Identifying the Weight of Potatoes using Artificial Intelligence on Raspberry Pi and Android Application

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***Abstract*— This paper introduces a novel method using Raspberry Pi based AI system to identify the weight of potatoes without measuring them physically. The Raspberry Pi bases AI system can measure the weight of potato just by taking a picture of it. The system uses pre-trained model called Inception V3 developed by Google. In our case, the model will is retrained for its last layer with labels of input images based on what it previously learnt which is popularly known as transfer learning. The system comprises of open source technology like python, inception model and Raspberry Pi.**

Keywords—artificial intelligence, python, raspberry pi, inception model, transfer learning

I. INTRODUCTION

Since decades weighing scales are used for measuring the weight of any object or physical quantity. There are only two popular methods of weight measurement today namely manual and digital. The paper suggests a new novel approach of weight measurement using Artificial Intelligence. The proposed AI system is trained like human by showing different shape and size of the potatoes. Once the AI model is trained it has been tested for accuracy which was more than 95%. When we study classifying images, we usually build our new model for greater accuracy, this is the solution but building a custom deep learning model requires huge dataset and high-power computing devices for lots of training data. Moreover, there already exists a pretrained model known as Inception by Google, which performs pretty well in classifying images from various categories. The popular one is ImageNet, and its Large Visual Recognition Challenge in which models try to classify a large number of images into 1000 classes, Inception V3 is the model Google Brain Team has built for the same. The model is so powerful, popular, light and easy to work with a smaller number of images to use for Transfer Learning. Inception is a pretrained convolutional neural network model on 1,000,000 into thousand categories.

II. METHODOLOGY

A. Dataset preparation

- To prepare the necessary dataset of potatoes of different weights, shapes and size from vegetable wholesale market of potatoes various photographs were taken. Fig1(a) and Fig1(b) shows the sample photos of 200gm and 400gm potato for training data.
- After collecting various photos of different weights of potatoes they were kept in separate folders with weights as labels.
- Improper, blurred and photos were removed

Fig. 1(a) Potato of 200gm

Fig. 1(b) Potato of 400 gm

- Taking photos of these potatoes respective of their weights and keeping them in separate folders for training the neural network.

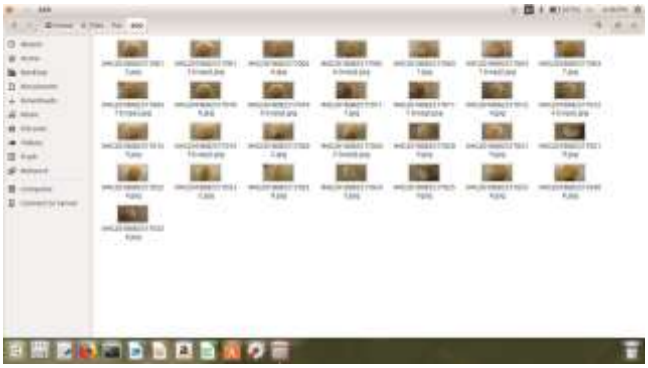

Fig 2. Dataset of potatoes of 400 Grams each

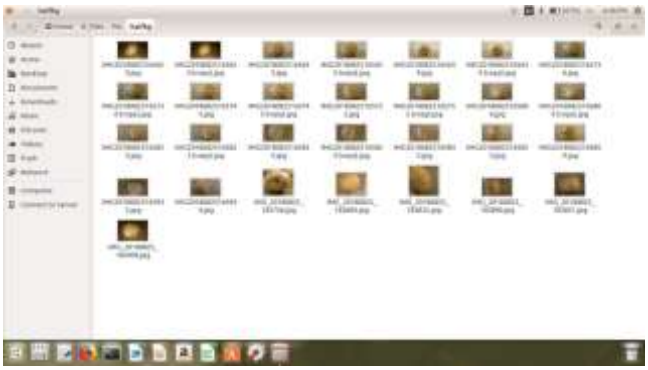

Fig 3. Dataset of potatoes of 500 Grams each

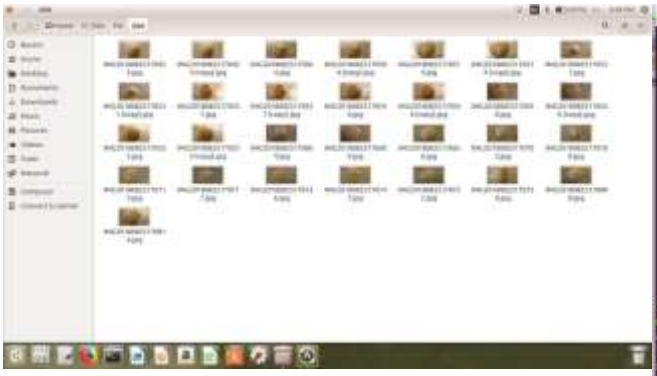

Fig 4. Dataset of potatoes of 200 Grams each

- Train the Inception image classifier using our new data of Potatoes photos

Fig. 5 Inception Architecture;
Source https://arxiv.org/pdf/1409.4842v1.pdf

- Porting the trained model to Raspberry pi
- Create the Potato weight Identifier on Raspberry pi

B. Setting up the enviornement for Raspberry Pi and Android TFlite

The system was developed on Ubuntu 16.04 LTS with necessary software like Python 3 and Android studio for Linux. Initially all the python and TensorFlow related packages, libraries and dependencies were installed.

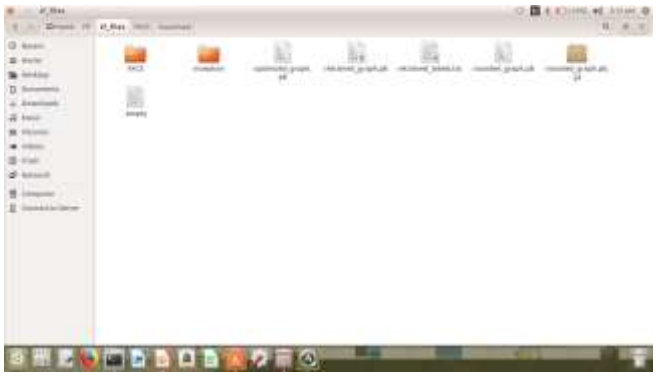

Fig. 6 Downloading the Inception model in tf_files

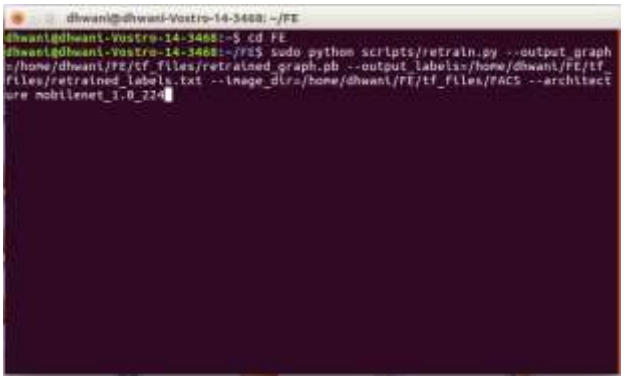

Fig. 7 Retraining the Inception model for potato weights

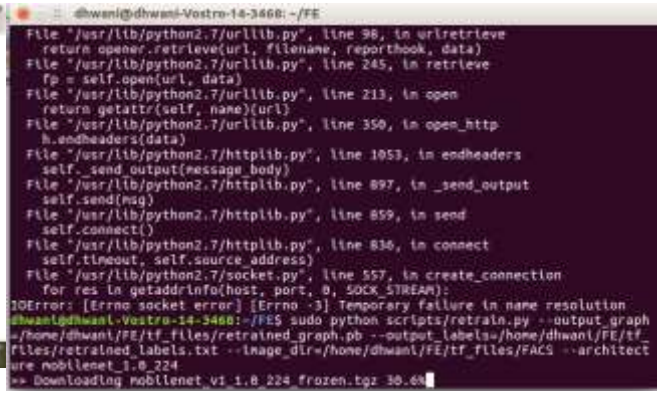

Fig. 8 Mobilenet v1.1.0.224 download

As shown in Fig.9 after downloading mobilenet, retraining will start for the last layer with potatoes weights labels. This will take few minutes to train on CPU but can be faster on GPU.

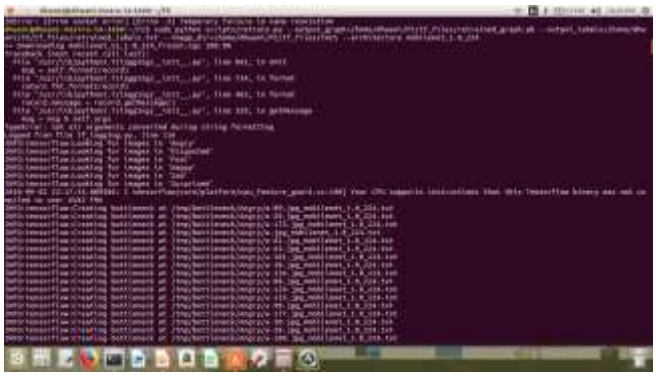

Fig. 9 Retraining of mobilenet for our dataset

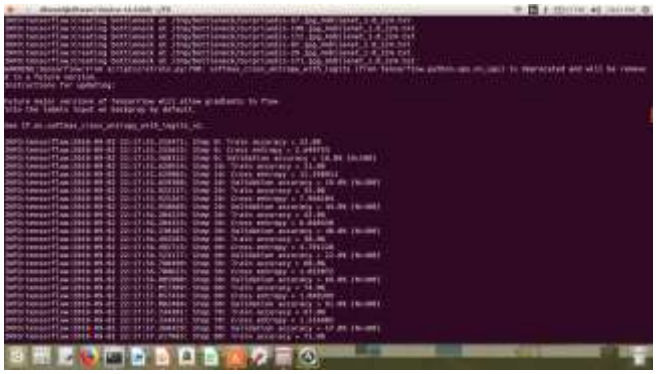

Fig.10 Bottlenecks will be created for each image of potato

As shown in the Fig.11 the Training Accuracy is the accuracy that is obtained from the model we have trained and the Testing accuracy is the accuracy that is obtained from the images that the model hasn't seen. In this case it was 100% and 94.3% respectively. Table I shows train, cross entropy and training accuracy during the training period

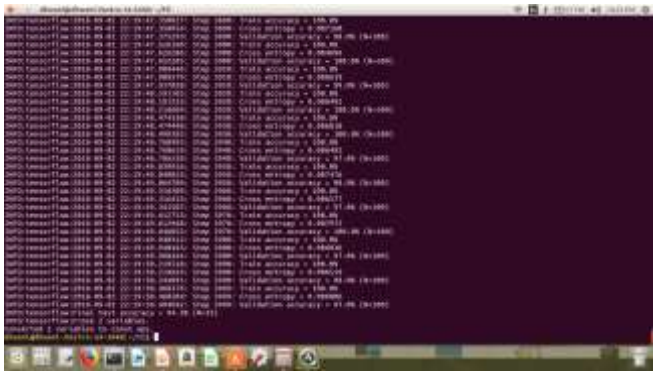

Fig.11 Testing and Validation accuracy

Fig.12 Conversion of retrained graph to optimized graph

The table of the training and testing accuracy obtained respective to the steps is shown in the Table I.

TABLE I. TESTING AND TRAINING ACCURACY

Steps	Accuracy in %		
	Train	***Cross entropy***	***Validation***
0	22.0	2.64	16.0
10	21.0	12.29	19.0
20	32.0	7.966	44.0
30	42.0	6.84	40.0
40	38.0	4.79	22.0
50	68.0	1.05	66.0
60	74.0	1.049	61.0

To use the retrained model in the android application a smaller size of the model is needed because mobile phone has constrained hardware requirements hence the 171MB size of the Inception model is converted to 13MB optimized graph and then to rounded graph model which is then transferred to the resource folder of the android studio as shown in the Fig.13 All retrained optimized and rounded models are available in the tf_files folder are ready to use as shown in Fig. 14

Fig.13 Conversion from optimized to rounded graph

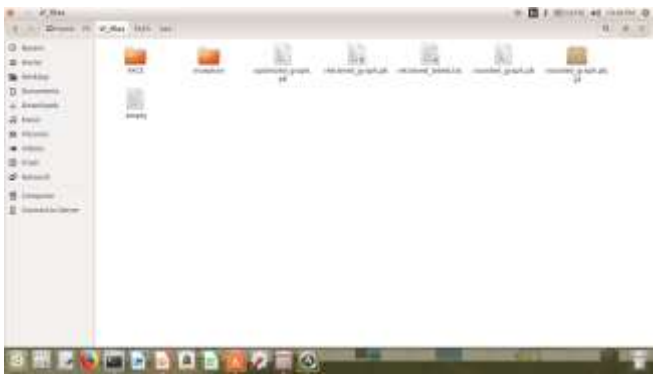

Fig.14 All retrained optimized and rounded models

Copy retrained_labels.txt which contains labels of potato weights 200gms, 400gms and 500gms and rounded graph.pb to asset folder as shown in the Fig.15

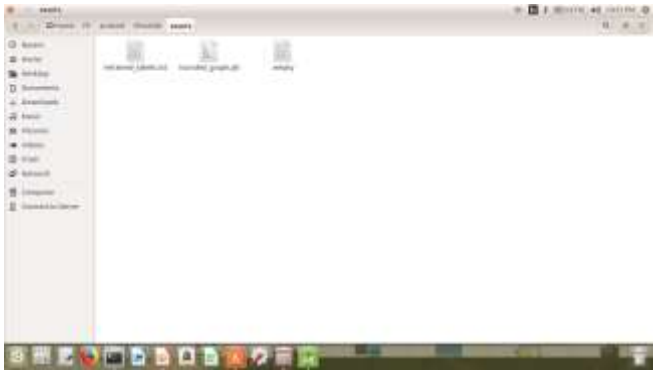

Fig.15 Contents of the asset folder.

After building and running the android app .apk file is generated which can be installed to mobile phone, which will open the mobile phone camera on startup to measure the weight of the potato kept in front of the camera. The weight of the potato will be displayed on the camera view finder screen itself. The system also sends the predicted weight of the potato with its photograph on telegram messenger app using an AI bot as shown in Fig. 18 and Fig.19

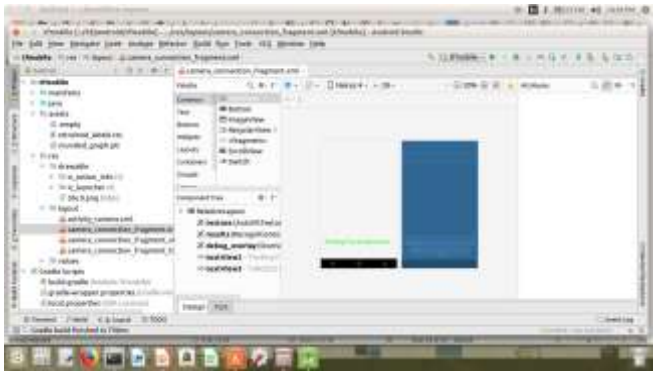

Fig.16 Android studio workspace

III. TESTING

Fig.17 Testing on Raspberry Pi hardware.

Fig.18 Results obtained on the AI bot on Telegram

Fig.19 AI chat bot on Telegram

IV. YOUTUBE VIDEO QR CODE

Fig.20 QR code Scan the code to watch the YouTube video

The Raspberry Pi connected with camera to identify the weight of the potato shown in the Fig. 17. When the program is executed the system captures the photo automatically and checks with the pre-trained model and the result is shown on the screen and AI bot (Fig. 18 and Fig. 19)

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