Messung kardiovaskulärer Strukturen in angiographischen Bildern mit navigierter Bildgebung
Measurement of cardiovascular structures in angiographic images with navigated imaging

Uwe Kirschstein[1], Dipl.-Ing. Carsten Lenze[2], Dr. med. Kay Kronberg[3], Prof. Dr.-Ing. Andreas Hein[2]

[1]Division of Automation and Measurement Technologies;
Department of Informatics;
Faculty II;
University of Oldenburg
[2]Division of Automation and Measurement Technologies; Department of Informatics; Faculty II; University of Oldenburg
[3]Clinical Center Oldenburg gGmbH; Heart Center Oldenburg; Clinic for Cardiology; Dr.-Eden-Strasse 10; 26133 Oldenburg; Germany

Introduction

In cardiology the angiography is a method to detect vascular stenosis by using X-ray radiation and contrast medium. There is special equipment, so called C-arms, to produce radioscopic images. An angiography system with one or two C-arms (monoplane/biplane) consists of an X-ray image intensifier (XRII), an X-ray source, and the mechanical structure to position the system around the patient.

In general the measurement of cardiovascular structures is limited and difficult to use. The usual diagnostic methods in angiography produce a high X-ray radiation exposure to patients and medical staff.

A biplane angiography system is used (figure 1). The measurement of lengths needs to be assigned absolutely in metric sizes, so it is possible to choose well-sized stent implants or balloons for balloon dilatation (PCTA). This prevents unnecessary X-ray radiation and will reduce examination time.

In this work a prototype for the navigated imaging, that means the combination of navigation with imaging systems, is presented, which gets over limitations of current measurement and built up the basis for future developments of exact volume reconstruction.

Material and Methods

To reach the specified goal the position measuring system Polaris (NDI, Ontario, Canada) is associated with self developed measurement software and the biplane angiography system Integris BH 5000 (Philips, Hamburg, Germany).
Further materials are self developed localization facilities and calibration methods to determine the exact position and orientation of X-ray image intensifiers (XRII) (figure 2).

While Polaris system delivers positioning data to the processing unit, the measurement software grabs frames from angiography system in real-time. These systems enable a measurement method. First a calibration method is designed to register the images against XRII-localizers and against each other to locate their correct positions. The new method models the beam progression and their coordinates which are registered on the coordinate system of one image (XRII-localizer). The point of intersection of two beams, which were represented as pixels in both images, is the position of the real object, the vascular structure for example (figure 3).

Results

Evaluation of measurement and positioning tests and several tests to determine reachable accuracy were carried out at the Clinic for Cardiology (Prof. Dr. G.-H. Reil) of the Clinical Center Oldenburg. In these preliminary tests an accuracy of 1 millimeter were shown.

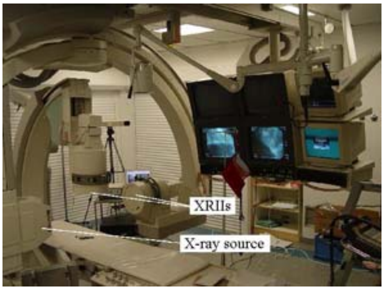
Several errors have been detected in evaluation phase. The main interfering influences are geometric image distortion and deviation of central beam. The distance between XRII and X-ray source varies and tracking of both positions with an optical position measurement system is impossible.

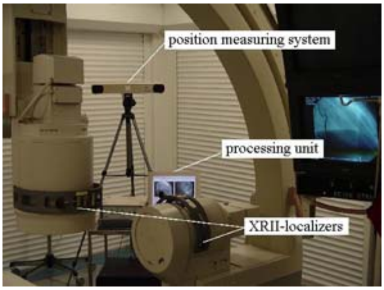
Discussion

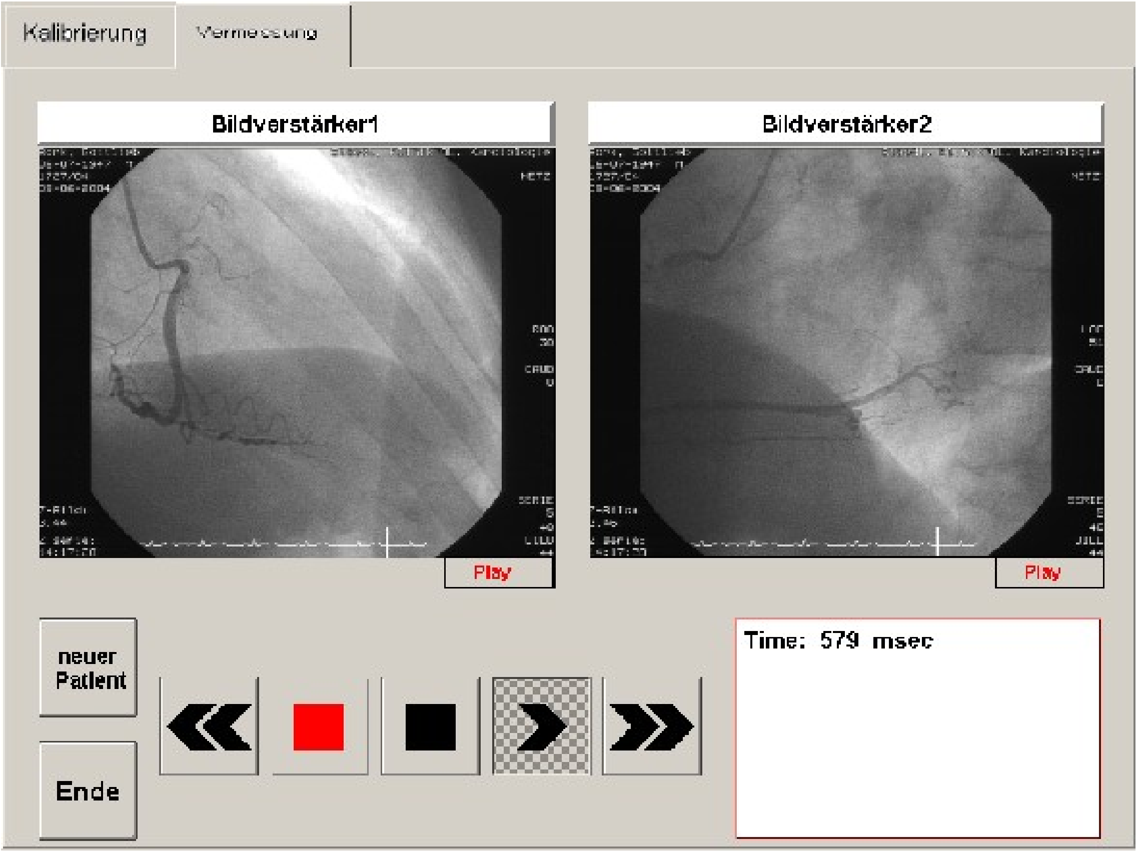
Preliminary tests show the feasibility to get over limitations of current measurement in angiography with an adequate accuracy.

The evaluation phase shows the necessity of further calibration of distance between XRII and X-ray source. The deviation of central beam and of geometric image distortions is probably the results of deformation of kinematic structure. Further measurements will be the basis for calibration of the complete system. Algorithms of distortion correction and correction of beam deviation are evaluated currently.

Figure 1: Biplane angiography system in Clinical Center Oldenburg (Reference: University of Oldenburg, 2004)
Figure 2: Navigated image recording (Reference: University of Oldenburg, 2004)
Figure 3: Screenshot of measurement software (Reference: University of Oldenburg, 2004)


XRIIs
X-ray source


position measuring system
processing unit
XRII-localizers


Kalibrierung
Vermessung
Bildverstärker1
Bildverstärker2
Play
Play
neuer Patient
Ende
Time: 579 msec