APPLICATION OF AN INERTIAL MOTION UNIT FOR SLICE EXTRACTION FROM VOLUMETRIC ULTRASOUND DATA SETS

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Ultrasound examination is one of the most important imaging methods, which is used in many different medical applications. The quality of ultrasound images depends on the experience and skills of the operator. Training is essential, but common ultrasound simulation systems are expensive and unwieldy.

Therefore this master thesis discusses an inexpensive Inertial Motion Unit(IMU)-based ultrasound simulation system. This system should use an ultrasound transducer, containing an IMU, as an input device. The motion and orientation of the simulation transducer affects the displayed ultrasound image.

Methods

The simulation transducer consists of a 9 Degrees of Freedom IMU, a bluetooth module, a microcontroller, a battery management system and a lithium polymer battery. The sensor information is sent to the computer via bluetooth.

The computer application loads a predefined volumetric ultrasound data set and calculates the estimated orientation of the transducer from incoming sensor information. Different filter techniques were tested to calculate the transducer orientation. A specific ultrasound slice is rendered with information about the transducer position. The orientation calculation process and the render process are updated continuously. The whole system is represented in figure 1.

Results

Figure 2 shows a hardware prototype consisting of the modules previously described. The hardware case is inspired by an existing ultrasound transducer. The orientation sensors are sampled and sent with a constant frequency.

Figure 3 shows the Matlab user interface. The left plot shows the operator the transducer orientation calculated. The right plot represents the ultrasound slice rendered. The framerate of the simulation system depends on the pixel size of the slice.

Discussion

This master thesis demonstrates that it is possible to use an IMU as an input device for an ultrasound simulation system. It is possible to calculate the transducer orientation and render an ultrasound slice in real-time. The orientation calculation filter showed a slight drift appearing as a yaw rotation. The filter algorithm should be improved in further applications. The outsourcing of the orientation calculation to the microprocessor would imply another improvement to the simulation system.

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Figure 1: schematic representation of the system

Figure 2: simulation transducer prototype

Figure 3: Matlab user interface.
left side: calculated transducer orientation
right side: calculated ultrasound image