CP301: Development Engineering Project

NOVEL CATARACT DETECTION CNN BASED METHOD

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Motivation behind the Project:

1. **Cataract is a major problem in the eyes of especially older people that hampers their experience to view the world around them properly.**

2. **Early detection of cataract and its grade can not only prove to be beneficial for the patient but also help doctors in the timely and less intensive treatment, as compared to cases where the grade of cataract is very high.**

3. **The detection of cataract is more crucial in rural and less developed lands, where the access to good healthcare is scarce**

Related work

1. Jing Ran et al.[6] proposed Deep convolutional neural network(DCNN) and random forest based approach for six level cataract grading method.DCNN consists of three modules for feature extraction at different levels on fundus images which is then given or fed to RF which performs more elaborate six-level cataract grading based on feature datasets generated by DCNN.The accuracy of six-level grading achieved by the proposed method is up to 90.69% on average.

2. MASUM SHAH JUNAYED et al.[1] proposed Cataract Net a novel deep learning neural network for automatic cataract detection in fundus images.The loss and activation functions are tuned to train the network with small kernels, fewer training parameters, and layers. Thus, the computational cost and average running time of Cataract Net are significantly reduced compared to other pre-trained Convolutional Neural Network (CNN) models. The proposed network is optimized with the Adam optimizer.Average Accuracy of 99.13% is achieved which proves that it outperform the state of the art cataract detection approaches..

Related work

3. Aditya Parulekar et al.[4] utilized ResNet architecture which is composed of 152 convolutional layers and 1 fully connected layer.ResNet is trained to perform human object recognition and is able to detect objects accurately.

4. Riyanto Sigit et al.[7] proposed a single layer perceptron method for classification in the form of normal eyes, immature cataract eyes and mature cataract eyes.The android smartphone based cataract detection system carried out classification with an accuracy of 85% .

5. Juyel Rana et al.[2] had conducted self screening of early detection of cataracts in the Bangladesh area. Cataract detection is done using a smartphone such as Android, iOS, Windows. The application uses the front camera to detect faces and eyes. Then the eye will be cut and displayed in 2 different views. After the eyes are detected, cropping is done on the pupils and determining the color of the pupils. Cataract detection is done using 4 stages.

Methodology

1. The proposed architecture consist of 5 blocks where the first two blocks comprise of :- Convolutional layer, Batch normalization layer, Convolutional layer, Max Pooling layer and next three blocks comprise of :- Convolutional layer, Batch Normalization Layer , Convolutional Layer, Batch Normalization Layer, Convolution Layer, Max Pooling Layer respectively.
2. Number of trainable parameters in the model are 0.7million which is lowest according to our research.
3. The average training time of model is 100 sec.
4. The size of the model is only 8MB.
5. The accuracy achieved is 99.16%, which is higher than the state of the art model, CataractNet (98.62 %).

Dataset

1.Images are captured using Fundus camera.

2. This dataset is meant to represent “real-life” set of patient information collected by Shanggong Medical Technology Co., Ltd. from different hospitals/medical centers in China.

3. In these institutions, fundus images are captured by various cameras in the market, such as Canon, Zeiss and Kowa, resulting into varied image resolutions.

4. It is a structured ophthalmic database of 5,000 patients with age, color fundus photographs from left and right eyes and doctors' diagnostic keywords from doctors.

5. It contains 7000 testing images and 1000 training images of which 6392 are pre-processed images.

Dataset

6. It classifies each image into eight labels including
Normal (N), Diabetes (D), Glaucoma (G), Cataract (C), Age-related Macular Degeneration (A), Hypertension (H), Pathological Myopia (M), Other diseases/abnormalities (O)

7. It contains exhaustive descriptions of each image as well as comments by doctors of various medical centers in China. Each image is classified not only on the basis of Cataract but also on various other Eye conditions.

8. All images are based on JPEG format having .jpg as file extension. JPEG is used for Lossy-compression of digital images.
Size of each image is around 50-60 KB.

Data Preprocessing

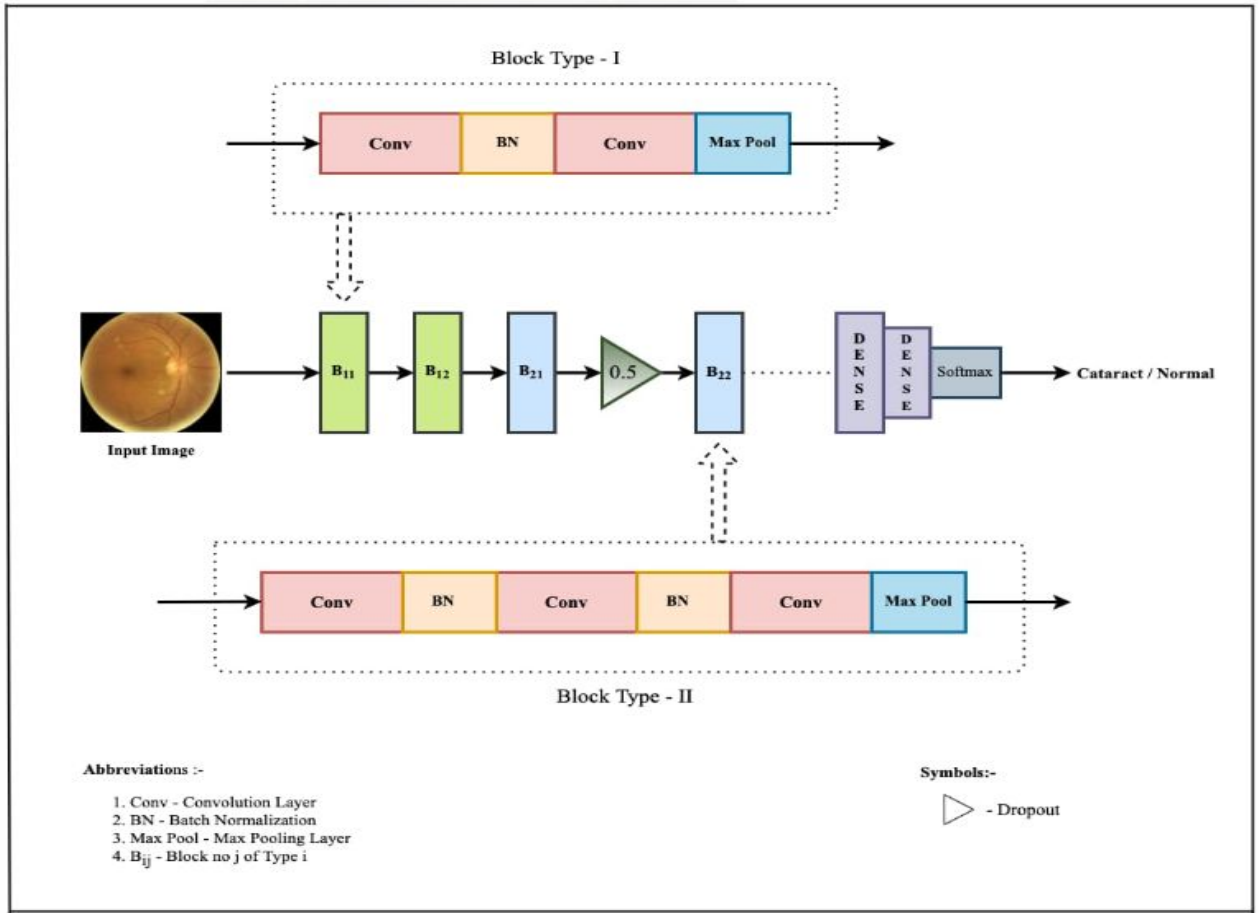
1. First of all segregation of images is done based on the labels i.e. Cataract and Normal Images as the dataset used contains images of several other eye diseases. Furthermore , the segregation is done in real-time as the images after segregation is not saved and is directly fed for further processing.
2. In the next step, the resizing of image is applied where the data set is resized into 224*224 pixels in this model using cv2.resize function.
3. In the next step, image augmentation is done. Deep learning model requires large amount of data to make model more robust and perform better. So Image Augmentation is done to gather more data out of the dataset.

Data Preprocessing

1. Keras provides methods to implement image augmentation using the class "Image Data Generator" which uses the parameters such as re-scale, shear, zoom, horizontal flip in our model.

2. On completing the data collection and preprocessing steps, the data set is totally fit to be applied to the neural network model.

MODEL ARCHITECTURE

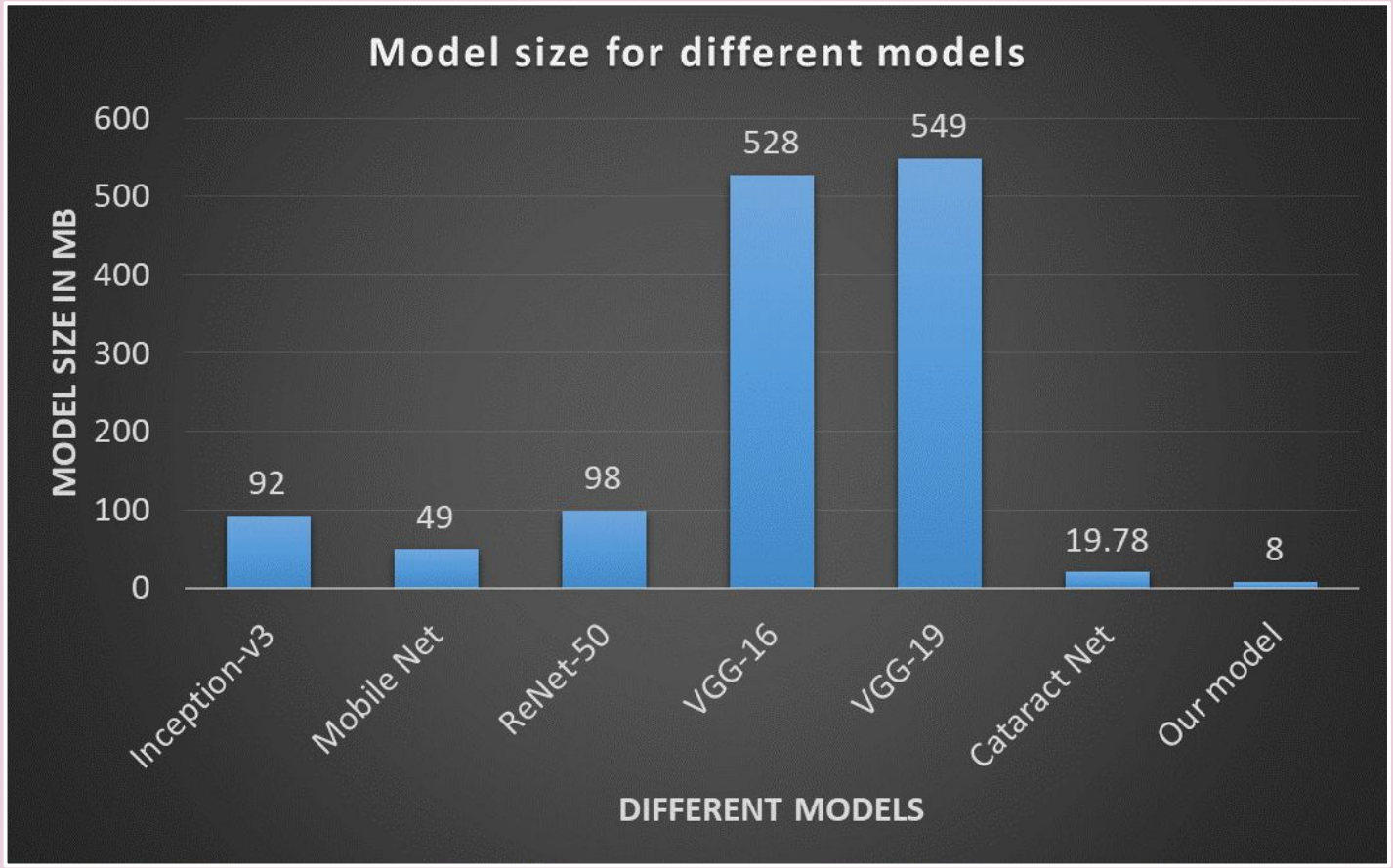


Comparison with other standard Cataract Detection Models

Comparison of different models based on size

INFERENCES:

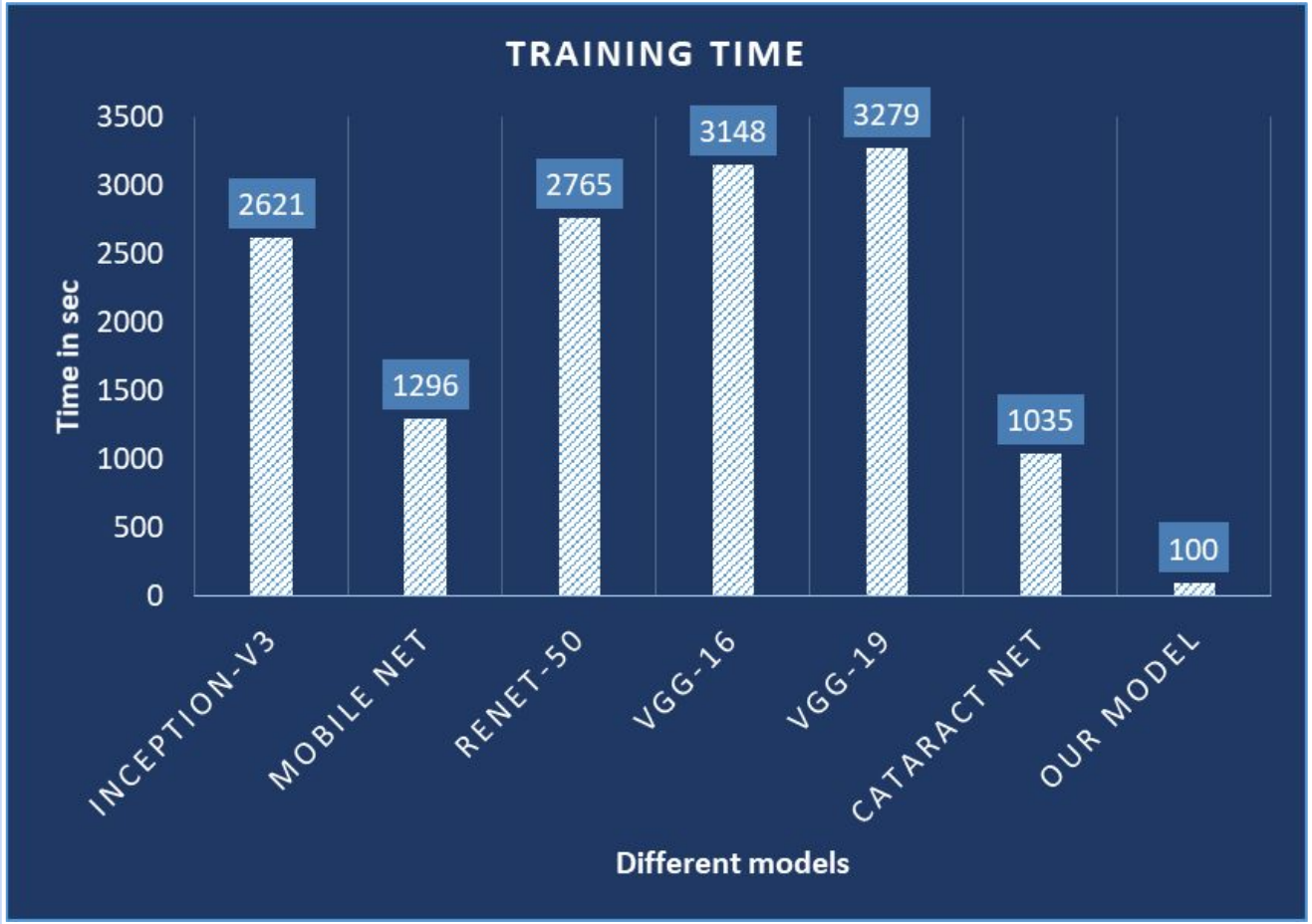
Our model size is just 8 Mb which is the least (and hence desirable) among all seven models i.e. Inception-V3, Mobilenet, ReNet-50, VGG-16, VGG-19 and CataractNet



Comparison of different models based on Training Time

INFERENCE:

- The training time of our model is the best i.e. 100 sec which is very less as compared to the other models.



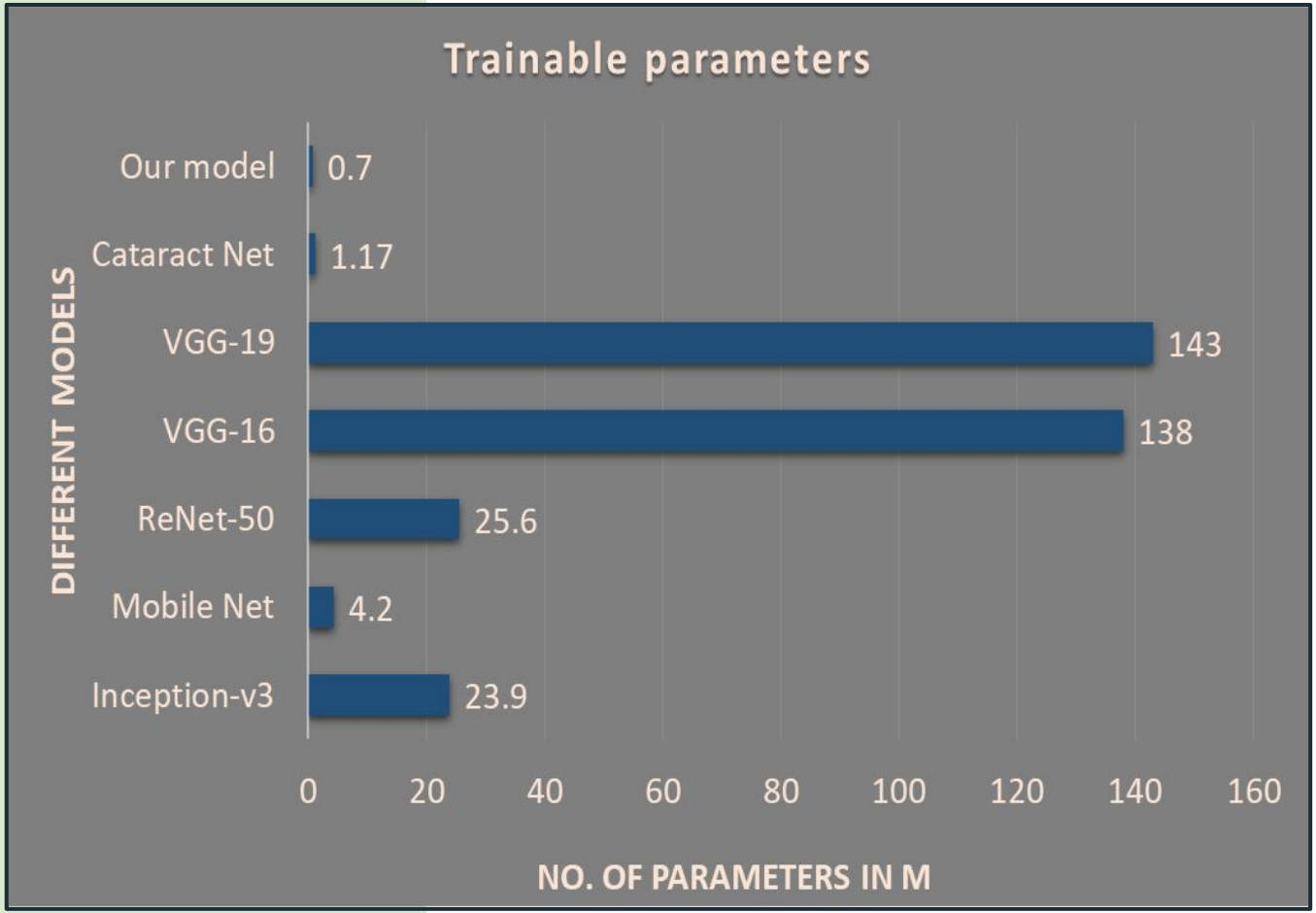
Novelties in our Solution

Comparison of different models based on Trainable Parameters

INFERENCE:

- The number of Trainable parameters in our model is the least i.e. 0.7 M

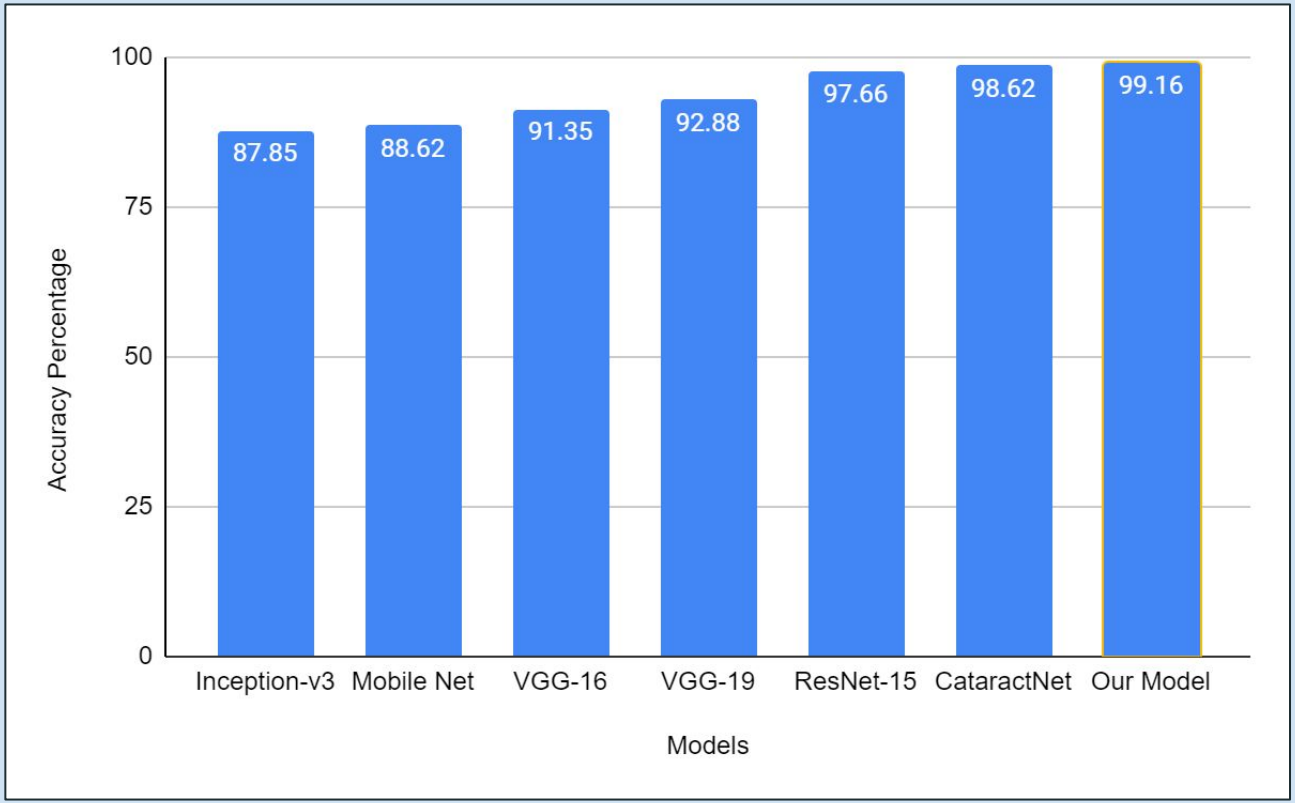
- This helps to reduce the computation cost and time



Comparison of different models based on Accuracy

INFERENCE:

- Our model has the best accuracy of **99.16%** among all the other models in comparison.



References

1. CataractNet: An Automated Cataract Detection System Using Deep Learning for Fundus Images
2. Cataract detection using smartphone
3. Machine Learning for Cataract Classification and Grading on Ophthalmic Imaging Modalities: A Survey
4. Advance Cataract Onset Detection Using Deep Learning
5. Cataract Detection Using Convolutional Neural Network with VGG-19 Model
6. Cataract Detection and Grading Based on Combination of Deep Convolutional Neural Network and Random Forests
7. Cataract Detection Using Single Layer Perceptron Based on Smartphone


Thank You!