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Artificial Neural Network based Nutrition Monitoring System Using Internet of Things

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Abstract

Nutrients intake through food is one of the essential thing to maintain good health. The wrong amount of nutrient intake through food leads to several health disorders and may cause serious diseases. So an automated system is helpful to monitor the nutritional facts present in the food for all age groups at home. In this paper, an automated nutrition monitoring system that makes use of Internet of Things(IOT) and Artificial Neural Networks(ANN) is presented. Here hardware part is used to quantify the nutrition present in the food. An algorithm based on artificial neural networks is used to extract the nutritional features present in the current meal, to calculate the calories needed to be burnt by the person and to predict the future meal. This proposed one also provides the amount of nutrients and weight of the food needed to be consumed. This prediction can be done by considering some parameters like the age of the person, current meal weight and quantity of nutritional facts required to be consumed by a person in a day. Hence this system helps a person to balance the diet and reduces the risks related to health.

Keywords- *Nutrition, Artificial neural networks, Prediction, Internet Of things, Nutrition Monitoring System, ANN.*

1. Introduction

Daily food intake monitoring is an important and relevant problem in health care. To maintain a healthy lifestyle, wearable's or monitoring systems are designed to focus on calorie input and calorie output. The main underlying motivation of the monitoring system is to address nutritional imbalances. Important nutritional imbalances are undernourishment and over nourishment. Undernourishment means consuming less amount of nutrition in food whereas over nourishment means consuming more amount of nutrition in food. This imbalance leads to many health issues like obesity, weak immune system, cognitive disorders, weaken the skeletal structure, thin hairline, bleeding gums etc., are some.

To monitor this nutritional imbalance, an automated system is proposed that makes use of the internet of things and artificial neural network. Internet of Things(IOT)[1] is a network of physical objects that make use of sensors and API's to collect and exchange the data. IOT is mainly used to automate the systems. Different applications of IOT are smart cities, smart agriculture, smart transport systems, smart healthcare systems etc. Here an IOT device is used to collect the weight of the food. An artificial neural network(ANN)[2] is made up of neurons that work together to produce the desired result. ANN is used for prediction, classification, clustering, regression problems. ANN is used to extract the nutritional information of the current meal and to predict the next meal.

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The paper is organized as follows: Section-2 describes the work related to existing ones. Section-3 describes the implementation part of the proposed one. Section-4 describes the experimental results and section-5 is about the conclusion and future work.

2. Literature Survey

Nabil Alshurafa et al[3] designed a wearable necklace is used to classify the type of food based on the skin motion. Vibration sensor and a smartphone application are used. The vibration sensor is used to detect the motion of the skin that produces output in voltage. Smartphone application makes use of short-time Fourier transformation, the wrapper method, and Random forest classification method to process the signals, to classify the type of the food and feedback is provided to user visually.

Parisa Pauladzadeh et al[4] proposed a system that runs on smart phones to measure the calories. The Smartphone application allows the user to capture the food picture. By using a convolution neural network and graph cut segmentation, it identifies the food item in the picture and calculates the calories intake.

S.Jasmine Mininja et al[5] developed a system that makes use of Local variation segmentation(LVM) and Multi-Kernel Support Vector Machine(Multi-Kernel SVM) to identify the food and to estimate the calories present in the food. LVM segments the images based on the degree of variability in the neighbor region of the input image. Multi-Kernel SVM is used to identify the food and to calculate the calorie intake.

Manal Chokr et al[6] proposed a machine learning approach to depict the number of calories from images of the food by finding the food item type and by estimating the food item weight.

Abdul Salam et al[7] made use of convolution neural networks to recognize the food images. After identifying the image, it classifies the food and provides the composition of nutritional facts like fat, carbohydrate etc., in the food.

Prabha Sundarvadivel et al[8] proposed Smart-Log. Microcontroller based Piezoelectric sensors with the wireless module are used for collecting and processing the sensor data. Nutritional Balance algorithm and Food classification algorithm for building a Bayesian network is used. Nutritional balance algorithm is used for extracting the nutrient values from food and to calculate the nutrient values of food based on the weight of the food. The food classification algorithm is used for extracting the nutrient values from the food and to classify the food as carbohydrate-rich, protein-rich etc., and to suggest the future meal. USSDA food dataset is used. Next meal prediction is done based on leftover food nutrient values and feedback from the user whether the goal of the meal is fulfilled or not.

3. Implementation

Figure1 describes the implementation of a system in two phases: i) Hardware implementation for weight ii) Implementation of Artificial Neural Network.

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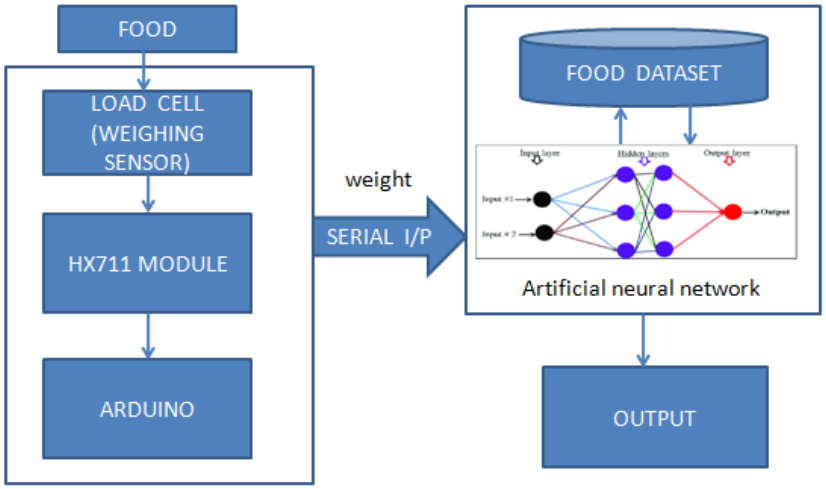

Figure1: Architecture of the ANN based Nutrition Monitoring System using IOT.

3.1 Hardware Implementation

The hardware part is implemented by using Arduino Uno, Load Cell and the HX711 amplifier module. Arduino Uno is a microcontroller board based on ATmega328p microcontroller board that process the data. A load cell is a transducer that converts force into measurable electric output. HX711 is a 24-bit precision amplifier that amplifies the low electric output of the load cell and converts the signal into a digital value which is fed to Arduino to derive the weight.

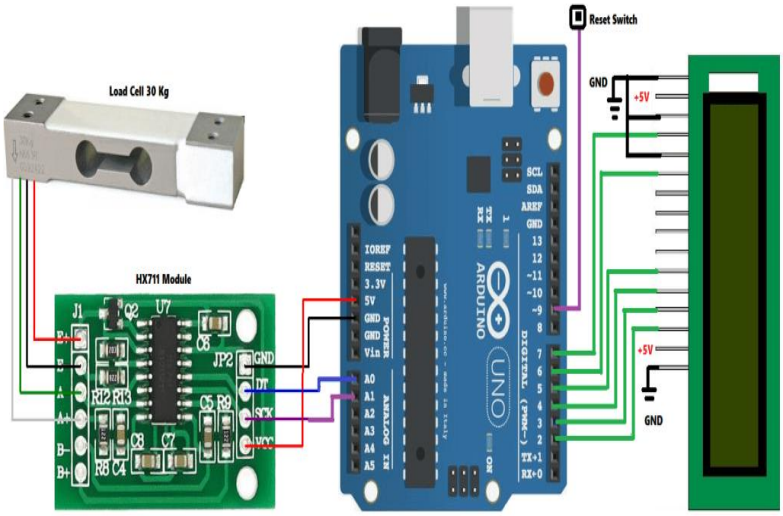

Figure 2: Connection between the hardware components.

Figure 2 describes how the load cell, HX711 amplifier module, and Arduino are connected. When food is placed on the load cell, it gives the voltage as output based on the force applied. After getting this voltage value is sent to the HX711 module which amplifies the low voltage value and converts into a digital value. This value is sent to the Arduino that process it and produce a weight of the food and displays on the LCD screen. After calculating the weight of the food it is sent to ANN through serial input.

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3.2 Artificial Neural Network Implementation

Implementation can be done in following phases:

i) Data Gathering and Preprocessing

ii) Parameters used for prediction

iii) Building an Artificial Neural Network

iv) Training the data and

v)Prediction.

Data Gathering and Preprocessing:

Data containing Calories, Carbohydrates, Proteins, Fats and Vitamins for Indian food is collected from different sources in the form of CSV file. After collecting the data, the data is cleaned to remove unwanted and redundant data by using different preprocessing tools.

Parameters Used for Prediction:

Food name, Food weight and age of the person are some of the parameters used in the prediction of the current meal.

AGE	Calories (K.Cal)	Carbohydrates (grams)	Proteins (grams)	Fats (grams)
4-24	1,150	225	60	40
25-50	1,700	325	90	58
50+	1,380	290	75	50

Table 1: Per day consumption of nutritional facts for different age groups.

Table 1 describes the per day consumption of carbohydrates, proteins, fats, and calories which is also used as parameters in the prediction of the next meal.

Building an Artificial Neural Network:

Input Layer takes input values and passes to the next layer without performing any operations. Neurons in this layer generate input weights. Input to this layer is food name, food weight, age of the person and per day consumption of nutritional values.

Hidden Layer performs different operations on the input value. This model makes use of rectified linear activation function(RELU) and contains two hidden layers.

Output Layer receives the output of the hidden layer as input. Softmax as the activation function is used to perform operations to produce the desired result.

Training the Data:

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Based on the food name and food weight we are going to train the neural network. Here 80% of data is used for training and remaining data is used for testing. This trained data is further used to verify the data during prediction.

Prediction:

Food name, food weight and age of the person are given as input to the neural network and neural weights are assigned to the inputs which are passed to the hidden layer. Hidden layer performs RELU activation function on those neural inputs to produce output neural weights. For accurate output, those output neural weights are compared with trained data output weights. If the prediction is not accurate then it makes use of backpropagation. In backpropagation, weights are sent back to the input layer and the input neural weights are adjusted. This process is repeated until the accurate value is predicted. Here the output is the next meal and its nutritional facts.

4. Experimental Results

ANN is implemented to increase the performance of the model. All the experiments are performed on the dell machine with Intel core i5, CPU@2.20 GHz and 8GB RAM, installed on windows8.1 and 64-bit processor. The entire system is implemented using python language in Spyder platform. Arduino IDE and C language are used for the hardware part. This system makes use of Keras package to implement ANN by making use of Tensor Flow as backend. Sparse-Categorical-Crossentrophy is used as Loss function and Adam is used as an optimizer. The accuracy of the meal prediction is considered as a performance evaluating factor of this model. The final accuracy attained by the system is 99.2%.

Model	Accuracy
Smart-log[8]	98.6%
S.Jasmine Mininja et al[5]	96.27%
ANN based Nutrition Monitoring System Using IOT	99.2%

Table 2: Comparison of the results.

5. Conclusion

This system helps the user to keep track of the nutritional imbalances to lead a healthy life. The implemented model is highly accurate that helps in tracking nutritional imbalances in food. ANN is used to predict the next meal, calculates the next meal nutritional facts and also used to calculate the current meal nutritional facts. It works for all age groups as the age-wise consumption of nutritional facts in a day was considered and suggests the number of calories needed to be burnt by a person after every meal. In future, health parameters and user activities are considered for more accurate prediction.

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