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Food Categories Classification and Nutritional Value Estimation using CNNs on Raspberry Pi 3B

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Abstract: ***Foods are important things to human beings, especially for elderly and diabetics. Tradition nutrition book is not the effective way for people to use and not cover all kind of foods. Most of the food nutrition in the book focused on Western dishes not Asian dishes. This research proposed the new way to categorized food dishes and estimate nutritional value using convolutional neural networks. These networks are transferred in to RaspberryPi 3B platform to simulate limited resources and calculation power platform likes in a mobile phone. The image of food is captured by the webcam and it is sent to Raspberrypi 3B where CNNs categorize the food dishes and estimate the nutrition value. In this we also used LEDs and slide switches where switches enable the device to know whether the human is diabetic or not and LED enable the human to take sufficient amount of food. The networks in Raspberry Pi 3B produce good prediction accuracy but slow speed. PeachPy is introduced to speed up the network and it can run at 3.3 seconds per food image.***

Keywords: Food, Raspberrypi 3B, CNNs, Switches, LED's, Webcam.

I. INTRODUCTION

The field and science of making the machines understand the world just like humans and attain human levels of thinking and decision making on their own is known as artificial intelligence(AI). Machine learning is one the application of AI which is aimed at giving the capability of think and learn to machines just like human beings. Machine learning is of few types Supervised, Unsupervised, Semi-supervised, Reinforcement learning. Deep learning is a sub domain of machine learning that deals mostly with unsupervised learning of machines. "You are what you eat" this phrase depicts the importance of food and its impact on one's health. In this busy world, one spends least time and interest in eating healthy food and actually caring about our food and diet. This gradually is leading to unhealthy food practices. In today's world, the touch of traditional homemade food is a long last thought and people are more into the fast and junk food because of its time saving concept. So, gradually, one has lost track on how much and what type of food is being consumed. Due to this lack of interest on our food habits, the negatives of this are coming into the limelight, there are any health issues and of the major causes for this is FOOD. Due to lack of knowledge on what we are eating, we are developing health issues like increase in cholesterol which in turn leads to many other health complications like heart attacks, obesity etc. the old fashioned possible way of getting to know the nutritious value of the food being consumed is first, having the knowledge about the ingredients used in the food and then searching about their nutritional values in the traditional nutritional book which is a tedious process and given now-a -days scenario , no one would opt to follow this procedure.

Aim of this research is to develop the way to extract food information from food dish images. First the Convolutional neural networks are used to determine the food categories and estimate the nutritional value. Switch 1 is moved according to know the person is diabetic or not, if the person is diabetic and trying to consume unhealthy food like(PIZZA) "This food is not good for diabetic patient" is displayed and if he is consuming healthy food like(APPLE) "This food is good for diabetic patient" is displayed . Switch 2 is moved if the person is willing to eat the same food item for the second time, Red led (led 1) glows if the person is over consuming the food. Green led(led 2) glows if the person is supposed to eat the food. Figure 1 shows the block diagram.

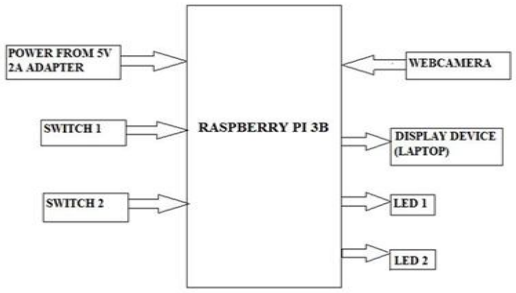


Figure 1: Block diagram

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II. CONVOLUTIONAL NEURAL NETWORKS

Convolutional Neural Networks named after Neural Networks of human brain referring to the functionalities. Convolutional Neural Networks or CNNs is most importance tool for modern image recognition application. Problem of patterns, objects or faces recognition are solved easily by using CNNs. There are many popular and useful algorithms developed in the past few years such as GoogLeNet [1], Inception V3[2] and AlexNet[3], YOLO[7]. The architecture of CNNs is a repetition of convolutional layer and a pooling layer and finally a fully connected layer and a dense layer. CNNs are trained using Tensorflow framework. TensorFlow is an open source library released by Google to build and design Deep Learning models. TensorFlow performs numerical computations in the form of a Dataflow graph. Since the main hardware of this research is Raspberry Pi, the Tensorflow GPU version is not improve the calculation performance much since Raspberry Pi GPU has only 4 calculation cores then Tensorflow. These CNNs categorise the food dishes and estimate the nuritinal value.

III. HARDWARE

Personal computer is used as a training machine, Raspberrypi 3B is used as a target embedded computer to simulate low resources embedded ARM processor platform such as in a mobile phone. Raspberry Pi 3 is a small development board that uses Broadcom BCM2837 SOC as the main processer and it consists of Quad-cores ARM Cortex-A53 CPU operating at 1.2 GHz, 1 GB of DRAM, MicroSD card slot, Camera Serial Interface and 2.4GHz 802.11n wireless LAN and Bluetooth LE IC. This board is run on Raspbian Linux operating system based on Debian Stretch Linux [8]. Python language is programming language. Webcam is used to capture the food image. Switches are used to know whether the patient is diabetic or not and LEDs allow us to know the information about the consumption of food. Figure 2 shows the Raspberrypi connected to camera, LEDs and switches.

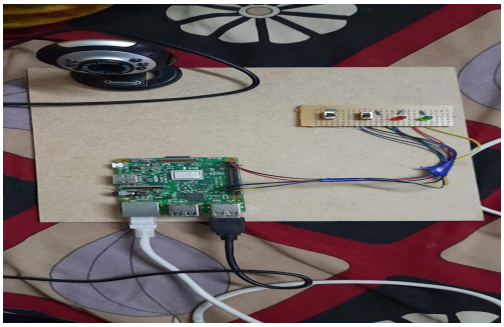


Figure 2: Pi connected to camera, LEDs and switches

IV. EXPERIMENTS

The input image(food image) is fed to Convolutional neural network where it undergoes through different layers like convolutional layer, pooling layer, fully connected layer(fc layer) and a dense layer to categorize the dish and to find nutritional value of the food. These networks are trained using tensorflow framework

We trained upto 6 food items, They are: Banana, Apple, Donut, Pizza, Sandwich, Orange. Several images of each dish are used for training CNNs. Food dishes are categorized by CNNs and complete nutritional value is estimated. The nutritional value which we got is compared with the nutritional value from WHO (world health organization). It also shows whether the food is good for diabetic patient or not. It warns the people if they are over consuming the food through LEDs their by reducing the risk of becoming obese. Figure 3 shows the nutritional value of orange and if person is diabetic it displays “This food is healthy for diabetic patient”.

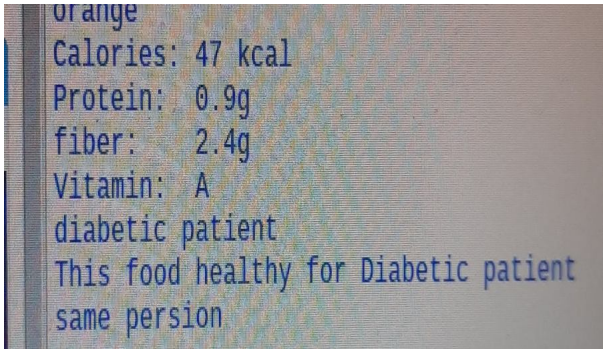


Figure 3: Nutritional value of orange

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When the person moves the slide switch1 indicating that he is a diabetic then the device will display whether the food is healthy for him or not an example of this is shown in figure 4. In Figure 4 when apple is detected it displays that apple is healthy for diabetic patient when donut is detected it displays that donut is not healthy for diabetic patient.

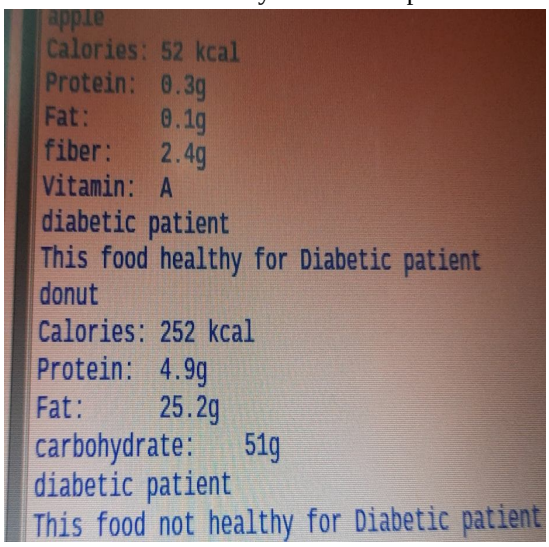


Figure 4: Nutritional value of apple and donut

When the person wants to eat the food item for the second time he has to move the slide switch 2 then based on the nutritional value red and green LEDs glows. Red led glows when the person consumed sufficient food and displays “you have taken the sufficient food” as shown in figure 5. Green led glows when the person is supposed to eat the food as shown in figure 6.

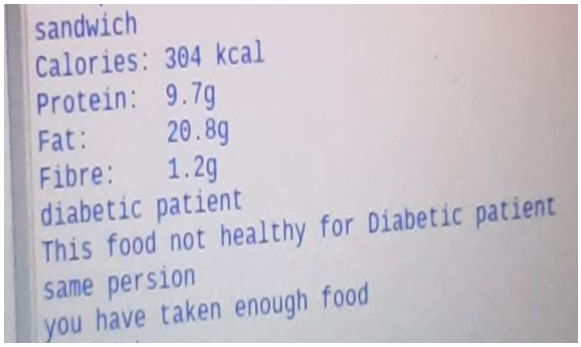


Figure 5: Nutritinal value of Sandwich

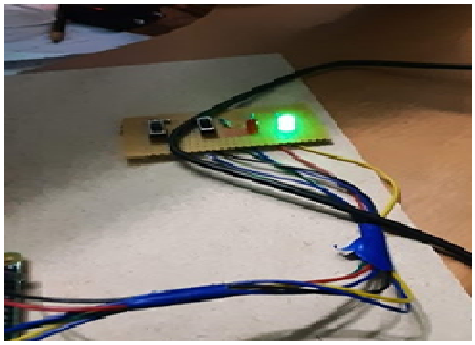


Figure 6: Green led glows indicating that the person can eat the food

The proposed system can detect food items and give the complete nutritional values and added a feature which facilitates in recognition of diabetic friendly food and also gives an alert if excess of food is consumed by a healthy person which is not present in existing systems. But the proposed system has a drawback that it cannot detect the food items which are shapeless like liquids.

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V. FUTURE SCOPE

As the field of Data Sciences and Embedded Systems are vastly expanding giving room to new technologies, there is always a possibility of improving this project using the state of art facilities. Implementation of YOLO algorithm. Faster CNNs can be used. PeachPy can be used to improve the computational speed tremendously. The whole idea could be made available via mobile application to the public.

VI. CONCLUSION

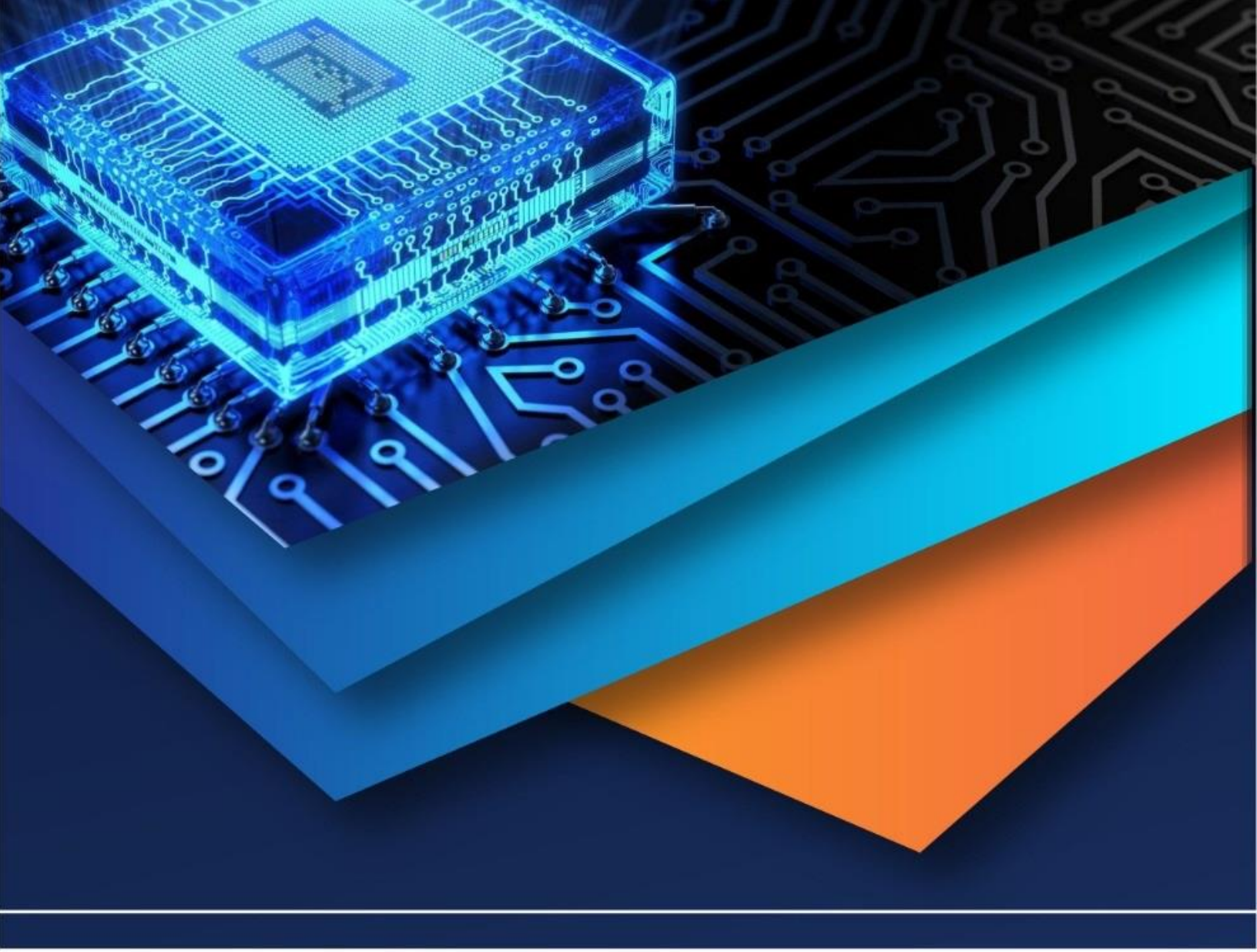
Food is one of the most important things for human life but traditional nutrition estimation via comparison book has limitation and hard to be understand for normal people. Food types are categorized and ingredients for a specific food dish are importance especially for elderly or diabetics. This proposed a new way to detect the food dishes using CNNs and estimate the nutrition value. food dishes images are used to train the networks in desktop environment and then transferred to Raspberry Pi 3 hardware in order to simulate limited calculation power and resources platform likes in a mobile phone. We also added LEDs, switches where switches enable the device to know whether the human is diabetic or not and LEDs enable the human whether he consumed sufficient food or not.

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