Research Plan for Next 5 Years

Next five years I am looking forward to focus on research areas that can extend the availability and usefulness of technology and its advancement to our society directly. I believe that this will certainly enhance their quality of living. These are some of my research problems :

Current Research Problems

- **Automated Human Brain Fiber Tractography Segmentation (*AHBFTS*)**

  1. **Introduction :** The streamline tractography estimates white matter tract trajectories following the most likely tract direction. It locally chooses the most likely fiber trajectory. Entire brain tractography is estimated by stepping along the major eigen vector direction using RK method. DTI with Tractography gives us the white matter fiber orientation. A fiber is represented as a set of points in 3D space (typically 20 to 30 points per fiber). Tractography produces thousands of fiber trajectories per subject (250K). Tractography can be seen as a 3D point cloud but that is not very useful. Useful information can be extracted only when they are organized into anatomically meaningful structure.
  2. **Problem Statement :** In this area we have started to address the problem of human brain tractography segmentation. In this problem the challenge is to segment the tractography data of a human brain automatically into tracts having similar fibers which are anatomically meaningful. Eight such major tracts are known namely, Arcute, Cingulum, Corticospinal, Forceps Major, Fornix, Inferior Occipitofrontal Fasciculus, Superior Longitudinal Fasciculus, Uncinate as shown in Fig. 1.
  3. **Collaboration :** We are collaborating with Dr. Chirag Ahuja, Associate Professor, Department Of Neuro-Radiology, PGIMER, Chandigarh. Also two B.Tech IIT Mandi (Mr. Anand and Mr. Mani) and one internship student from BITS Pilani Hyderabad (Mr Vedang) are working over it.

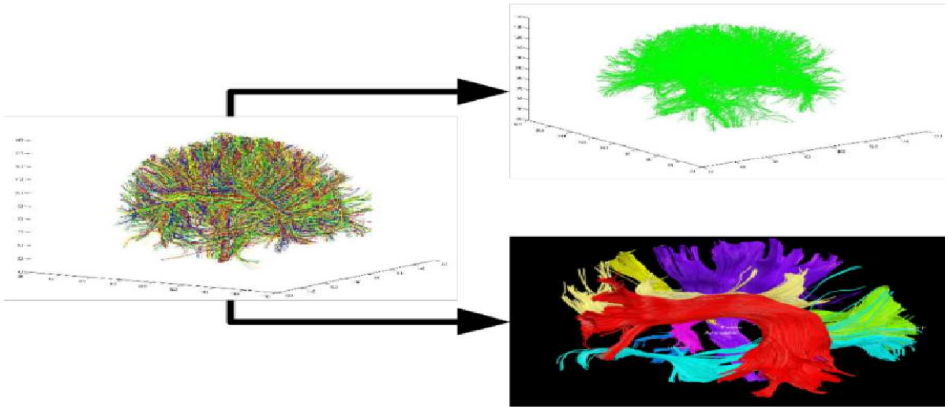


Figure 1: Brain Fiber Tractography Segmentation

- **Unsupervised Fully Automated cartilage segmentation from Knee MRI Images**

  1. **Introduction :** Knee osteoarthritis (OA) is a common joint disease highly prevalent among aged person and its is increasing from middle age also. Because cartilage cannot be regenerated

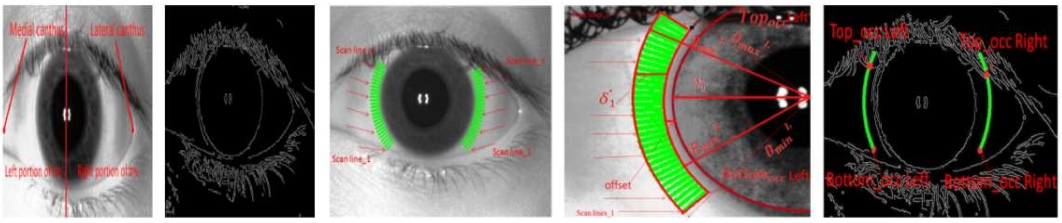
and its loss is irreversible, it is important to detect cartilage damage in early stage, so that preventive treatment can be used to stop the progression any further. Magnetic Resonance Imaging (MRI) has the capability to directly image cartilage. It has the potential to provide sensitive and specific measurements of tissue damage occurring at an early stage of OA.

2. **Problem Statement :** In this area we just have started to study the use of MRI images in order to identify some purely image based metrics on knee MRI images that can be used to identify OA progression as early as possible as shown in Fig. 2.
3. **Collaboration :** We are collaborating with Dr. Mahesh Prakash, Associate Professor, Department Of Radiology PGIMER, Chandigarh.

Figure 2: Cartilage Segmentation from Knee MRI Images

- **Automatic Contact Lens Detection in Iris Images**

1. **Introduction :** Iris is considered as one of the best biometric trait for human authentication due to its accuracy and permanence. However easy iris spoofing raise the risk of false acceptance or false rejection. Recent iris recognition research has made an attempt to quantify the performance degradation due to the use of contact lens.
2. **Problem Statement :** An fully automated algorithm is required to detect soft and cosmetic contact lens from NIR iris images. The lens border is detected by considering small annular ring-like area near the outer iris boundary and locating candidate points while traversing along the lens perimeter as shown in Fig. 3.
3. **Collaboration :** I started this work along with Mr. Balender Kumar, who was a M.Tech student at IIT Kanpur and now graduated.



(a) Original Image (b) Edge Map (c) Scan-lines (d) Annotated (e) Top/Bot Occlusion (L/R)

Figure 3: Automatic Contact Lens Detection in Iris Images

- **Multi-Modal Biometric Trait Acquisition System**

1. There are several different biometric traits available such as face, iris, palm , fingerprint *e.t.c.* But none of them is considered as error free.

2. Multi-modal biometric trait based fusion at sensor level or trait or algorithm level is a hot topic. Researches often fuse multiple trait in pursuit of better performance as well as to reduce the spoofing risks.
3. But there is not a single multi-modal database available in which data for each trait per subject is captured.
4. It is difficult to capture all possible biometric trait at one due to various different acquisition sensors.
5. Hence there is a need to device and acquisition system that can automatically capture all the required biometric traits at-once from any subject and in real time.

- **Wireless Android based application for attendance management (WAM)**

1. Wireless attendance management (WAM) can be realized as an android application.
2. A central secure database server is maintained for users enrolled data.
3. Any device running android can download the application and use it for his attendance marking.
4. The biometric trait considered for attendance authentication are face and palm.
5. The probe data acquisition can be done by the mobile phone camera itself.
6. There can be one automated acquisition machine installed for those who don not have smart phone or having some problem.
7. In any wi-fi enabled campus from anywhere one can mark the attendance and simultaneously without waiting in queue for his turn.

- **Automatic Line Fault Detection in Lawn Tennis Videos**

1. **Introduction :** Fault detection is an important and difficult task in sports involving small and fast moving objects with narrow decision boundaries. Tennis is a sport in which fault detection is tedious as it involves monitoring of small and fast moving ball over narrow lines. To aid manual umpiring in order to improve precision, video processing technique can be used to automate this task of decision making.
2. **Problem Statement :** To track the ball and detect the touch point, including cues based on monocular vision. We are planning to capture Stereo data so as to estimate the ball depth accurately and use that to compute the true ball locations as shown in Fig. 4.
3. **Collaboration :** I started this work along with Mr. Mohit Raghav, who was a M.Tech student at IIT Delhi and now graduated. Presently, I am working with Mr. Ambuj Som, who is a final B.Tech IIT Mandi student.

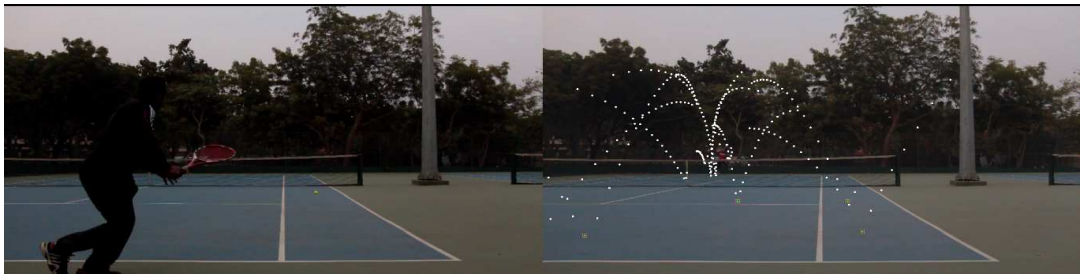


Figure 4: Automatic Line Fault Detection in Lawn Tennis Videos