obstruction of the cardiovascular tree over all projections acquired by rotating the C-arm gantry in the trajectory is the objective of the whole method. Figure 1 shows exemplarily the optimal trajectory path based on 14 patient data sets. In the color coded map, each pixel represents the cost between 0 and 100% of a projection, which is positioned by two gantry angulations: LAO/RAO defining the *x*-direction and CAUD/CRAN defining the *y*-axis of the chart.

The angiographic images can be acquired on a clinically feasible time scale, and once a 3D representation is available, the method is fully automatic. The concept of feature-based acquisition trajectories can also be extended to optimize acquisitions with respect to other features like contrast agent inflow or patient heart rate.

Results

The method is validated by leave-one-out cross-validation [10] on the 14 rotational venography data sets and on simulated venograms of a segmented CT data set. Projection images with a foreshortening value below 10% and overlap below 20% are rated 'optimal'. In 12 (85.7%) data sets 43% more optimal images were acquired by using the presented method compared to the standard circular arc trajectory. As well, in 13 (92.8%) data sets 38% more vessel segments can be optimally visualized in the acquired images. The optimized views improved the centerline extraction accuracy of the semi-automatic two view modeling method. The resulting average root-mean-square error of the extracted centerline points of the segmented CT data set compared to the error based on the views from the circular arc was reduced from 2.52 to 1.55 mm.

Conclusions

In this first test the method for the determination of feature-based acquisition trajectories for 3D rotational coronary angiography proved to deliver improved image quality, wider anatomical coverage, and is expected to be applicable for rotational coronary venography of a larger patient population. This method facilitates the simultaneous acquisition of diagnostically relevant projections and projections that are required for improved 3D visualization with modeling or reconstruction techniques.

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Dynamic CT scanner environment effects on a DC electromagnetic tracking system

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Keywords CT guided intervention · Electromagnetic tracking · Image guided intervention

Purpose

Electromagnetic (EM) trackers provide a steady stream of highly accurate data on instrument position, needing only to be registered to imaging data to provide simple, intuitive displays to guide the operator. Also, increasing emphasis is being placed on remotely actuated interventional devices to reduce radiation exposure to the operator and also to obtain greater accuracy and consistency. Such systems require internal spatial sensors to ensure they are operating properly.

Several investigators have evaluated the potential for the interference of the CT environment with the performance of electromagnetic trackers. However, there are few extant studies of the effects on tracker performance during scanning or closely integrated into the scanning operation. The purpose of this study is to evaluate the performance of current state of the art DC EM trackers during the operation of a CT scanner to measure the accuracy, induced noise, and stability of the tracker signals during different phases of a typical CT scanning procedure.

Methods

The performance of an advanced commercial DC electromagnetic tracking system (the MedSAFE tracking system with a prototype flat plate transmitter), supplied by Ascension Technology Corp. (ATC) was evaluated in a Siemens Somatom 64 slice CT scanner.

All studies were conducted as a part of a scanning protocol, to reproduce the conditions under which the sensors would operate in a clinical procedure. During the experimental protocol, the flat plate transmitter of the MedSAFE tracker system was placed on the patient table, and the 1.8 mm EM sensor was also fixed to the table, near the center of the working volume of the system. The MedSAFE system was oriented with a coordinate system defined by the *x* axis lying normal to the scanner bed, and the *y* axis spanning the table in the lateral direction. At all times during the CT scan, the sensor lay fixed in relation to the transmitter. For experimental runs with the protocol, a Scout or Topogram image was made initially. Then the bed was moved into an appropriate position for the following full scan. Finally, a full scan of the working volume was done. Following initial observations which showed its possible importance, the status of the CT scanner gantry (rotating or fixed) was recorded during the experimental runs. The orientation of the sensor was adjusted in successive data runs to correspond to the major Cartesian axes, since prior investigators reported that position readings were sensitive to sensor orientation.

Results

The following data analysis corresponds to the configuration where the sensor was placed in the X-positive orientation relative to the flat plate transmitter. Data showed baseline variation to a maximum of 0 mm in the *x* axis, 0.11 mm in the *y* axis, and 0.11 mm in the *z* axis with the EM field of view within the fixed gantry. Upon taking a scout

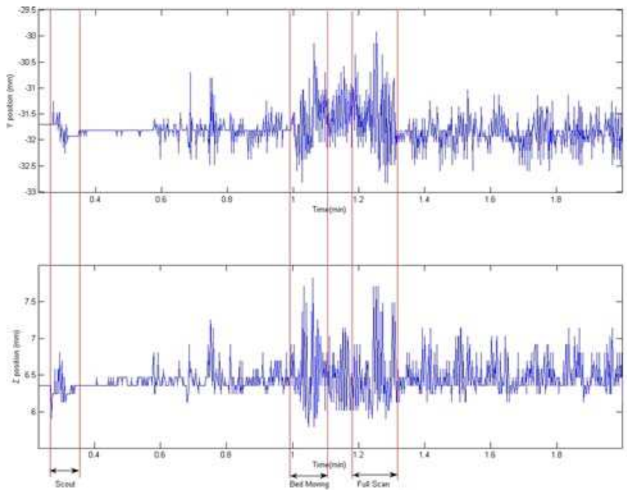

Fig. 1 This Figure shows the noise in the position signal for a stable electromagnetic sensor on the CT scanner table measured using the ATC Flatplate transmitter. It shows the effects of taking a scout image, table movement while the gantry is running, and of actual X-ray scanning. The background noise level was observed to increase significantly when the scanner gantry was moving

image, variation in EM sensor readings increased to a maximum of 0.4 mm in the *x* axis, 1.01 mm in the *y* axis, and 0.89 mm in the *z* axis. At this point, a change in baseline EM sensor readings was observed by a factor of 0.1 mm in the *Y* axis readings. The gantry began to rotate soon after in preparation for the full scan. The variation in EM sensor readings increased to a maximum of 0.8 mm in the *x* axis, 1.78 mm in the *y* axis and 1.12 mm in the *z* axis. The scanner bed was then moved to the appropriate position prior to the full scan. The variation observed while the scanner bed moved was at a maximum of 1.3 mm in the *x* axis, 2.68 mm in the *y* axis, and 2.01 mm in the *z* axis. There is a brief decrease in variation after the bed moves and before the full CT scan; however, the gantry continues to rotate during this period. Variation in EM sensor values decreases to a maximum of 0.7 mm in the *x* axis, 1.79 mm in the *y* axis and 1.12 mm in the *z* axis. During the CT scan, the variation increases again to a maximum of 1.5 mm in the *x* axis, 2.91 mm in the *y* axis, and 1.786 mm in the *z* axis. Variance and standard deviation were not calculated given the approximate nature of time recordings relative to event initiation during the CT scan cycle and the subsequently short duration of the cycle events. Figure 1 depicts the *Y* and *Z* axis EM sensor readings along the course of the CT scan cycle. These figures were chosen because of their large variation in comparison to the *x* coordinate plane.

Conclusions

We have demonstrated that a CT scanner induces increased variability in EM sensor readings and that the effect is more severe when the CT gantry is rotating. There is also evidence of a baseline shift after the scout image was taken. At this point, the gantry is fixed yet the CT scanner bed is in motion. This implies that bed motion may cause a measureable shift in values that can be compensated for during clinical intervention. The implication for CT guided procedures includes the desire to always take measurements under the same CT operation conditions, in a well tested, stable protocol. We further recommend stopping the gantry motion when a precision measurement is required.

Videodensitometric myocardial perfusion assessment on coronary angiograms

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Keywords Densitometry · Myocardial perfusion · Angioplasty · Acute myocardial infarction

Purpose

Successful recanalization in acute myocardial infarction (AMI) is described by an increase in blood flow in the epicardial artery. It is usually characterized by Thrombolysis in Myocardial Infarction (TIMI) flow grade. However, microcirculatory reperfusion in the myocardium does not depend only on the epicardial flow. Several techniques, such as myocardial contrast echocardiography, magnetic resonance imaging, and radionuclide studies show that many patients have inadequate flow at myocardial tissue level despite a reopened epicardial coronary artery. Therefore, assessment of myocardial perfusion has a great importance in risk stratification after AMI and successful intervention. Assessment of perfusion on coronary angiograms is currently performed by visual grading in the clinical practice. Interobserver and intraobserver variabilities associated with subjective angiographic assessments are limitations of these visual grades. An automatic, computerized, densitometric measurement method is presented to assess myocardial perfusion, on coronary angiograms.

Methods

The present prospective study comprised 62 patients who underwent AMI followed by successful angioplasty of the occluded coronary artery. Phase matched digitally subtracted angiographic images were

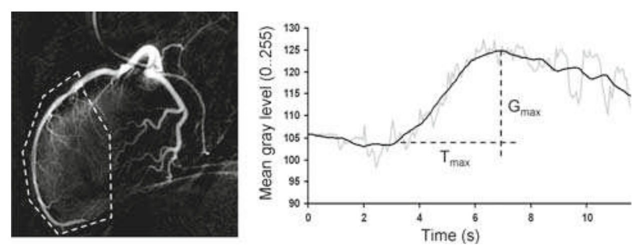

Fig. 1 Videodensitometric measurement method. Region of interest (*dashed white polygon*) after a proximal LAD occlusion. Corresponding time–density curve is shown right to the angiogram

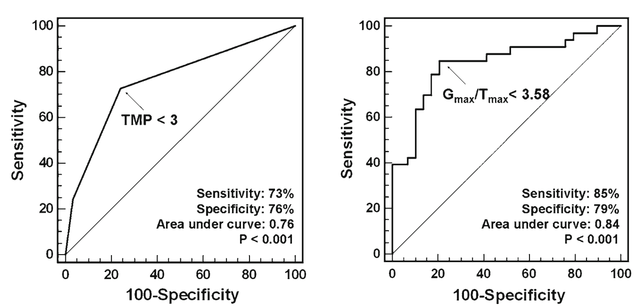

Fig. 2 Visual assessment versus videodensitometry. Receiver operating characteristic curves of TMP (*left diagram*), and G_{max}/T_{max} with vessel masking (*right diagram*) to predict enzymatic infarction size characterized by sum CK > 5,000