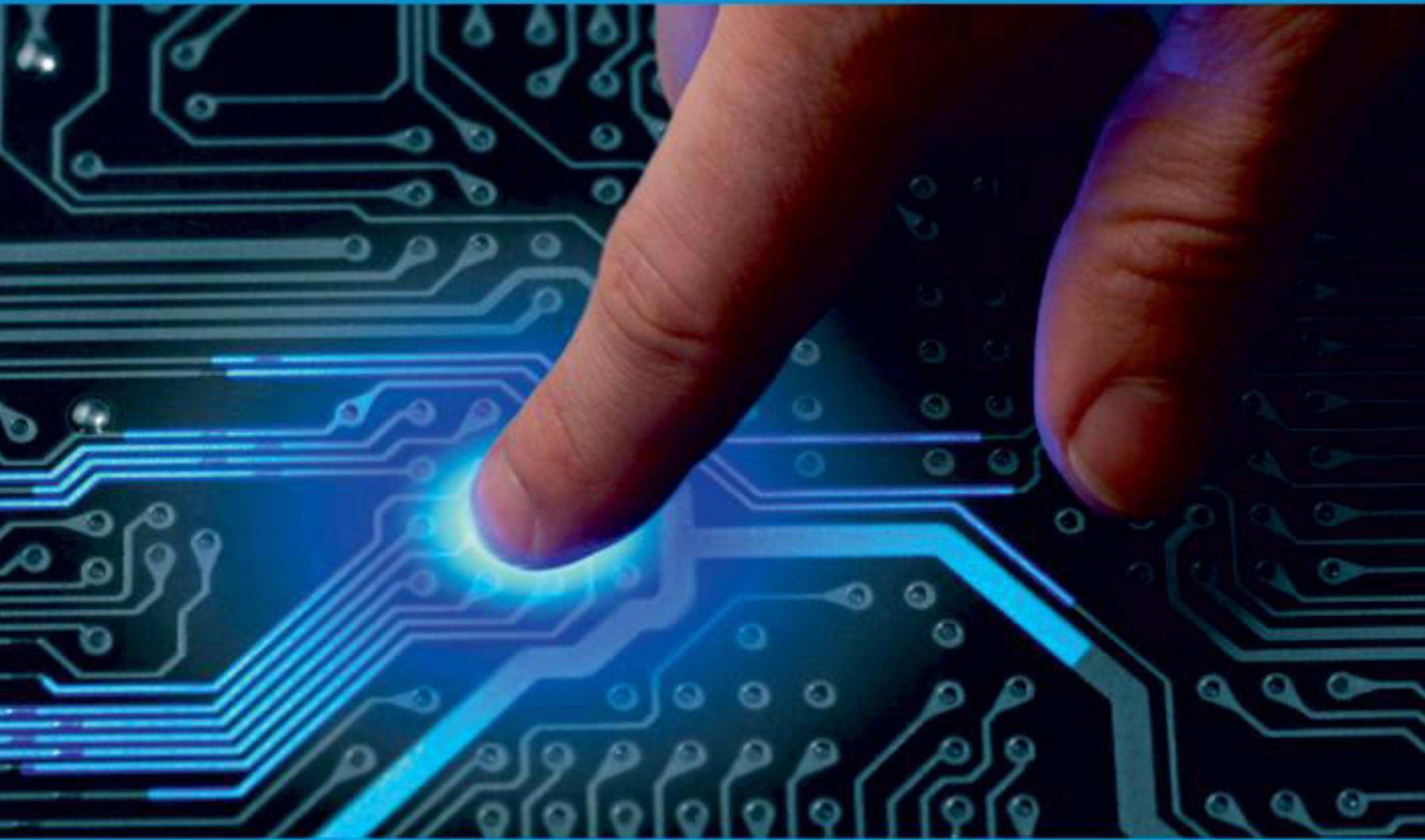
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 6, June 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.542

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Implementation of Smart AI Lifestyle Monitoring App

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ABSTRACT: Smart AI Lifestyle Monitoring App is a combination of different Neural Networks and Dynamic Algorithms. Combining all creates System that will monitor and help user to maintain their Lifestyle. System consists of 2 different Neural Networks and 1 complex Dynamic Algorithm. First and complex Neural Network is to predict Body Mass Index (BMI) from user's selfie (Image), It is based on VGG16 which is Convolutional Neural Network (CNN). Second Neural Network is to predict Health Score from various input from users as well as from android device sensors, it is based on Deep Neural Network (DNN). Third is Dynamic Algorithm which is used to create schedule for notifications for Food intake, Water Intake and to notify inactivity as well as exercise. The application will help to predict any Chronic diseases based different factors observed by the System over specific time period. Also, the app will take survey from user after specific time interval to generate report on user's health.

KEYWORDS: VGG-16 CNN, Java, Android, Python, Body Mass Index (BMI), Machine Learning, Deep Neural Network

I. INTRODUCTION

To combine and integrate different Neural Networks and Dynamic Algorithm to monitor user's Life-style, Daily activity and according to that predict Health Score of the user as well as predict BMI from image in single Android Application. Also, to process raw data from pedometer to be more accurate and only count when user is walking or running as well as to create schedule of Food and Water intake, exercise timings and inactivity. As an important application of medical informatization, healthcare big data analysis has been extensively researched in the fields of intelligent consultation, disease diagnosis, intelligent question-answering doctors, fitness scores, and medical assistant decision support, and has made many achievements. In order to improve the comprehensiveness and pertinence of the medical examination, this paper intends to use healthcare big data analysis combined with deep learning technology.

PROPOSED SYSTEM

A. To improve the availability of the system we tried to fit/combine the different models in single Android application so every person can access it to improve lifestyle and be precautious rather than getting ill beforehand.

B. To do that we created DNN which takes BMI, daily intake and step count as a input to predict the health score of the user. This health score represents the condition of the users. It predicts score from 0 to 100, in which 0 represents worst case so the current lifestyle of the user isn't good fit and user must change immediately whereas 100 is best case so the user lifestyle doesn't have any changes.

C. To train this system we used un-supervised learning with dataset on the Kaggle. The dataset contains different values from different sensor data from the wearables but as we don't want to use any wearables so we used only sensors data that any android has that is pedometer sensor. Other values calculated and taken by the user. We used one-hot encoding for the training, so we can increase the efficiency of the model.

D. As we want output ranging from 0 to 100 to predict such large range the AI must train on large dataset as well as for longer time. By one-hot encoding we can reduce it to 0 to 1 such that we can use sigmoid function at the output layer, after that we can multiply that output with 100 to get desired value.

E. This method improved efficiency by 20%.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542 |
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Architecture

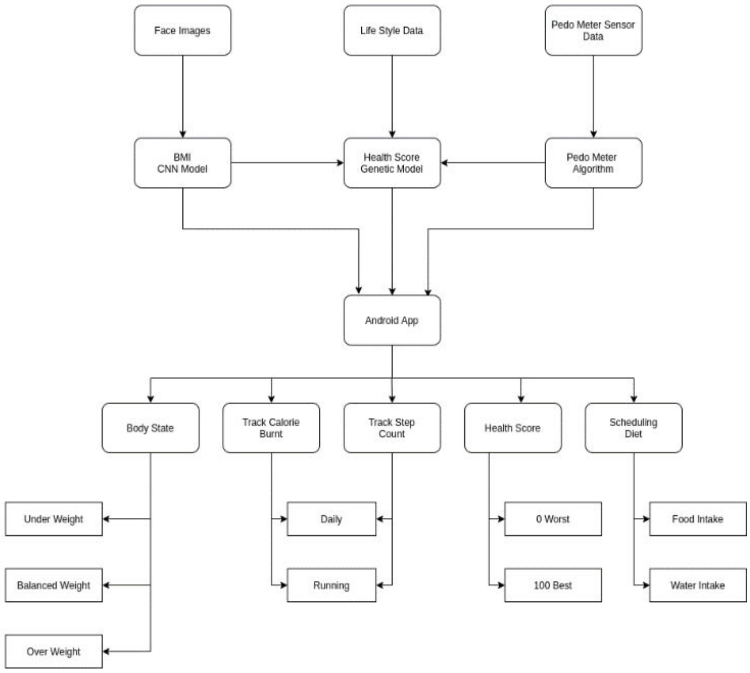


Fig 1 *architecture of proposed system*

The app consists of two main modules viz user and dataset along with trained models. Also, the most relevant and accurate heath score calculation according to the user data generated is the most challenging task. The three main features which eventually become the inputs for the final calculation are BMI score, Pedo-Meter readings and third sleep cycle, inactivity and food intake. This architecture is further divided into small sub architectures of the related module or algorithms used. The body state is generated using BMI score from the user image input data, further, the health score calorie burnt and is calculated using the step counts from the pedo-meter sensor walking or running motion and the scheduling diet and notifying user is suggested according to these values processed by our mathematical models. Further the sub-modules architecture and related input data are given.

BMI ARCHITECTURE

• This system is used for predicting the BMI score of users using their close-up face image (selfie will do).

• It uses modified VGG16 (CNN) model to extract features from the image.

• When the user submits the image, it is first enhanced then cropped and resized for better accuracy,

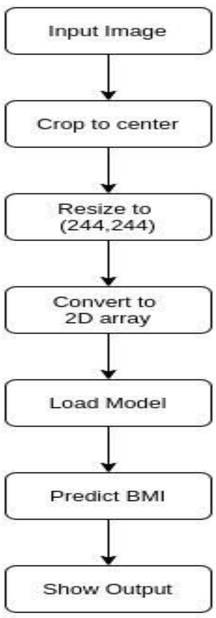
• Next the image is converted into a 2D-array which is the input format required by the pre-trained Convolutional Neural Network.

• Our CNN model is trained and tested on a dataset of 10k samples and has an accuracy of 85-90 percent depending on the image quality.

• To get BMI from image we need first load the trained model.

• Then it will apply those trained weights and bias on the input image.

• After that it will output a raw output which gets processed again before showing to the user.



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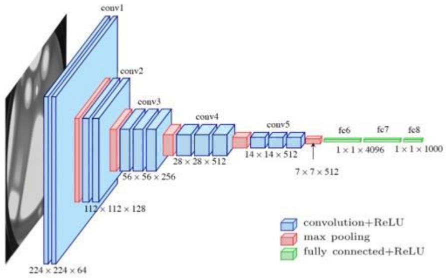

Fig 2 VGG-16 Model

• VGG-16 is the base structure for our CNN model which includes total Five Convolutional 2D layers (conv1, conv2, conv3, conv4, conv5).

• After each convolutional layer there is one max pooling layer, which are used to reduce kernel size and extract features from the image.

• In the end there are 3 fully connected layer Dense layers; these layers flatten out the extracted features to desired output format.

Health Score Architecture

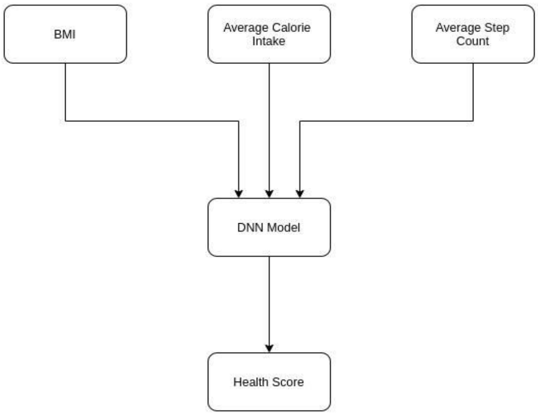

Fig 3 Health Score Design

This is the design of how the health score is calculated using the DNN Model.

DNN which is the Deep Neural Net takes three inputs which is the BMI score given by previous module i.e., the BMI module, the average calorie intake along with the average step count values as shown in the diagram above.

Finally, it predicts the health score of the user in between 0 to 100 where 0 is the ideal worst case scenario for the user and 100 is the ideal best-case scenario for the user.

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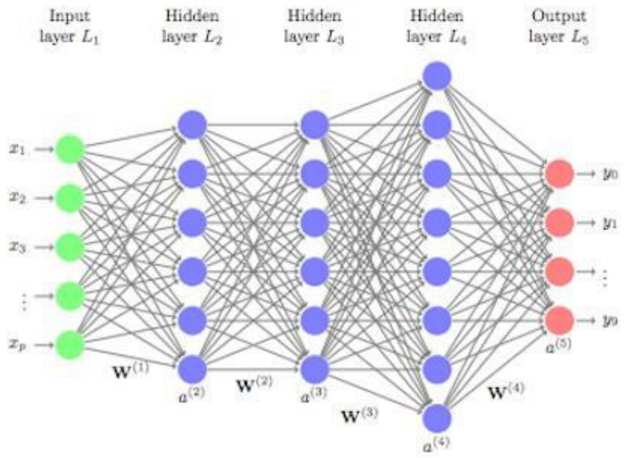

Fig 4 Feed Forward Neural Network

- This is the general architecture overview for any DNN (Deep Neural Network) model.
- It consists input layer with n numbers of nodes, these nodes represent input features from the given data.
- There are some hidden layers which are fully connected and their number is proportional to the output requirement.
- Also, each connection has its own weight and biases which are randomly generated initially and gradually changes as training goes on.
- Each layer has its own activation function which determines which corresponding node should be activated or not depending on the set of previous layer's outputs.
- Finally, the output layer is where all the layers converge according to the activation functions and previous outputs hence concluding the prediction for resultant required.

SCHEDULING SUGGESTION ARCHITECTURE

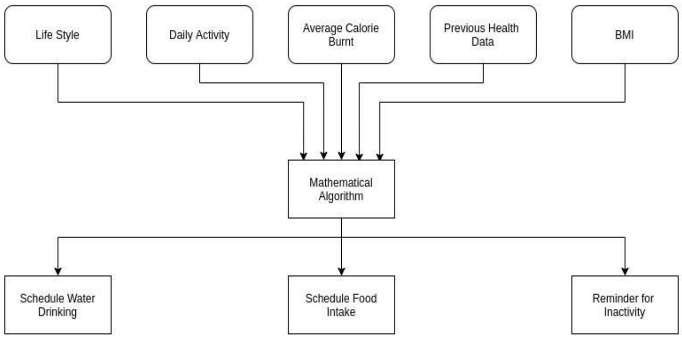

Fig 5 Suggestion Scheduling

- This is the third module which is customized for every user depending on data generated by the systems and given by the user.
- This algorithm then suggests the user accordingly regarding the health tips such as water intake reminder, or a better time to have food and also if the user is very inactive throughout his daily cycle, then some reminders for physical motion (like exercise, running, cycling, yoga etc.) or mental well-being (like play games, read books, watch a movie etc.)
- These suggestions will be given as a notification to the user.

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MATHEMATICAL MODEL AND ANALYSIS

Any neural network requires loss function, optimizer and activation functions. These functions are base mathematical model for any neural network. Loss function is generally used while training the neural network it calculates loss between predicted value and actual value, this function starts back-propagation. Next is optimizer which optimize the steps to train NN, optimizer set learning rate for the NN. Optimizer calculates the minima for the weights in NN. The last one is activation function; this function is applied to each node to calculate the value of the node from previous node's weight and biases.

Following are some examples with their mathematical expression

$$m_t = \beta_1 m_{t-1} + (1-\beta_1)\left[\frac{\delta L}{\delta w_t}\right] v_t = \beta_2 v_{t-1} + (1-\beta_2)\left[\frac{\delta L}{\delta w_t}\right]^2$$

LOSS FUNCTION

binary cross entropy

$$H_p(q) = -\frac{1}{N}\sum_{i=1}^{N} y_i \cdot log(p(y_i)) + (1-y_i) \cdot log(1-p(y_i))$$

This function also known as Log Loss. Where **y** is the **label** (**1 for green** points and **0 for red** points) and **p(y)** is the predicted **probability of the point being green** for all **N** points.

Optimizer:

Adam:

Adaptive Moment Estimation is an algorithm for optimization technique for gradient descent. The method is really efficient when working with large problem involving a lot of data or parameters. It requires less memory and is efficient. Intuitively, it is a combination of the 'gradient descent with momentum' algorithm and the 'RMSP' algorithm

Activation:

ReLu:

- ReLU stands for rectified linear unit, and is a type of activation function. Mathematically, it is defined as *y = max (0, x)*
- ReLU is linear (identity) for all positive values, and zero for all negative values. This means that:
- It's cheap to compute as there is no complicated math. The model can therefore take less time to train or run.
- It converges faster. Linearity means that the slope doesn't plateau, or "saturate," when *x* gets large. It doesn't have the vanishing gradient problem suffered by other activation functions like sigmoid or tanh.
- It's sparsely activated. Since ReLU is zero for all negative inputs, it's likely for any given unit to not activate at all. This is often desirable (see below)

Sigmoid

- The sigmoid function used is 1-S(-x), where 's' is the input and '*f*' is the output.
- The output of a sigmoid function, superimposed on that of a threshold function.

Modified VGG16 (CNN)

CNN is highly used when we want to deal with image data as CNN can take input as image which is converted into 3D array. Each pixel is converted into integer value which represents the intensity of that pixel. As image consists 3 color

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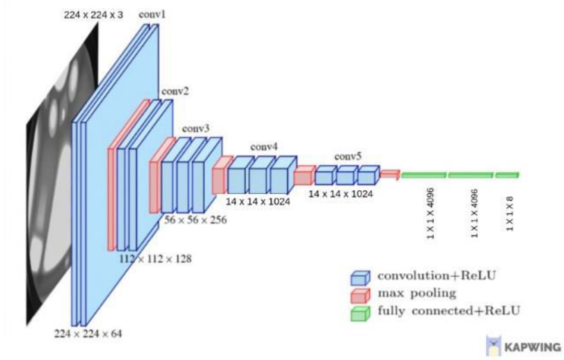
pixels (Red, Green, Blue) each layer converted into 2D array in which each value represents the intensity of respective pixel value.



Input Layer:

Convolutional layer (Conv2D) is input layer with shape of 224 * 224 * 3 in which first value is for pixels on X-axis, second value is for pixels on Y-axis, third value represents number of filters or channels, 3 for each Red, Green, Blue.

Hidden Layer:

Hidden layers in CNN mostly consists of conv2D layers and max pooling layers. Conv2D used for increasing filter layers and max-pooling layers used to reduce and extract the features from image. There are 5 conv2D and 5 max-pooling layers in hidden architecture of VGG16, but to increase extraction of more features we increased the size of filters to 1024.

Output Layer:

Output layer is final stage of the CNN. The layer structure depends upon the required output. In our case we need the only one value as an output. So, to output get only one output node we need to flatten the conv2D layer that is to convert 2D array to 1D array. There is total 3 dense layers which flattens the conv2D layers. These layers are fully connected and the last dense layer consists of 8 nodes to output 8-bit binary number.

Structure:

1. Conv2D_0 224x224x3
2. Conv2D_1 224x224x64
3. Max Pooling 1
4. Conv2D_2 112x112x128
5. Max Pooling 2
6. Conv2D_3 56x56x256
7. Max Pooling 3
8. Conv2D_4 28x28x1024
9. Max Pooling 4
10. Conv2D_5 14x14x1024
11. Max Pooling 5
12. Dense Layer 1 1x1x4096
13. Dense Layer 2 1x1x4096
14. Dense Layer 3 1x1x8

DNN

Deep Neural Network is complex structure of fully connected layers. DNN has 3 main layers Input, Hidden and Output.

Input Layer

Input layer with shape (3,) input nodes. There are 3 inputs BMI, Calorie intake, Average step count each node takes each one input.

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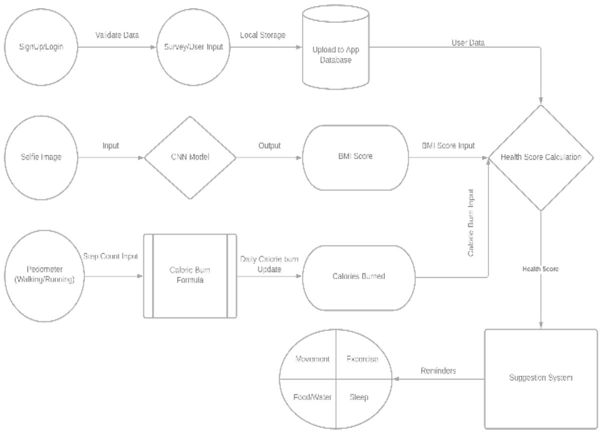
Hidden Layers

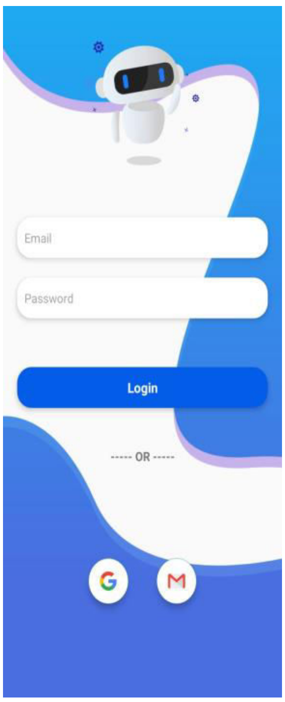
There 5 different hidden layers with different number of nodes. These all layers are fully connected and has different number of nodes. This is the base of the DNN, the hyper-parameters from the hidden architecture defines the learning capabilities of the NN. All the layers have ReLu activation function.

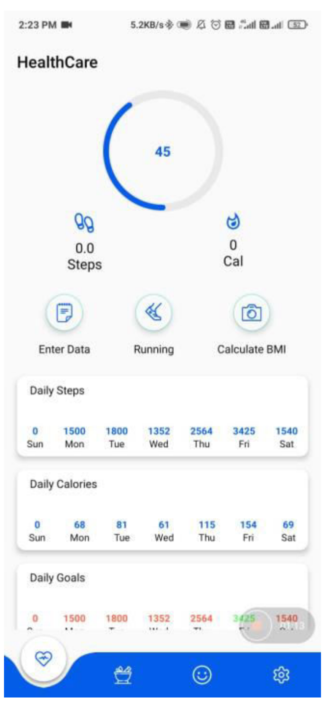


Data Flow Diagram

Output Layer

This DNN has only one node at the output as it will only output the Health Score the of user. The activation function used for this layer is Sigmoid. This function will output value from 0 to 1 so multiplying that value with 100 will give the user's Health Score.





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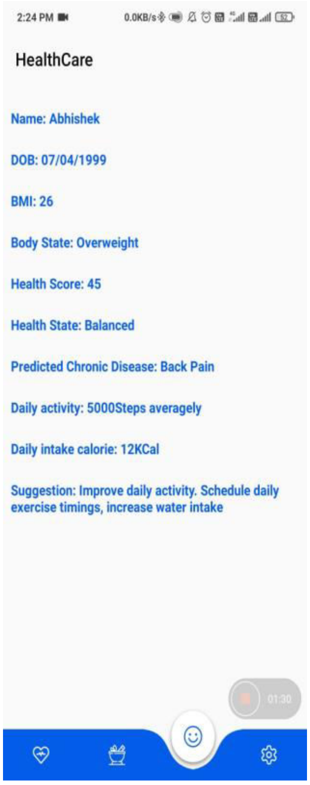
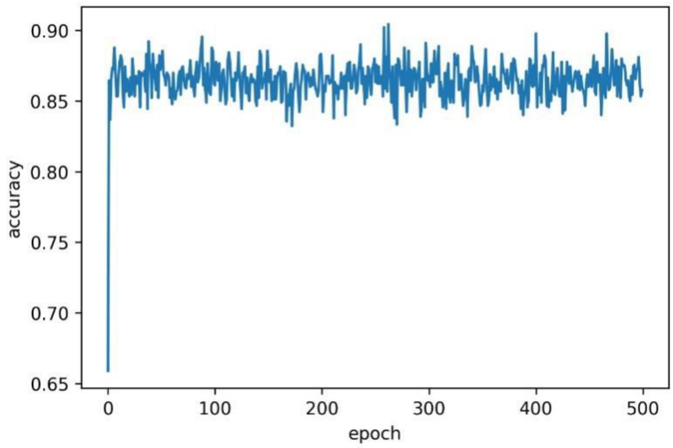
II. RESULT





Accuracy Graph Result

III. CONCLUSION

The android application developed for lifestyle monitoring is not based on Internet of things, that gives it an advantage to eliminate the need of external monitoring devices but is also restricted of more features because of the same. It is an alternative that can be used to help people with diseases and improve overall way of living in terms of health. Likewise with this set of solutions the aim is to improve the quality of lifestyle, and just self-monitoring maintaining privacy, but also to enable and direct them to improve their eating habits and workout routines. Also, it aims to provide recommendations and tips to improve the daily habits of people.We will try to imburse a forum consisting of various doctors' from around variable medical sciences belonging to multiple and different specialties, where people can

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have general awareness discussions and suggestion talks.We will deploy the application for iOS devices in near future.Also, a feature for displaying various health related newsfeed for knowledge purpose.With all these updates will also aim to improve the accuracy of all the models and eventually the app as whole.

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