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Developing and Testing an In-Home Tele-Knee Rehabilitaiton System for Patient after Knee Surgery

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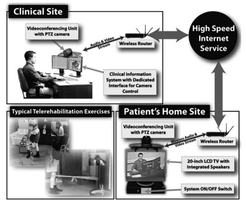
Background 1

Musculoskeletal pain, such as osteoarthritis of the knee (KOA) , is the most prevalent medical condition and the second largest contributor to "global disability" [1]. The total number of operations with artificial knees is expected to increase by almost 700% by 2030 [2], which underlines the need for optimal treatment of KOA. Moreover, human resource management will be one of the most challenging issues, due to achieving higher quality medical services and considerable decline in population growth. A proper tele-knee rehabilitation program would be an effective approach to reducing healthcare expenses, improving quality of healthcare services and achieving superior human resource management[3], [4].

State of the art 2

The audio/video communication were widely utilized in previous studies as a tele-physical rehabilitation tool and video conference between patients and healthcare professional are deemed as an optimized alternative for regular training for remote area [5].



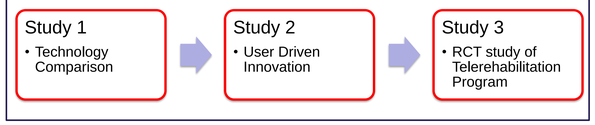
Whereas, the sensor technologies are being developed to facilitate rehabilitation without depending on a real-time video communication [6] , [7].

Aim 3

The aim of this study is to identify needs for in-home telerehabilitation and develop, test and impalement a system for patients after knee surgery. It has been observed, the system should enable patient and healthcare professional to communication easily and help the healthcare professional to track the patient's health recovery.

Consequently the study is divided into the three sub studies.

Studies Design 4

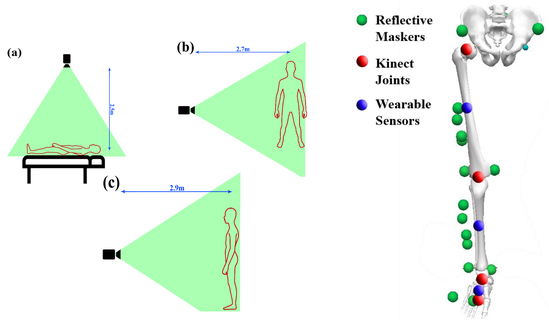


Study 1 5

In this study accuracy and usability three commercially available human body tracking technologies were evaluated using a golden standard marker based motion capture system. The subjects performed seven common exercise during the test, while a Microsoft Kinect v1, a Microsoft Kinect v2, three Shimmer 3 sensors and Qualisys motion capture system tracks the subject's physical activities.

Three different body postures were involved during the exercises which they are lying, sitting and standing.

Correspondingly the Kinect sensors were place differently as is shown in following figure.



The results indicated, the Kinect sensors and Shimmer 3 sensors had an acceptable performance in the most of the exercises. While, Microsoft Kinect skeleton SDKs were not able to track body and corresponding skeletal joints, where the subject lying on the floor.

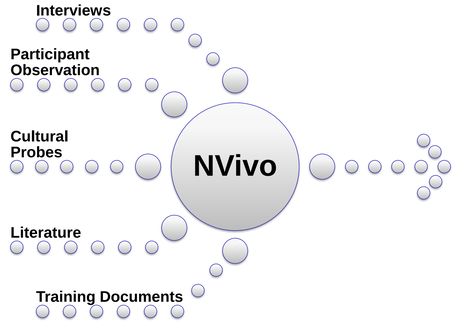
The average RMSE values for the Kinect v1, Kinect v2 and Shimmer 3 sensors were 13.4°, 4.9° and 2.1° respectively.

Study 2 6

In this study the tele-rehabilitation system has been developed together with the user of the system (patients and healthcare professionals). According to the literatures the study has been divided into following phases [8],[9].

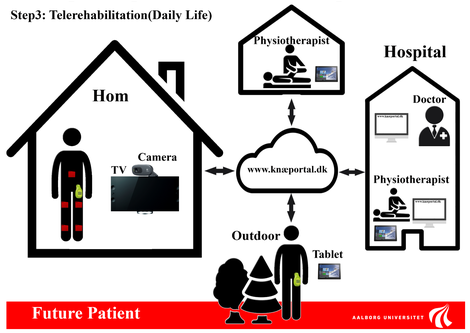
Identifying Issues and Challenges

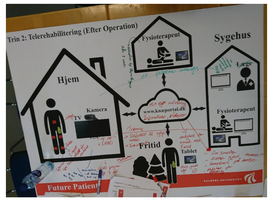
The current issues and challenges with the regular knee rehabilitation program were identified using a structured interview (n=7), participant observation during the interview, received cultural probes, provided relevant documents from the healthcare sector and literatures.



User Driven Innovation

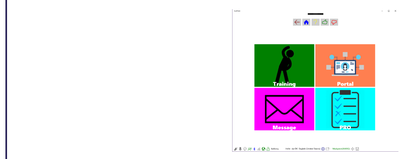
The first workshop in the participatory design study has been held to find the possible solutions for the identified issues within a telehealthcare and telerehabilitation context. A group of researchers, healthcare professionals and patients participated in the workshop.

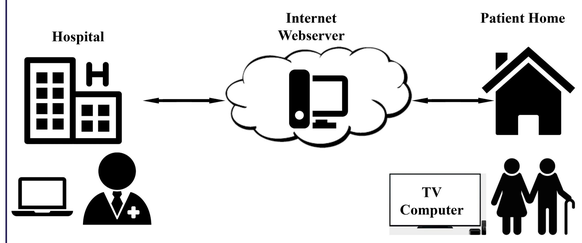




Telerehabilitation Program

Visual graphical user interface demo, Mockups and paper prototyping are employed in developing the system. Meanwhile patient report outcome and navigation tree has been considered in the development.





Study 3 7

The aim of this study is to evaluate feasibility of using a telerehabilitation program for patients after knee operation. 30 patients will be recruited to participate in the study, and the study community will be randomly divided into two groups. Both groups will receive an 8-week post-operative rehabilitation plan. The control group will follow the regular at home exercise, while the target group will receive a remote monitoring package.

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