International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

Anterior Cruciate Ligament tear Prediction using Convolutional Neural Network

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Abstract - *Traumatic pathology is by a wide margin the most incessant issue among youthful competitors. Game wounds speak to an enormous piece of these mishaps, and those of the knee are the most significant, ruled by meniscal and ligamentous sores including that of the anterior cruciate ligament (ACL). Magnetic Resonance Imaging (MRI) is the reference for knee investigation, the quantity of knee MRI tests is in a never-ending increment subsequently of its commitment in the patient appraisal and MRI machines accessibility. In this way, radiologist's time has become a constraining component due to the enormous number of pictures to inspect, notwithstanding the chance of mistake in the translation. The chance of mechanizing certain translation capacities is as of now conceivable so as to restrain the measure of mistakes and between spectator fluctuation. Deep learning is valuable for ailment recognition in clinical radiology since it amplifies the symptomatic presentation and lessens subjectivity and mistakes because of interruption, the multifaceted nature of the case, the misapplication of rules, or absence of information. The reason for this work is to create a model that can remove ACL from MRI input information and characterize its various injuries. We created two convolutional neural systems (CNN) for a double reason, the first is to separate the ACL and the second to arrange it as indicated by the nearness or nonattendance of sores. We examine the chance of robotizing the ACL tears demonstrative procedure by breaking down the information gave by cross segments of patient MRI pictures. The investigation and examinations dependent on genuine MRI information show precise tear of ACL.*

KeyWords: Machine learning, Convolutional neural network(CNN), Alexnet

1.INTRODUCTION

An ACL injury is a tear or sprain of the front cruciate tendon (ACL) — one of the significant tendons in your knee. Upper leg tendon wounds most normally happen during sports that include abrupt stops or alters in course, bouncing and landing —, for example, soccer, b-ball, football and downhill skiing. Many individuals hear or feel a "fly" within the knee when an ACL injury happens. Your knee may grow, feel shaky and turn out to be too difficult to even think about bearing weight. Depending on the seriousness of your ACL injury, treatment may incorporate rest and recovery activities to assist you with recapturing quality and solidness or medical procedure to supplant the torn tendon followed by restoration. A legitimate preparing system may help diminish the danger of an ACL injury.

Magnetic Resonance Imaging (MRI) may be a non-invasive imaging technology that produces three dimensional detailed anatomical images. It is often used for disease detection, diagnosis, and treatment monitoring. It is supported sophisticated technology that excites and detects the change within the direction of the rotational axis of protons found within the water that creates up living tissues.

2. METHODOLOGY

- Each patient has three MRI scans taken with respect to three different planes: axial, sagittal and coronal.
- Build 3 independent CNN models that allow to classify ACL tear per plane.
- Each of these networks will specialize in detecting ACL tear from a given plane.
- In order to have a model that performs well everywhere, combine these three models into single model.

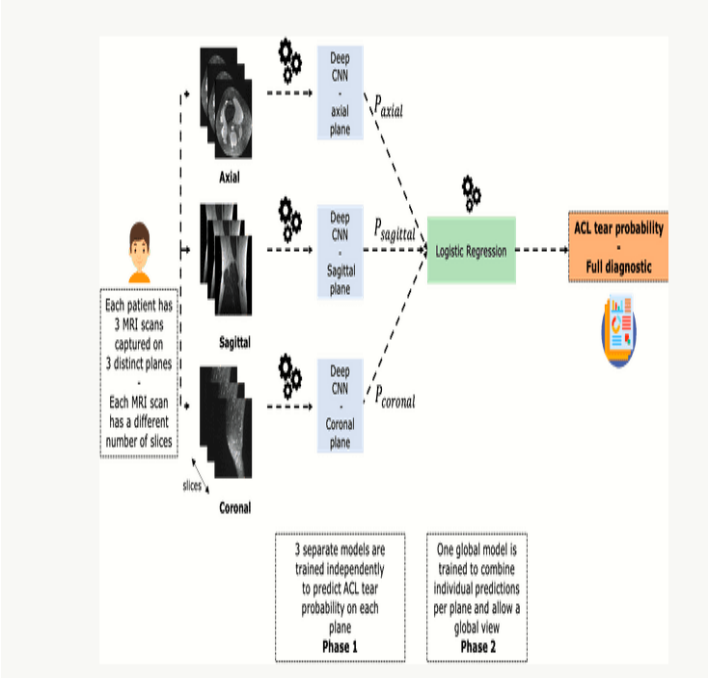

Fig.1 Summary of Methodology

The MRNet is a convolutional neural network that takes as input an MRI scan and outputs a classification prediction, namely an ACL tear probability.The input has dimensions s x 3 x 256 x 256 where s is the number of slices (i.e. images) in the MRI scan. 3 is number of color channel per slice.First, each MRI slice is passed through a feature extractor based on a pre-trained AlexNet to obtain a s x 256 x 7 x 7 tensor containing features for each slice. AlexNet consists of 5 Convolutional Layers and 3 Fully Connected Layers.A global average pooling layer is then applied to reduce these features to s x 256. Basically, each 7x7 matrix is reduced to its mean.Then max pooling across slices is applied to obtain a 256-dimensional vector which is passed a fully connected layer and sigmoid activation function to obtain a prediction between 0 an 1.

Table -1: Hardware Requirements

Model	HP au620tx
Processor	Intel Core i5 CPU-2.71GHz
RAM	8 GB(DDR4)
System type	64-bit Windows Operating System

3. EXPERIMENTAL RESULT

The training of the model is done through the minimization of the cross-entropy loss utilizing Adam optimizer. To consider the imbalanced idea of the classes, the loss of a model was scaled contrarily relatively to the pervasiveness of that model's class in the dataset so as to punish the mistake more on the least present models. During training, the inclination of the loss is processed on each training model utilizing the backpropagation calculation and the system's parameters are then balanced the other way of the slope. During training, some geometric changes are applied on the info MRI. These changes are mark invariant. They are intended to acquire assorted variety the dataset and increment the security of the model while decline its propensity to overfitting. This technique is called information increase.

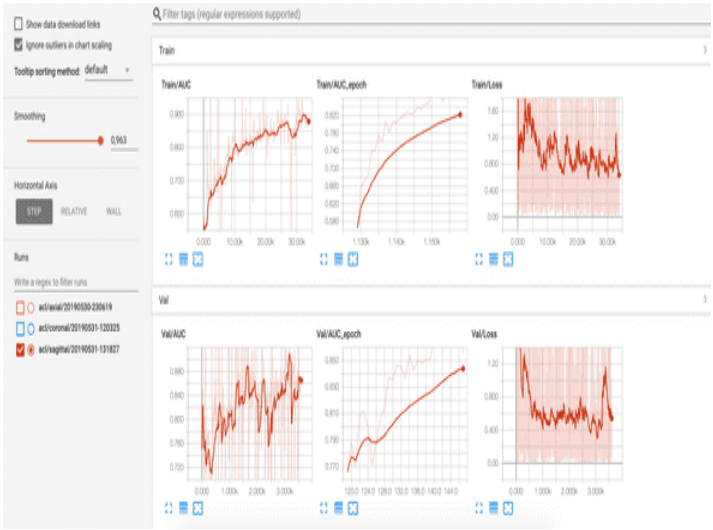

Fig2. ACL AUC Result of all planes

- On every epoch, numerous things are executed:
- We train the model utilizing train_model
- We evaluate the model utilizing evaluate_model
- We print the AUC metric and the loss on train and approval information
- We let the learning rate scheduler update the learning rate
- At each progression:

- A solitary MRI sweep and its comparing mark and weight are passed to GPU
- The system registers a forward pass on the MRI check which brings about a prediciton
- The loss between the expectation and the genuine mark is registered
- Backpropagation of the loss: calculation of the angles & loads update by the optimizer

4. CONCLUSION

The intention of the paper was prediction of ACL tear using convolutional neural network on MRNet Dataset Architecture. It helps the system to detect tear in ligaments of body while doing physical activities such as sports,yoga,gyms and so on.

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