Preclinical test on augmented reality 4-D ultrasound in prenatal medicine

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Abstract

Purpose:
The aim of the preclinical test was to evaluate an augmented reality (AR) based 4-D ultrasound system regarding performance, robustness of the marker detection and its acceptance by pregnant women in prenatal medicine.

Material and methods:
The used hardware consists of a clinical ultrasound device (Esaote MyLab70 XVG with 4-D curved array transducer) and a tablet PC (Toshiba AT300SE, 10", Android 4.1.1) with an integrated camera device. The ultrasound device collects ultrasound volumes continuously using the 4-D transducer and renders them on a standard monitor screen. Furthermore the ultrasound device acts as an image server that holds the render results available for the tablet PC (client). The tablet PC collects these results via WLAN. The integrated camera enables to track an optical marker fixed to the transducer (see figure 1). Finally the tablet PC displays the rendered (virtual) ultrasound volumes as a 2-D texture at the marker position under the (real) ultrasound transducer.

Eight pregnant women in different states of pregnancy (12th-37th week) were scanned trans-cutaneously in supine position with the ultrasound device. During this examination they were able to watch the ultrasound volumes on a standard monitor screen. Afterwards they used the tablet PC and watched the rendered ultrasound volumes directly on site – "inside" their abdomen (see figure 2).
After the examination they rated their acceptance of the two different visualization techniques on a scale 1 (poor) to 10 (very good).

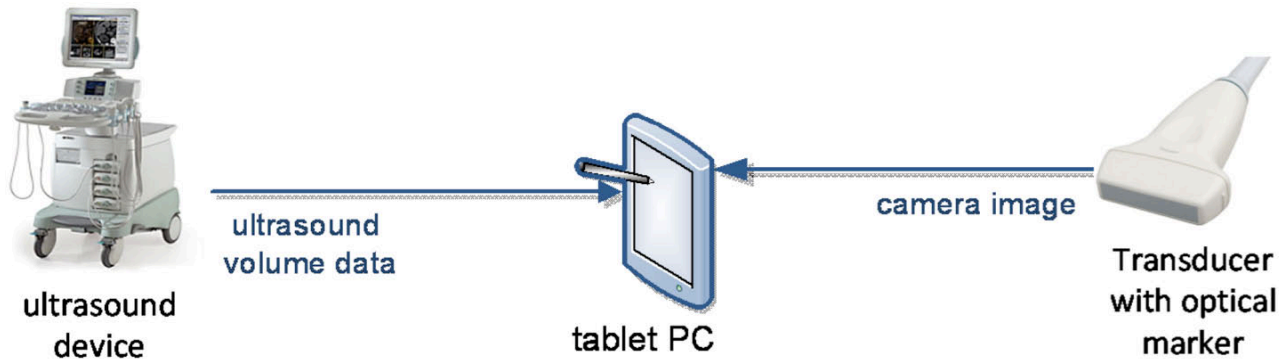

Fig. 1: Data flow for realizing AR ultrasound on tablet PCs

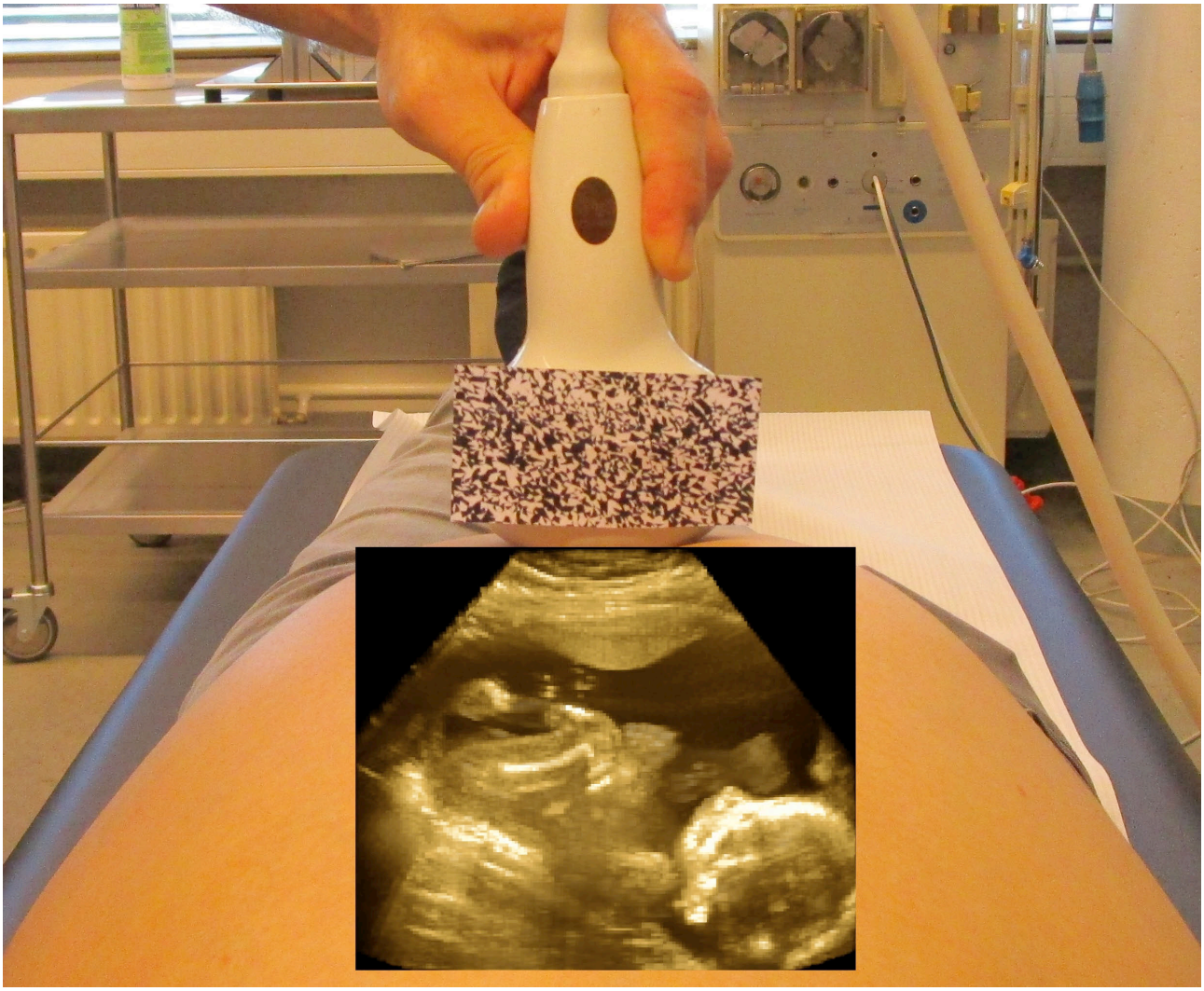

Fig. 2: Postposed view of the augmented reality scene; virtual ultrasound volume beneath a real transducer.

Results:
The visualization of the AR system achieved about 52 frames per second at a resolution of 256x256 pixels and a constant detection of the optical marker up to an angular deviation of about 75 degrees from the line of sight.
Each woman granted eight of ten points on acceptance of the conventional visualization and ten of ten points on the AR system.

Conclusions:
The preclinical test shows that the AR based 4-D ultrasound system can be used in prenatal medicine. The performance and robustness of the system is adequate and the acceptance of the AR system is higher than the conventional 4-D visualization technique.
However the detection of the optical marker needs enhancement to realize higher viewing angles. The visualization needs to be upgraded to 3-D textures instead of 2-D textures. This will improve the optical impression.