Medicine 4.0

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I. Introduction

The MIC procedures represent today the first-line approach to the interventional management of patients with a large spectrum of cardiovascular diseases. Compared to surgery MICs are far less invasive and far less traumatic; the recovery of patients after MIC is rapid and typically uneventful. The major limitation of MIC compared to surgery is the inability of the operators to view the sites directly; they must fully rely on reading imperfect dynamic (cine) and static X-ray images. Image reading skills are fundamental to all decision making in MIC; estimated 90% of all data processed by MIC-operators is visual, the rest is divided between tactile and verbal signaling. Furthermore, MIC- operators are unable to control directly the target sites; instead they must rely on manipulating of instrumentation at distance in the range of several to about two hundred centimeters to perform treatments. To overcome these limitations considerable cognitive and motor skills are required.

To overcome these limitations MIC-operators must develop cognitive skills allowing rapid, consistent and flawless mostly X-ray but also intravascular ultrasound and optical coherence tomography image reading skills. Treatment strategy designs and tactical decisions during MIC-treatments is nearly exclusively image guided. Particularly, in performing emergency cases and complex, escalating procedure rapid and correct interpretation of images is absolutely necessary to save lives; errors may be deadly to the patients.

All studies are performed in real-life clinical environment. The studies are conducted while the operators are performing real-life unselected (all comers), elective (non-emergency) cases in a catheterization laboratory equipped to treat the full spectrum of cardiovascular diseases employing MIC. The current study includes the following MIC-procedures:

1) Coronary angiography and intervention.
2) Peripheral arteriography and intervention.
3) Cerebrovascular angiography and intervention.

II. Knowledge Transfer

We are focusing on this part in creating x-ray videos of the operations with the expert gaze, Figure 2. To create these videos we used eye-tracking and digital vision methods, in figure 3 we can see the steps for creating the video. For the screen detection we used shape based method, then for the marker detection we used color based method find the markers. Then the homography transformation used to map the gaze to the x-ray video [1]. To have high quality x-ray videos we record the operation x-ray using a camera, then we map the eye-tracker gaze to these videos.

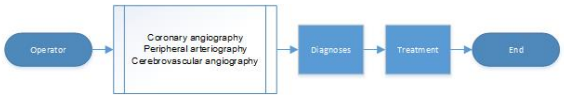

Fig. 1. Minimally Invasive Catheter-Mediated (MIC) cardiovascular interventions

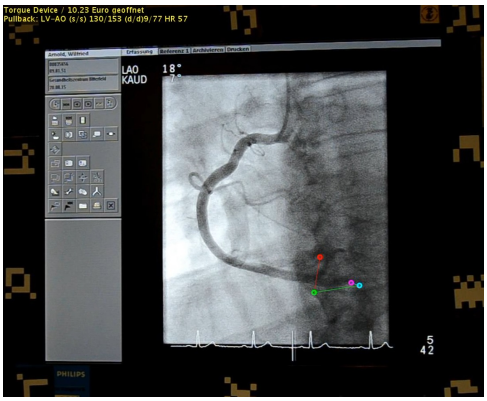

Fig. 2. Minimally Invasive Catheter-Mediated (MIC) cardiovascular interventions

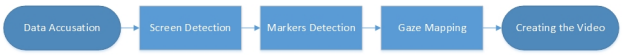

Fig. 3. Minimally Invasive Catheter-Mediated (MIC) cardiovascular interventions

Also the work is going on in dividing the x-ray video to projections based on the operation procedure, the projection is a set of the x-ray frames taken by the operator from a specific angel to the operation site. Then the gaze of the projections frames will be aggregated on a key frame represents the projection, figure 4.

III. Future Work

In the future, we are working on automatic video synchronization method to synchronize the several videos recorded from the eye-trackers and the camera. Also we are planing to

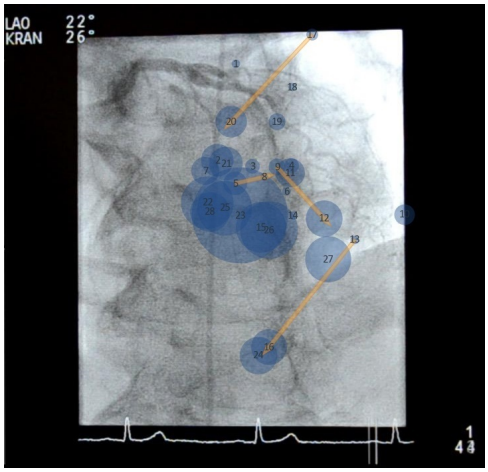

Fig. 4. Scanpath of the projection aggregated gaze on the key frame

use the deep learning method (CNN) [3] to train a system by the x-rays can perform the diagnosis part. Moreover we are working in creating a model for the expert eye movement x-ray reading behavior during the Interventions, statistical method like hidden markov model (HMM) and Bernoulli process is the possible methods to be used [2].

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