IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

TARGET REGISTRATION ERROR ESTIMATION IN A SURGICAL NAVIGATION SYSTEM

IITM Technology Available for Licensing

PROBLEM STATEMENT

- **Surgical navigation**, an application of Image-Guided Surgery (IGS) technology, allows surgeons to track the location of a surgical tool during surgery to a corresponding point in a patient's image space.
- This tracking aids in making **intraoperative decisions and selecting a suitable path** for surgical treatment.
- In IGS, registration is the **process of determining the geometrical transformation** linking medical images to the patient in the operative space.
- **Fiducial markers,** such as anatomical points, skin-affixed markers, or bone-implanted markers, are commonly used to provide the transformation between image and physical spaces.
- **Point-based rigid-body registration** is widely used in surgical navigation systems, but errors are common due to errors in localizing markers.
- A system is needed to **estimate expected tracking error during tracking**.

TECHNOLOGY CATEGORY/ MARKET

Technology: Surgical tool tracking error & target registration error

Category: Medical & Surgical Devices

Industry: Bio Medical Engineering

Application: Medical & Surgical tool tracking error

Market: The global market size was surpassed at **USD 128.83 billion in 2023** and is expected to increase around **USD 431.55 billion by 2033** with a notable **CAGR of 12.85% from 2024 to 2033**.

TECHNOLOGY

Steps involved for surgical navigation based on point-based rigid-body registration

- Display medical images of patient
- Localize fiducial points in image space
- Attach a coordinate reference frame (CRF) with marker(s) to patient and marker(s) to tool to enable tracking with a tracking camera
- Define reference location of the CRF relative to a tracking camera coordinate system
- Localize fiducial points in the physical space using the tool trackable by a tracking camera (Fig. 1)
- Determine rotational and translational motion between image and physical space using locations of fiducial points
- Determine current tool tip location relative to reference CRF in the physical space (**r**) during tracking and the corresponding location of the tool tip in the image space (**p**).

The invention provides method to estimate the overall target registration error (TRE), which is the error in identifying the actual corresponding location of the tool tip in the image space.

Research Lab

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Key Features / Value Proposition

The invention relates to analysis of errors in a surgical navigation system based on point-based rigid-body registration. It involves identifying errors involved during each step of surgical navigation including registrations during localization of fiducial points in the physical space (Fig. 2) and registrations during tracking (Fig. 3) and computing an expected value of overall tracking error (TRE).

Potential technical advantages of the present invention

- ❑ Help the surgeon locate the anatomical target point precisely and accurately, and enhance the patient outcomes.
- ❑ Determining the estimate of expected overall TRE value during tracking may aid the surgeon to get real time updates and make quick intraoperative decisions, which in turn may result in successful completion of surgery with minimal invasiveness and thus speedy recuperation of the patient.
- ❑ Another notable advantage is that this estimation of expected overall TRE may be used to design placement of trackable markers in surgical tools and CRF and placement of fiducial markers to register the image and physical space such that the overall TRE can be reduced at desired surgical target regions.

TRL (Technology Readiness Level)

TRL- 3, Proof of Concept ready & validated

INTELLECTUAL PROPERTY

IITM IDF Ref. 2354
Patent No: IN 547026

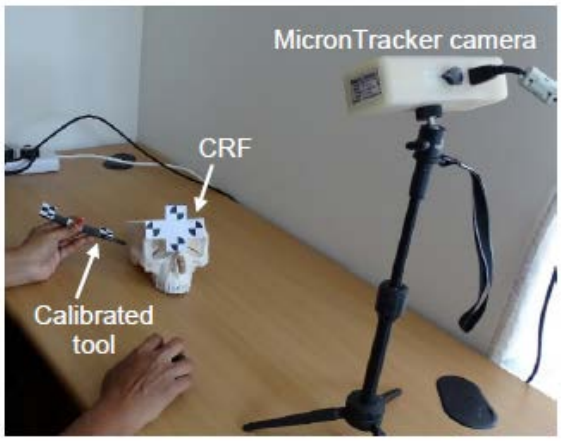

Fig. 1 illustrates the basic components of a surgical navigation system for physical data collection.

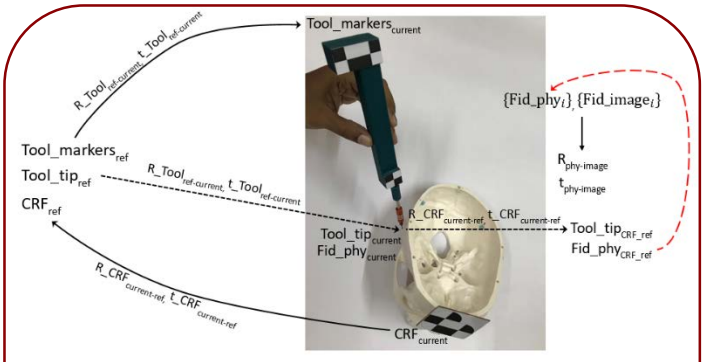

Fig. 2 illustrates a schematic drawing of the registrations involved during localization of fiducial points in the physical space.

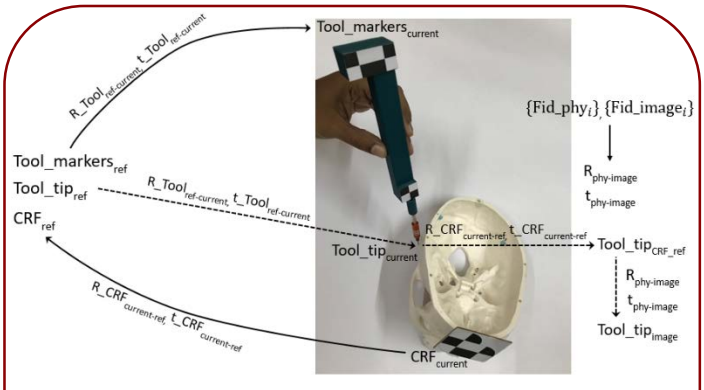

Fig. 3 illustrates a schematic drawing of the registrations involved during tracking.

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