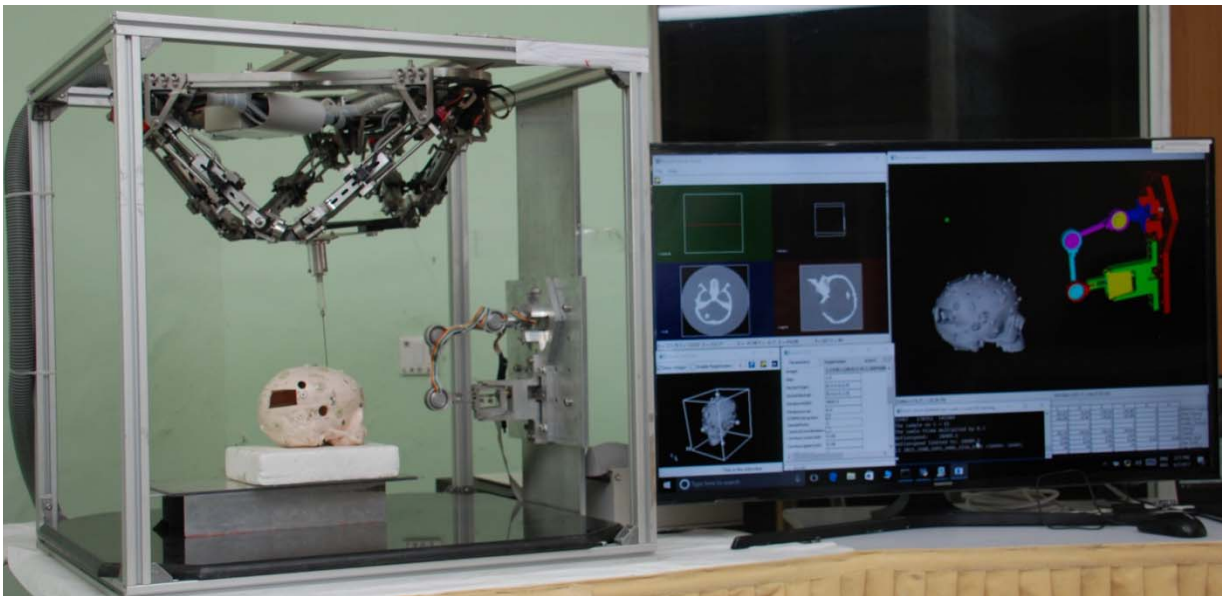
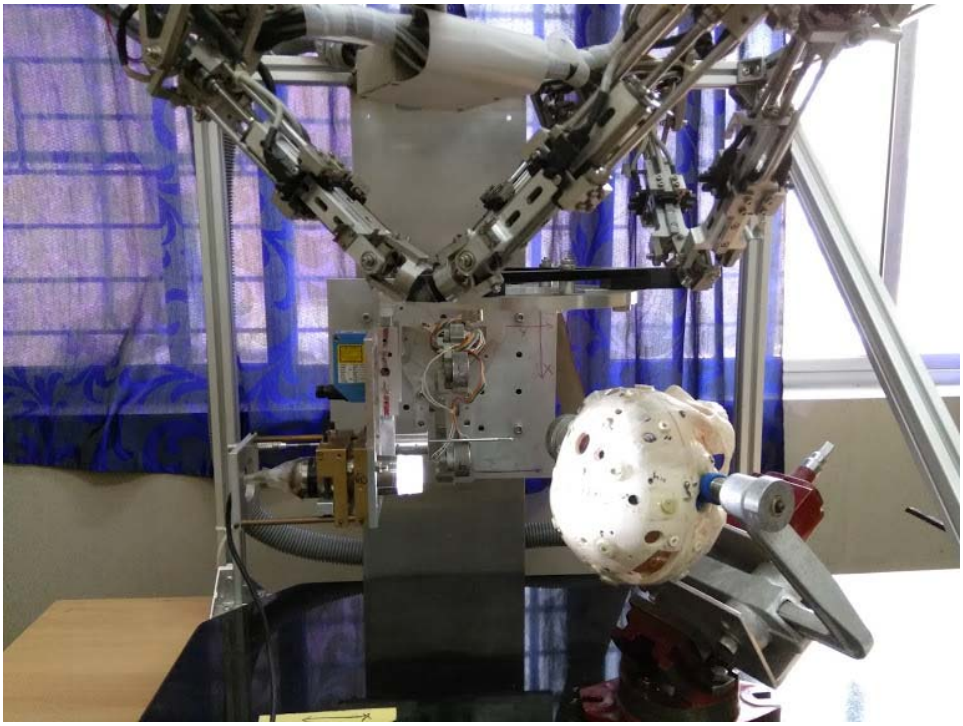
Robot assisted Neuronavigation and Stereotactic Neurosurgery Suite



Neurosurgical Suite



Neurosurgery Suite delivered at NIMHANS, Bangalore for clinical trial runs

Neurosurgery Suite delivered at ACTREC, Kharghar for clinical trial runs

Project: Robot Assisted Technologies for Healing Neurological Ailments (RATHNA)
for
High Precision Robot based Neurosurgery
to Nurture State-of-the-Art Surgical Practices for Societal Benefit

An initiative is undertaken by Bhabha Atomic Research Centre to extend affordable high quality neurosurgical practice in India. This automates the frameless Stereotaxy using a high precision ***6 DOF Parallel Kinematic Mechanism (6D PKM)*** based Robot and a ***Surgical Coordinate Measuring Mechanism (SCMM)***. The system provides high accuracy as well as high patient comfort level as compared to conventional existing practices in neurosurgery.

Salient Features

High precision and accuracy- Biopsy of extremely small, deep rooted tumour can be achieved.

Integrated Display– Multi-sectional views and transparent 3D view to provide real time feedback on the progress of the tool insertion.

No line of sight problem- Ideal for complex manoeuvres which miss camera sight.

Low cost- Costs one tenth of the currently available traditional systems.

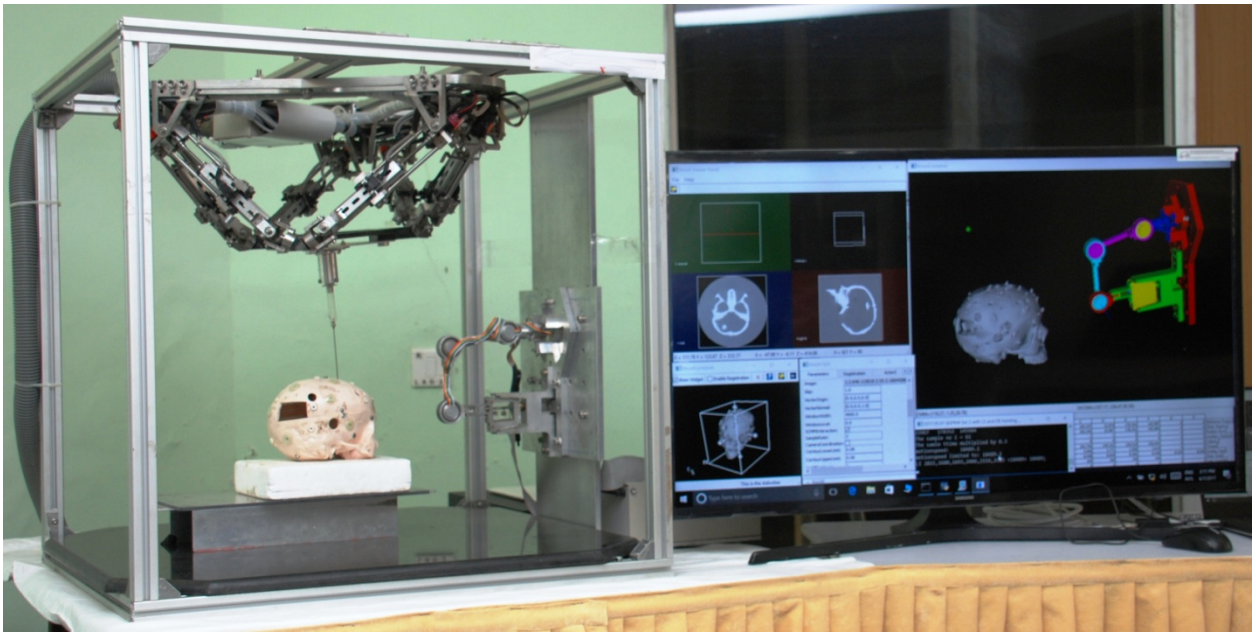
Indigenous– Can be customised to suit local surgical practices.

Minimal footprint- Lesser space requirement gives surgeons more free space.

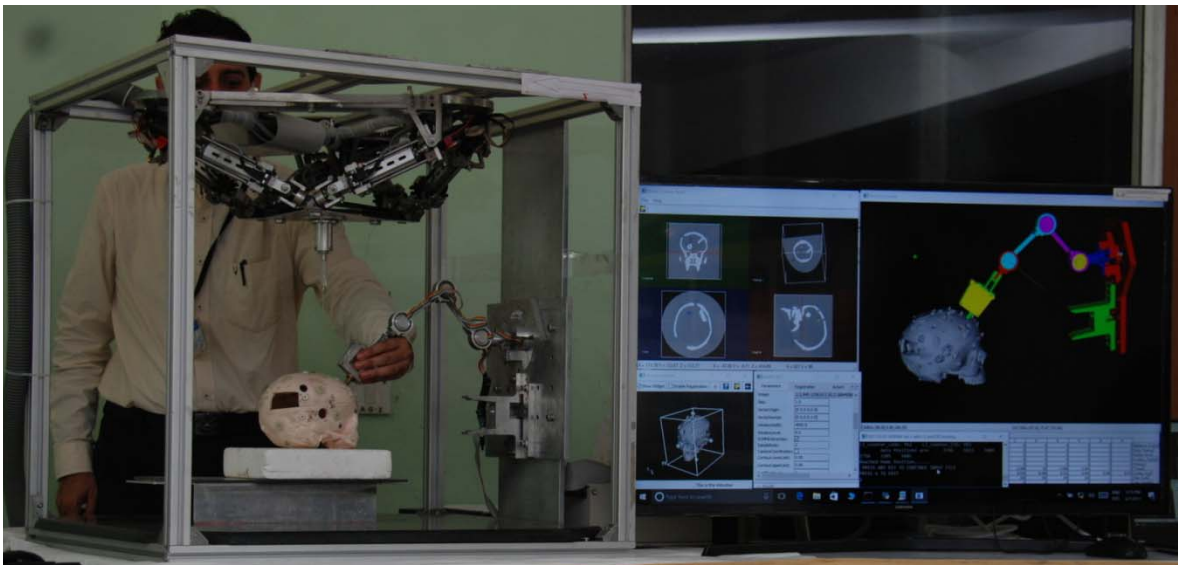
Neuro-registration & Neuronavigation

In neuronavigation, multiple re-constructed MRI images and 3D construction of the patient along with real time interaction of the surgical tool is available on the computer screen to the neurosurgeon. During surgery, the surgeon can observe in real time, the traverse of the surgical tool in the MRI images and in the 3D view of the patient on the computer workstation. Pre-requisite for neuronavigation is the initial registration of the patient with the imaging data.

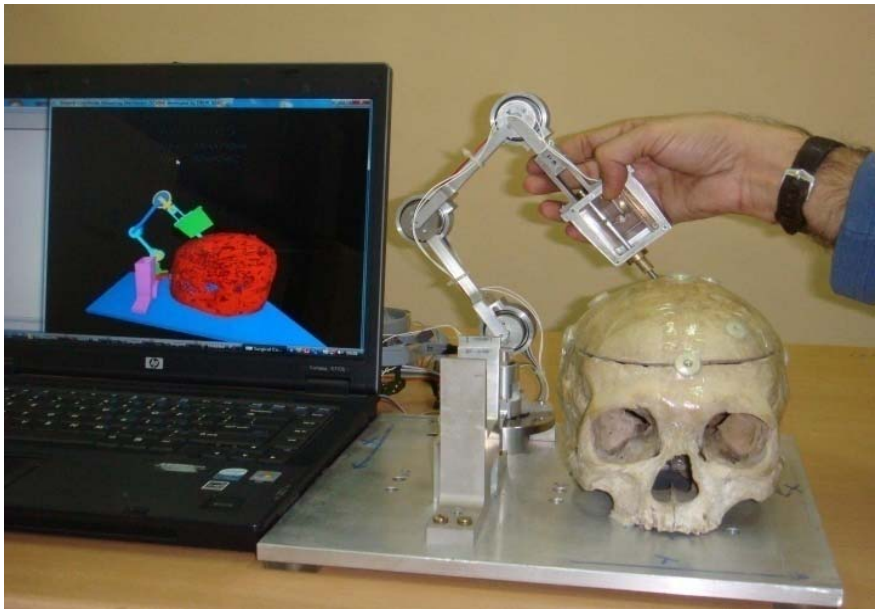
A portable, high precision Surgical Coordinate Measuring Mechanism (SCMM) has been developed for using in the neuro-registration and neuronavigation. It is a passive four degree of freedom serial mechanism with a base fixture. It measures the coordinates of the anatomical point. The real time recording and storing the history of the tool tip coordinates is provided.



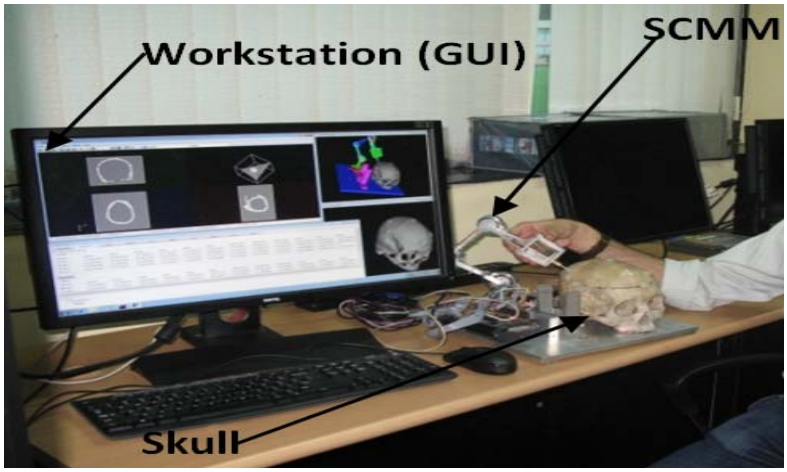
Demonstration of Neurosurgical Suite



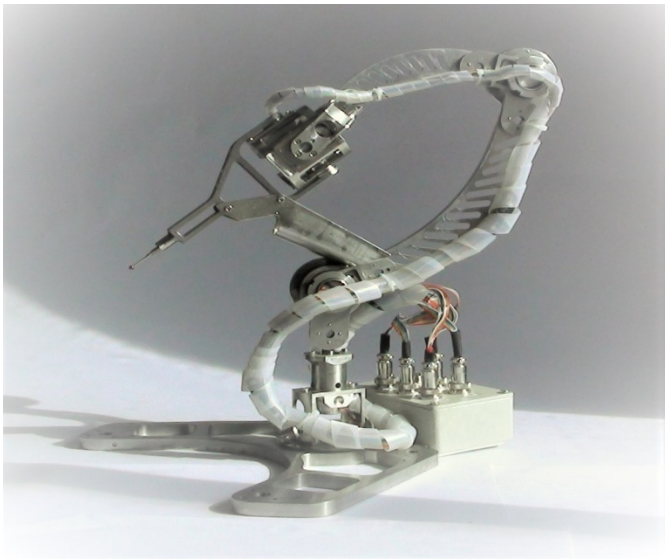
Neuro-registration procedure demonstrated using SCMM

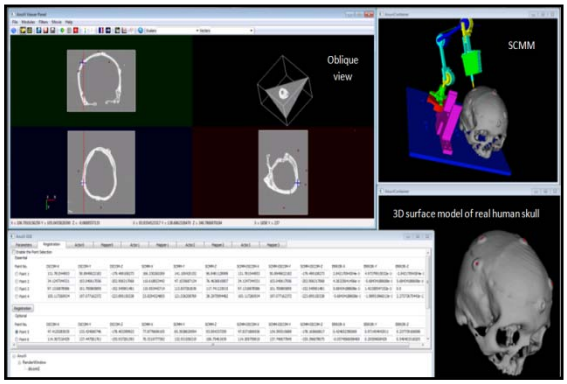


Measurement of an anatomical point using 4 DOF SCMM

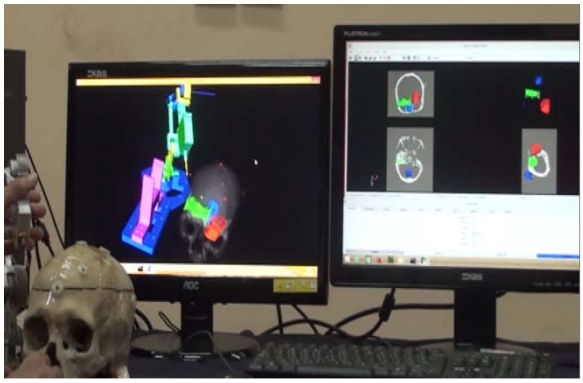


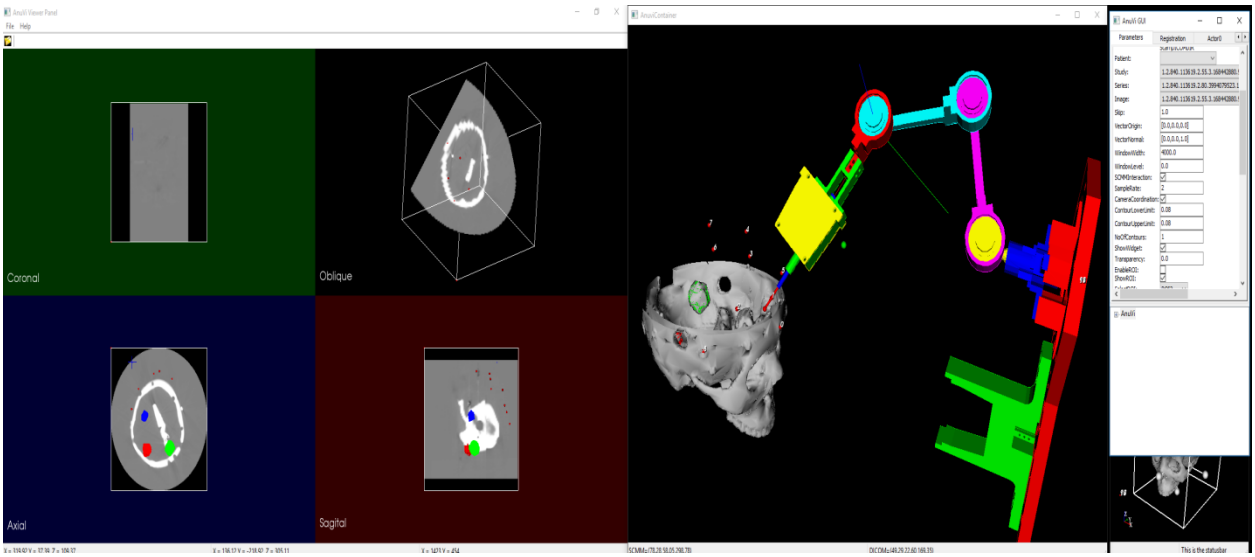
Neuronavigation procedure demonstrated using 4 DOF SCMM


5 DOF Surgical Coordinate Measuring Mechanism



GUI showing run-time views and relation of tumour w. r. t. 3D model of human skull


3D model of Region of Interest generated by Neurosurgeon w. r. t. 3D model of SCMM



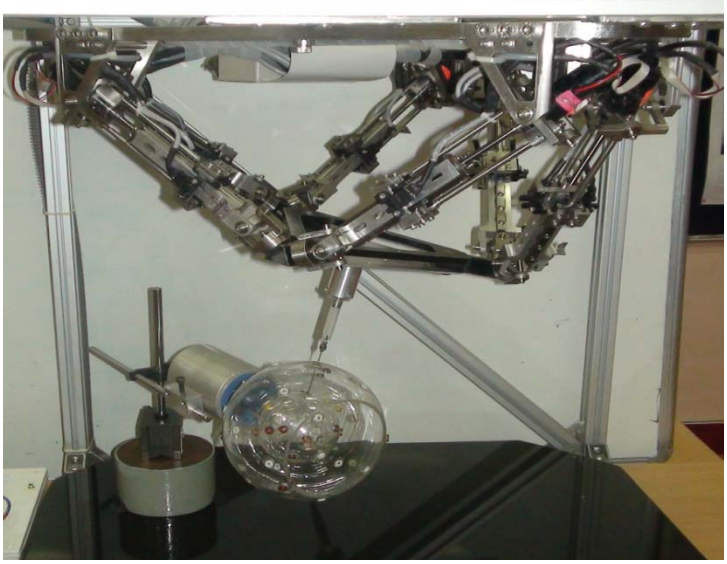
Visualization of Region of Interest, relationship of tumor w. r. t. surgical tool during Neuronavigation

A user friendly graphical interface has been developed to carry out neuro-registration and neuronavigation. The graphical interface has features to visualize the different re-constructed views of the MRI images along with the re-constructed 3D model of the patient's brain. The portable SCMM is compact and provides high accuracy. It also eliminates the line of sight constraints of the camera mounts used in traditional neuronavigation systems. Aim of this work is to develop an economical indigenous neuronavigation system with high accuracy.

Robotic Frameless Stereotactic Neurosurgery

An indigenous initiative is undertaken to extend affordable high quality neurosurgical practice in India. The stereotactic surgery is a minimally invasive form of surgical intervention which makes use of a three dimensional frame of reference outside the body to locate the tumour within the body.

A high precision 6D PKM (6 DOF Parallel Kinematic Mechanism) based robot is developed to perform neurosurgery. Surgical attachments to guide the surgical tool precisely along a preset direction to the preset extent are part of the surgical suite. The precise tool guidance can be achieved autonomously or manually. The robot based frameless Stereotactic system is developed which has accuracy comparable to a frame based system and patient comfort comparable to a frameless system. It automates the frameless Stereotaxy using a high precision parallel mechanism based robot. A 3 dimensional 6D-PKM graphic simulator is developed to support planning and rehearsing the surgical procedure.



A robot based frameless stereotactic neurosurgery using a high precision Robot

A 6 DOF Parallel Kinematic Mechanism (6D PKM) Robot for Stereotactic Neurosurgery

The phantom based trial runs are conducted to demonstrate high precision feature of the 6D-PKM. The accuracy of the robot is 100 microns. Many aspects of design, visualization and features are considered for a successful stereotactic neurosurgical procedure.

This research project is developed by Division of Remote Handling & Robotics and Computer Division, BARC, Mumbai.

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