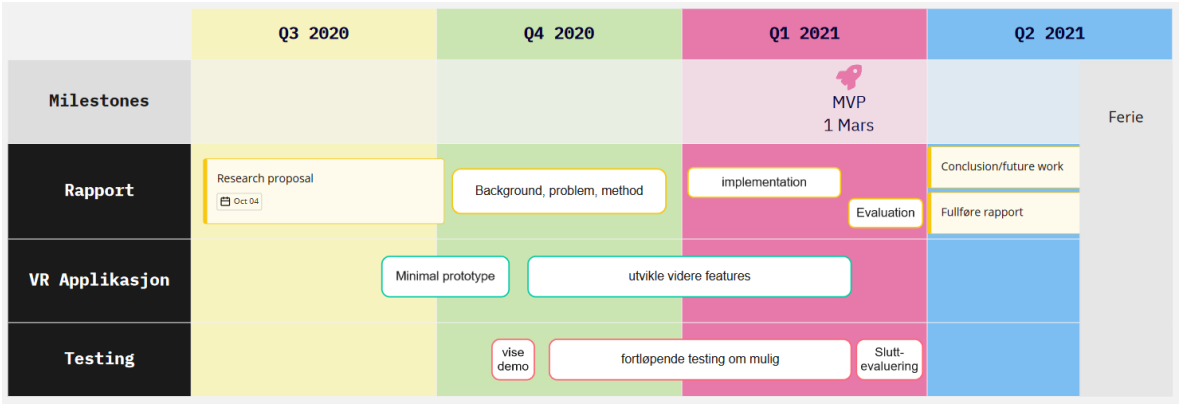
- Evaluation(10-12 pages)

  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

8 Project Plan



9 Conclusions and Outlook

10 Literature and References

References

[1] *Dicom Director mixed reality DICOM viewer*. URL: `https://www.dicomdirector.com/for-surgeons/` (visited on 05/04/2021).

[2] *Medical 3D Printing — 3D Printing In Medical Field — Materialise Medical*. en. URL: https://www.materialise.com/en/medical (visited on 05/04/2021).

[3] *Medical Holodeck, VR DICOM viewer*. URL: https://www.medicalholodeck.com/en/ (visited on 05/04/2021).

[4] 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 (December 2019), pp. 350–355. ISSN: 1008-1275. DOI: 10.1016/j.cjtee.2019.07.006.