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Fruit Image Recognition and Calorie Measurement Using Convolutional Neural Network (CNN)

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Abstract
In this paper, a web-based application for estimating fruit calories and improving individual's utilization propensities for wellness is developed. We design an easy approach to the new deep convolutional neural network (CNN) configuration and built an application to recognize fruit images using a Tensor Flow Lite model trained on Teachable Machine.
The tensor flow is one of the best process to classify the machine learning method. This method is implementing to calculate the food calorie with the help of a Convolutional Neural Network. However, deep learning has been widely used as an efficient image recognition method, and CNN models are built to evaluate its performance on image recognition and detection dataset. A convolutional neural network (CNN) is specifically used to complete the task of recognition of fruit. CNN framework is inspired by biological processes and includes alteration of multilayer preceptors that result in minimal amounts of preprocessing. In a CNN, there are multiple layers that each have distinct functions to help us identify an image. CNN achieved significantly higher accuracy than the conventional process. A convention design application is developed for capturing the image, recognition, and automatic calculation of calories.

Keywords: ConvolutionalNeuralNetworks, Fruit image recognition, Tensor Flow, Deep Learning, Teachable Machine, Calorie Measurement

I. Introduction

In recent years, due to a rise in health consciousness, many mobile applications for recording everyday meals have been released. Some of them enlist fruit image recognition, which estimates not only fruit names but also fruit calories. It's important to recognize that high-fat fruits have greater calorie density since a gram of fat has over twice the calories of a gram of protein or carbohydrate. Fresh fruits are not sold with nutrition facts. Whether the goal is to limit carb intake, count calories, or simply try to eat more whole fruit, the calorie chart will pinpoint which fruits best fit into your healthy eating plan.
A calorie deficiency occurs when you spend more calories than you take in. Calories are listed in the nutritional information on all fruit packaging but not fresh fruits. Calories are essential for human health. The key is consuming the right amount. Everyone requires a different level of energy every day, depending on age, sex, size, BMI, and activity level. Fruits high in energy but low in nutritional value provide empty calories. If people consumed only the calories required every day, they would probably have healthy lives. Calorie consumption that is too low or too high will eventually lead to health issues. The number of calories in fruit tells us how much potential energy they contain.
In this study, we use a convolution neural network to solve fruit recognition in an initial algorithm. The further algorithm focuses on calorie measurement and identifying the origin of the fruit.
Convolutional Neural Networks (CNN) is one class of deep neural networks Deep learning is a class of machine learning algorithms that uses multiple layers to progressively extract higher-level features from the raw input

which helps to interpret the data such as images, audio, and text. The concept of Deep Learning arises from the study of Artificial Neural networks, Multilayer Perceptron which contains more hidden layers is a Deep Learning structure.

II. Convolutional Neural Network

A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm that can take in an input image, assign importance to various considerations in the image, and be able to distinguish one from the other. It is a multilayer neural network, whose neurons take small shifts and rotations. CNN's are generally a configuration of three types of layers. Convolutional layer, fully connected neural network, apply a number of convolution filter with specific weight (n x n) to the input image. For each section of the image, a set of mathematical operations is applied to produce a single value in the output. Each input convolves these filters. Each layer has many filters that generate several outputs. The filter is called a kernel. The second type of layer is the pooling layer, which produces a downsample of the resulting image produce by the convolution layer to reduce the size of the feature map for faster processing time. There are several algorithms such as maximum polling and average pooling. A widely used algorithm is maximum pooling. This makes the CNN output more invariant with respect to position Fully connected layer, perform classification on the extracted feature after downsampling by a pooling layer. Each unit of the final layer represents the class probability. This layer is used to enumerate the score classes i.e. which class has the maximum score comparable to the input image as shown in Fig.1.

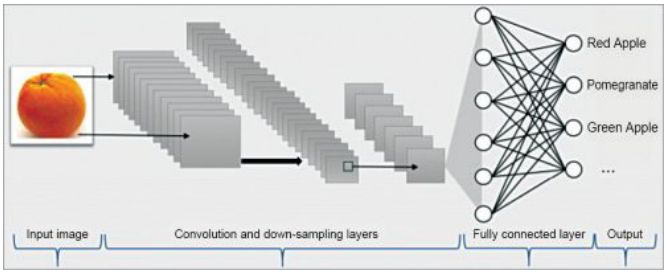

Fig 1. Convolutional Neural Network 1

III. Literature Review

Paper [1]: - *Qian Yu (Stanford), Dongyuan Mao (Stanford), Jingfan Wang (Stanford) "Deep Learning Based Fruit Recognition" Year 2016 IEEE*

In this research paper, authors proposed a CNN-based fruit recognition method on the fruit recognition problem: the transfer learning and the fine-tuning on the whole architecture based on the Inception-ResNet and Inception V3 model. Here, algorithm is performed on the Fruit-101 dataset and obtained impressive recognition results: Inception-ResNet converges much faster and achieves top-1 accuracy of 72.55% and top-5 accuracy of 91.31%.

Paper [2]: - *Chang Liu, Yu Cao, Yan Luo, Guanling Chen, VinodVokkarane, Yunsheng Ma "Deep Fruit: Deep Learning-based Fruit Image Recognition for Computer-aided Dietary Assessment" Year: 2015, IEEE*

In this paper, authors have proposed a new deep learning-based approach to address the fruit image recognition problem. Deep learning, aims to learn multiple levels of representation and abstraction that help interpreting knowledge from data such as images, videos, audio, and text, is making astonishing gains in computer vision, speech recognition, multimedia analysis. Specifically, authors proposed Convolutional Neural Network (CNN)-based algorithms with a few major optimizations, such as an optimized model and an optimized convolution technique.

Paper [3]: - *Parisa Pouladzadeh, Pallavi Kuhad, Sri Vijay Bharat Peddi, AbdulsalamYassine, ShervinShirmohammadi "Fruit Calorie Measurement Using Deep Learning Neural Network" Year: 2016 IEEE*

In this paper, authors proposed an assistive calorie measurement system to help patients and doctors succeed in their fight against diet-related health conditions.Proposed system runs on smartphones, which allow the user to take a picture of the fruit and measure the amount of calorie intake automatically. In order to identify the fruit accurately in the system, authors used deep convolutional neural networks to classify 10000 high-resolution fruit images for system training. Results show that the accuracy of this method for fruit recognition of single fruit portions is 99%. The analysis and implementation of the proposed system are also elaborated in this paper.

Paper [4]: - *MdTohidul Islam, B.M. NafizKarimSiddique, SagidurRahman, TaskeedJabid "Fruit Image Classification with Convolutional Neural Network", Year: 2018 IEEE*
In this paper authors tried to classify fruit images using convolutional neural network. Fruit classification is very difficult task because there is high variance in same category of fruit images. Authors developed a convolutional neural network model to classify fruit images in fruit-11 dataset. Authors also used a pre-trained Inception V3 convolutional neural network model to classify fruit images.

IV. Methodology

A. Data Collection

Acquisition involves accumulating or adding to the data holdings. There are several methods of acquiring data

i) Using your own previously collected data.
ii) Reusing someone others data.

B. Building a Dataset

In this study, we will cover one of the ways in which building Tensor Flow-based models is getting easier – that is, through Google's AI experiment Teachable Machine. TensorFlow is an open-source programming library for machine learning (ML) applications. It can be used for generating a training dataset and training a Machine Learning model straight from a web browser. TensorFlow bundles together a takeout of machine learning and deep learning (aka neural networking) models and algorithms and makes them useful by way of a common metaphor. It uses Python to provide a convenient front-end API for building applications with the framework, In fact, as we shall see, the trained model can be exported for usage in native Tensor Flow, TensorFlow.js, and Tensor Flow Lite. MNIST, CIFAR-10, Fruit-101, Caltech-256, is relatively easy to start exploring datasets and make some first predictions using simple Machine Learning (ML) algorithms.

C. Export & integrate the trained model to Android Application

Although to make these trained models useful in the physical world, it is needful to make them available to make predictions on either the Web or Portable devices. TensorFlow Lite is a platform developed by Google to train Machine Learning models on mobile or any portable devices. Using TensorFlow Lite, all the workflow is executed within the device, which avoids having to share data with the server and back to the user. TF lite model is a special format model efficient in terms of accuracy and also is a lightweight version that will occupy less space, these features make TF Lite models the right fit to work on Mobile.
We created an Application on Android Studio using the TensorFlow Lite Dataset model trained on the Teachable. Teachable was created in order to resolve some constraints brought from creating huge and deep neural networks for image classification tasks. We used Android Studio as the IDE to integrate all the required Tensor Flow Lite dependencies.
We applied the transfer learning method to our data model which is by using the pre-trained model as a checkpoint and continue to train the neural network. The reason that we can do so is that a Teachable Machine is a web-based tool that makes creating machine learning models fast, easy, and accessible to everyone. A method for creating and training your own Machine Learning models from the browser. Teachable has a very large amount of
dataset and is trained quite well. We can make full use of the pre-trained ML model and get the feature based on the Teachable dataset.

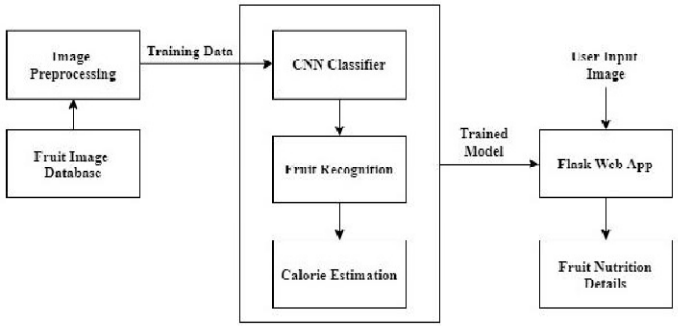

Fig2. CNN Algorithm Flowchart

V. Results and Analysis

We received the output on the built application as referred in the Fig 3.

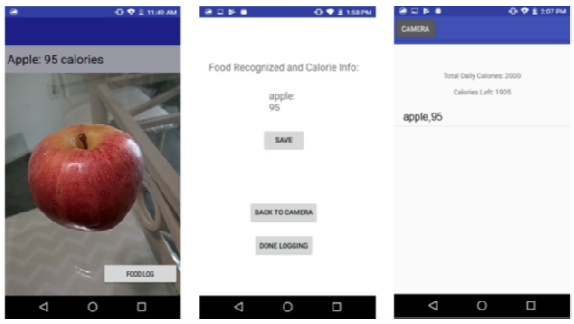

Fig.3 Application Result

Dataset Model Training Analysis

Machine Learning algorithms learn from data. Neural networks and other artificial intelligence programs require an initial set of data, called a training dataset, to act as a foundational measure for further processing and utilization. This dataset is the baseline for the program's growing library of information. The training dataset must be accurately labeled before the model can process and learn from it. The dataset you want to use for training usually needs to be upgraded, enriched, or labeled. There are multiple factors in play for concluding how much machine learning training data you require. First and foremost is how important accuracy is. Say you're creating a sentiment analysis algorithm. A sentiment algorithm that achieves 80 or 90% accuracy is more than enough for most people's needs. To a system or machine, an image is just a series of pixels. Some might be green, some might be brown, but a system doesn't know this is a fruit until it has a label associated with it that says, in essence, this collection of pixels right here is a specific fruit. If a machine detects enough labeled images of fruit, it can start to understand that similar groupings of pixels in an unlabeled image also constitute a fruit. The best way to prepare training data so that it has the features and labels your model needs to succeed is with a human-in-the-loop who can label and upgrade your data accurately and efficiently. The performance of the model is directional dependent on the accuracy of the labels for your training data.

VI. Conclusion

In this study, we have built an easy and effective approach to build CNN based application to identify the fruit and measuring calories. The dataset were collected from web and trained on the web application Teachable.

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