Pulse-by-pulse photoplethysmography quality index for signal reliability assessment based on pulse morphology

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**26 & 27 January 2017, Egmont aan Zee, The Netherlands**

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Abstract: Rupture of atherosclerotic plaques in the carotid artery is a major cause for stroke. Currently, the level of lumen occlusion caused by the stenosis is used to estimate the risk of plaque rupture. However, plaque rupture occurs when the mechanical stress in the cap of the plaque exceed the local tissue strength, not necessarily when the luminal occlusion exceeds a certain level. Therefore, a biomechanical model of the plaque and its mechanical properties may help to better assess rupture risk.
To determine the risk of rupture, mechanical properties of plaque components and cap strength are measured in 2D inflation experiments and assessed using inverse numerical modeling. In this study, we developed a method to assess material properties in vitro setting. Thin slices of material were cut and slightly compressed between two glass plates. Fluid was injected into the lumen, through a hole in the bottom plate, to inflate the sample. A pressure sensor monitored the intraluminal pressure, while a high speed camera recorded the displacement of the sample. The lumen diameter was calculated from these images. Material properties were assessed using a 1D model, describing radial displacements. For validation purposes, thin rings were manufactured from the rubber, with known material properties, were inflated in the experiments. The obtained material properties (using a Neo-Hookean material model) were compared to the properties calculated from tensile tests on rectangular samples of the same material. Next, for validation on fresh carotid tissue, ultrasound measurements have been performed on 4 healthy porcine carotis arteries, measured in the inflation experiment and the material properties (using a Holzapfel-Gasser-Ogden material model) were compared to the ultrasound measurements. The results reveal a good agreement between properties found by classic tensile tests and our new inflation method, for rubber rings. For the fresh carotid tissue, a good fit of the model on the data was obtained. However, a different set of parameters was obtained for the ultrasound and ring-inflation measurements. Application of the Holzapfel-Gasser-Ogden model gives parameter estimations that depend on the experimental boundary conditions. This needs further research. In future applications, heterogeneous properties, like in atherosclerotic plaque material, may be assessed as well, using vital staining techniques to distinguish different tissue components without affecting their mechanical behaviour.

**13:45**

**PHASE-RECTIFIED SIGNAL AVERAGING FOR AUTOMATIC DETECTION OF QRS FRAGMENTATION**


Abstract: QRS fragmentation is visible in the ECG signal as the presence of one or more deflections, notches or slurs in the QRS complex. The presence of QRS fragmentation is strongly related with the myocardial fibrosis or scarings and has been associated with adverse outcome in patients. Since detection of fragmented QRS complexes is mainly done on a visual basis, its practical use is limited. We propose an automatic method to detect the Rectified Signal Averaging (RSA). The method calculates the PRSA curve, approximates it with a linear fit and derives four parameters related to the slope and linear fit. Analysis of a dataset from the University Hospitals of Leuven with 268 patients shows that all four parameters are significantly different in fragmented channels compared to normal channels (p<0.001). Furthermore, Cohen's d suggests that three out of four parameters have at least a large effect size (d > 0.8).

**14:00**

**AN INNOVATIVE IMPULSE CROSSING TOOL FOR CHRONIC TOTAL OCCLUSIONS**

Aimee Sakes, Dimitra Dodou, Paul Breedveld

Abstract: Chronic Total Occlusions (CTOs) are the most challenging physical barriers interventionists face during Percutaneous Coronary Interventions (PCIs). During PCI, a guidewire and deflated balloon catheter are fed from the femoral artery ( groin ) or radial artery ( wrist ) towards and through the CTO in the coronary arteries. Subsequently, the balloon is inflated, and a stent is placed to prevent collapse. The most common failure mode during PCIs of CTOs is the inability to cross the lesion with a guidewire, accounting for approximately 63% of the failure cases, mainly due to guidewire buckling [1]. The goal of this study was to explore the use of a dynamic impulse \( \int F \cdot dt \) with \( F \) being the impact force [N] and \( dt \) being the time interval for which the force acts [s] to improve the chance of a successful crossing procedure. Applying an impulse on a CTO has several advantages over the static loading that is currently applied, including an increase in the buckling resistance of the guidewire, a decrease in displacement of the CTO and surrounding tissues during crossing, and a decrease in the penetration load of the CTO. A proof-of-principle prototype (Ø2 mm) of a CTO crossing tool was developed that generates translational momentum \((p=m \cdot v)\) and 20 N, respectively, which is well over the measured puncture force of real CTOs of 1.52 N [2]. The goal was to study the effect of varying model parameters without affecting their mechanical behaviour.

**14:35**

**FITTS’S LAW STYLE TASK**

Stergios Verros, Arjen Bergsma, Edsok Hekman, Bart Verkerke, Bart Koopman

Abstract: The most common form of muscular dystrophy in humans is Duchenne muscular dystrophy (DMD). The mean age of death was 20 years but due to improved health care practices and ventilation the life expectancy is increased to 25-30 years[2][3]. By increasing the life expectancy, the function of upper extremity becomes more important for giving DMD patients more independence to perform daily tasks[4]. The loss of muscle function not only affects the arms, but it also causes instability of trunk and head. Furthermore, assisting the arm function with an assistive device, like the A-gear[5], can cause extra instability of the trunk and loss of visual feedback of the arm. So, a trunk assistive device is essential to stabilize and support the trunk during arm movements whereas a head assistive device is essential to stabilize, support and provide visual control during arm movement.

**References:**

1. [My reference]
2. [Another reference]
3. [Yet another reference]
this project we focus on the development of assistive devices that will stabilize and support the trunk and the head and on the development of control interfaces that can realize user's intention of movement in a trunk assistive device. A useful control interface is the surface electromyography (sEMG) but intuitive mapping of sEMG from trunk muscles results in a poor performance due to body fat concentrated in the trunk area, ECG noise etc. This problem can be avoided by using non-intuitive mapping from other muscle areas in healthy subjects. In this study we compared the intuitive sEMG mapping from trunk muscles with the non-intuitive mapping of leg muscles under isometric conditions for both trunk and leg. We evaluated the two control interfaces using Fitts's law in terms of throughput and path efficiency. Both control interfaces showed poor performance at the beginning (path efficiency: 54.9% for trunk, 61.3% for leg) but during the experiments, both control interfaces had a learning effect leading to better performance after 5 trials (76.6% for trunk, 77.5 for leg). In the throughput performance measure, non-intuitive mapping performed better whereas in the path efficiency both non-intuitive and intuitive control performed similar in the whole experiment. It can be concluded that with more training the non-intuitive mapping can perform better than intuitive control (p-value 0.026 between fourth and fifth task). Future work will include more control interfaces for evaluation such as joystick and Force control.