A Study on Predicting Body Weight through Footprints Using Fuzzy Logic

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APPROVAL

This Project titled "**A Study on Predicting Body Weight Through Footprints Using Fuzzy Logic",** submitted by Sahid Adnan (ID:171-15-8645), Mitu Sarkar (ID:171-15-9552) and Shadakat Hossain Ramim (ID:171-15-9121) to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 2nd June 2021.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Mr. Aniruddha Rakshit , Sr. Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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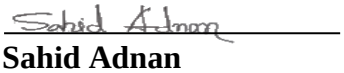

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ABSTRACT

Predicting body weight by scanning only footprints is an emerging topic of research. There are lots of statistics in different regions of the earth. There are several techniques to detect body weight from footprints. This study reviews some recent phenomena. But the inputs or scanning of images are vague in major cases. Crisp measurements deliver results with an error. Fuzzy logic captures the uncertain systems perfectly. In this study, a fuzzy logic model has been designed for predicting body weights from footprints. Here length, area of feet and gender are taken inputs for the Mamdani FIS system. These inputs are perfect for detecting body weights. This study also compares similar results. This study also includes discussing human body weight prediction from footprints by deep learning method and statistical analysis for male females' body weight through their footprints.

Keywords: Footprints; Body weight; Fuzzy logic, Statistical analysis, Deep learning.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Footprints have been extensively researched because of different factors. Many persons worldwide have based their knowledge on the study of fossilized footsteps [1-4], orthopedic , prosthetic [5-12] and other surgical research, anatomical and anthropological studies [13-22], dermatoglyphic and genetic studies [23-25], biomechanical studies [26-34], ergonomics [35] and forensic driven studies of footprints. It can be useful for forensic science in a country like India, Bangladesh, where people walk barefoot for different reasons like religion, environmental, social and economical Footprints are typically used. Footprints [36,37] can be quickly collected from nearly any kind of crime scene. These techniques may be used for determining body size (stature, weight, etc.), human characteristics and foot morphology of the offenders. A variety of experimental experiments have been carried out on the determination of stature from observations of footprints. A few experiments have demonstrated the correlation between fat and footprints. There is a strong connection between height and body sections as we know. There must be a connection between your weight and footprints. These findings have been validated in recent forensic research [38, 39]. Any scholars have looked at the connection between anthropometric proportions and body weight. The new research assesses the associations between weights and footprints. This research investigates the impact of extra body weight on the measurements of footprints. Crisp data sometimes, put vagueness in input images. Thus exact measurements and shape are not captured in scanning photos.

Fuzzy logic treats knowledge that is imprecise and ambiguous. The first presentation of Fuzzy logic, algorithm and decision making by L.A.Zadeh [46 - 48]. After the automatic stream engine control, Mamdani [49] applied fuzzy logic. Several industries, such as automated management, banks, hospitals, and academia, have been used. Elley et al. [51] applied fuzzy logic to student assessment in laboratory implementation results. Dekeseredy [50] suggested the use of fuzzy logic in the teacher's performance

analysis in an educational institution. This research also aims to measure body weight through fuzzy logic techniques.

1.2 Motivation

Footprints have been extensively researched because of different factors like fossilized footsteps, orthopedic, other surgical research, anatomical and anthropological studies, and genetic studies etc. So it is very useful for forensic science in a country like Bangladesh, where people walk barefoot for different reasons like religion, environmental, social and economical footprints are typically used. Footprints can be helped in any kind of crime scene.so these techniques may be used for determining body size (stature, weight, etc.), human characteristics and foot morphology of the offenders. Hence, we have been highly motivated to work on this.

1.3 Rationale of Study

If we complete our project then it will be very helpful for our country. Predicting human body weight accuracy is very important for a country. If we predict accuracy of body weight properly then we can

-identifying the culprit.
-be able to do biometric authentication.
-can make people aware of their obesity.
-can find out the difference between the footprints of men and women.

1.4 Research Question

Here are some primary questions those are the key point in this thesis are outlined below:

- Can you give the right input to make decisions?
- Can you show the difference between male and female footprints?
- Can you predict body weight through fuzzy logic?

1.5 Expected Outcome

This research aims to measure body weight through fuzzy logic techniques. Identifying the difference between Male and Female footprints by statistical analysis. And also give the concept of deep learning.

1.6 Report Layout

The project report contains six chapters. Summarization is given below:

Chapter 1: The introduction, motivation, rational of study, expected outcome have been discussed in details in chapter one.
Chapter 2: The background of our project which is covered with related works, scope and challenges is discussed in this chapter.
Chapter 3. In chapter three there will be a segment named “Research Methodology”.
Chapter 4: Chapter four will contain the experimental result and discussions.
Chapter 5: The impact on the society, environment and sustainability will be described in this chapter.
Chapter 6. Conclusion and implication for future research are available in this chapter.

Chapter 2

BACKGROUND

2.1 Preliminaries

In our country, there are no such related works was done which can predict accuracy of body weight from human footprint accurately. So the background is to predict the body weight of the people of Bangladesh from their footprints.

2.2 Related Works

The study of K. Krishan [52] includes 50 adult males from a North Indian village situated in Siwaliks mountains' foothills. This Gujjar group is a sedentary, agriculture-based society with a range of agriculture-based occupations. Both participants involved in the analysis were stable and free from any obvious sign of foot deformity. The research subjects' body weight was assessed using spring-loaded scales.

A total of 300 footprints from 50 persons were entered manually and examined. First of all, the left and right footprints were drawn from the subject's usual weight. After the topic had an additional bodyweight of 5kg, impressions were taken. It means 20 pairs of bilateral footprints of the same subjects of 5 kg excess weight were also obtained. The procedure used was found in Cummins and Midlo. Before the feet were lifted off the paper, following anatomical landmarks of the feet were recorded and labelled on the paper.

(a) Mid-rear heel point (pternion);

(b) Medial metatarsal point (mt.m);

(c) Lateral metatarsal point (mt.l);

(d) Calcaneal concavity medial (cc.m);

(e) Calcaneal tubercle lateral (ctu.l).

Nine measurements were taken on each subject's heel and toe. A baseline or extensional axis was formed following Robbins. The context information regarding designated longitudinal axis (DLA) and base line (BL) can be found here.

Following measurements were taken on each footprint:

1. T-1 length (pternion–d1.t).
2. T-2 length (pternion–d2.t).
3. T-3 length (pternion–d3.t).
4. T-4 length (pternion–d4.t).
5. T-5 length (pternion–d5.t).
6. Breadth at ball (mt.l–mt.m).
7. Breadth at heel (cc.m–ctu.l).
8. Big toe-pad length (d1.t–d1.ps).
9. Big toe-pad breadth (d1.pm–d1.pl).

The calculations and contrasts were then made on the three kinds of footprints (normal weight, the additional weight of 5 kg, and the additional weight of 20 kg). The footprints of people taking extra weight are weighed with a bigger ruler than the footprints of people who did not. In this way, t-test was used to analyse the statistical importance of the mean variations. These correlation coefficients demonstrate the clear ties between the scales of these three kinds of footprints and body weight. Regression formula was used to assess the estimate of normal body weight from different measures

of normal weight footprints and footprints of 20 kg added weight. The data is analysed using the Statistical Package for Social Sciences (SPSS).

Results show the scale of the daily calculated footprints of the 50 participants. Comparison of all three sets of footprints showed that there is a substantial gap between the left and right foot dimensions. The meaning of the measurements on standard weight footprints is then subtracted from the measurements' means on the four footprints. Thus left side measurements were subtracted from like side measurements. These findings in the table explicitly demonstrate that the calculation of a person's weight on their feet with 5 kg weight is higher on both sides than with 20 kg weight. As anticipated, the 5-kg increased weight did not impact our participants. This figure does not indicate any major variations. Even though the weight variance in both height and weight dimensions is minor, they are substantially high. On the right hand, we have found mean variations on T-1 and T-5 are statistically important. The right-hand side displays statistically important variations for T-1, T-4 average length and width at ball in both JA and FA. The largest disparity in percentage disparities is on the left side.

It reveals that both left and right regular weight footprints are positively associated with body weight and also with feet dimension. A positive and important link have been identified between measures and body weight. Longest T-1 and T-2 has the greatest association with body weight. On the upper left, the maximum (0.75) is conferred by T-1 duration and the lowest (0.40) is received by T-3 length. Various foot length dimensions report between 0.69 and 0.74 inches on the left and right feet. The ball is well aligned with the body weight (0.71). There is less clear association between body weight and width at foot, big toe-pad length and breadth.

The extra weight of 5 kg and more or less close associations between these dimensions and body weight, one may safely achieve the same findings by utilising the usual weight footprints

The regression equations are described in tables 4 and 5. Assuming that a man with a left regular weight foot print (T-1 length) of 24.3 cm will have an average weight of $1.20 \times 24.3 + 36.56 = 65.70$ kg. This can be allowed for the difference using a plus- or-minus factor.

68.12 T 2.88 (mean error).

2.3 Comparative Analysis and Summery

Bangladesh has a huge population with less land. The people here have very little knowledge about their footprints. Many types of crimes are organized here. Most of the people here walk barefoot and get involved in various crimes. Although our government and administration are very much aware of this, but sometimes it takes a lot of time to investigate or the culprit is hard to identify. Another thing is, it can also be used for biometric authentication. So hopefully, this system will play a groundbreaking role in the context of crime scene of Bangladesh.

2.4 Scope of the Problem

We recognize that a broad range of expertise is required for this entire project, ranging from image processing, visual analysis, motor control, development and potentially 3D printing, wireless communication, battery charging and database management. These subjects go far further than this thesis. This research focused on the perfection of the predicting body weight. Sometimes the error occurs. Thus fuzziness is appropriate for the representation of uncertainties. In this study, fuzzy logic (Matlab Mamdani version 2.0) is used for predicting body weight.

2.5 Challenges

In this research, we work with Fuzzy Logic method, Statistical analysis, and discuss about deep learning. Nowadays, Fuzzy system can be used to resolve numerous decision making problems. It often gives outstanding decision inputs and knowledge based rules. Fuzzy systems are designed based on human judgment. So, the most difficult challenge is to get the right input so that the level of accuracy is high.

Chapter 3

RESEARCH METHODOLOGY

3.1 Research Subject and Instrumentation

We are working to predict body weight from human footprint. In this study a fuzzy logic model has been designed for predict body weight. Basically, this model works according to the rule where the rules are based on data analysis. and also we used statistical analysis with T-test method. and also we are trying to solve this topic by using deep learning.

3.2 Data Collection Procedure

The data was collected through the presence of rural and urban people between the ages of 30-35. That also includes both male and female. As such, their body weight, height and the size of their feet were taken through the presence of each participants.

3.3 Statistical Analysis

Zadeh initially implemented fuzzy logic, algorithm and decision-making [1], [3, 4, 5, 6]. In the automatic streaming engine control, H. Mamdani [7, 8] has applied fuzzy logical. Fuzzy's reasoning was implemented [9, 10] in many fields, for instance, automated control decisions [11, 12], banks and hospitals and universities [13, 14, 15, 16]. In [18] Srinivasan et al. introduced perception-based performance analysis of higher institutions, ranking performance analysis and promotion [17] in Korea's military organizations. In this document, the authors considered expectations of students, teachers, investor researchers and the public and this model is also based on a number of parameters. The KSM index of ranking educational institutes based on fugitive systems was introduced in [19]. According to the Mamdani law, input membership values according to the weight of input data are assumed in this analysis. The simple result of the defluence in the Mamdani method is obtained. It takes lots of rules to combine more than two inputs in crisp results. In teaching, for example, Analysis received 70 percent, and Infrastructure received 50 percent. These rules are going to offer a performance. Similarly, adjusting somewhat like teaching earned 89% credit, Analysis received 72%, and facilities

received 51% credit. There must also be prepared an infinite number of laws. Realistically, Fuzzy logic is updated. Regulations
are restricted as parameters in low, medium, high or few more categories are divided.
There is no further survey.

3.4 Proposed Methodology/Applied Mechanism

A. **Membership function:** A membership function is a function that determines how a membership value between 0 and 1 is mapped to each point in the input space. Figure 1 has shown an example of a membership function. Also, Figure 1 has shown an example of a triangular membership function.

B. **Fuzzy logic:** One of the branches of the fuzzy set theory is fuzzy logic. It is distinct from standard logic because there are two values for an element in the set: 1(true) and 0(false), which mean that either the element belongs fully to the set or not. These real-world ambiguities and fuzziness can be operated with fuzzy logic. To save time and to save resources, many home appliances are updated every day using fuzzy logic.

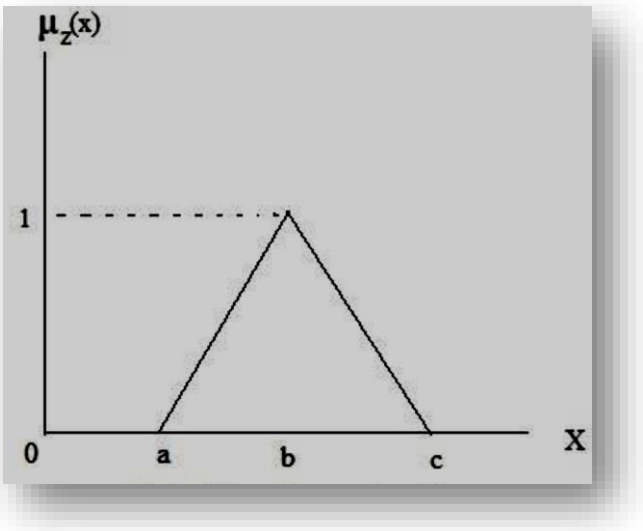


Figure 1: Triangular membership function

C. **Linguistic variables:** In the implementation of fuzzy logic, linguistic variables play a significant part. In a language, linguistic variables are variables whose values are terms. "Height of a man" is a linguistic variable because the values of this variable are very low height, low height, tall height, very tall height. Figure 2 has shown an example of a linguistic variable.

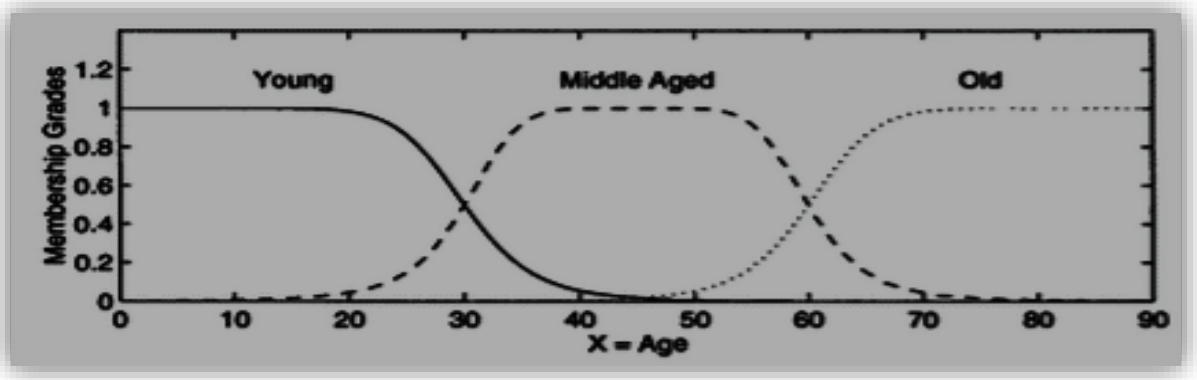


Figure 2: Example of linguistic variables

3.5 Implementation Requirements

A. Fuzzy Inference System: The method of constructing a mapping of fuzzy logic from an input data set to output is referred to as the fuzzy inference method. There are four components of the Fuzzy inference system: fuzzification, fuzzy rule foundation, fuzzy inference, defuzzification. Figure 3 has shown the fuzzy inference system.

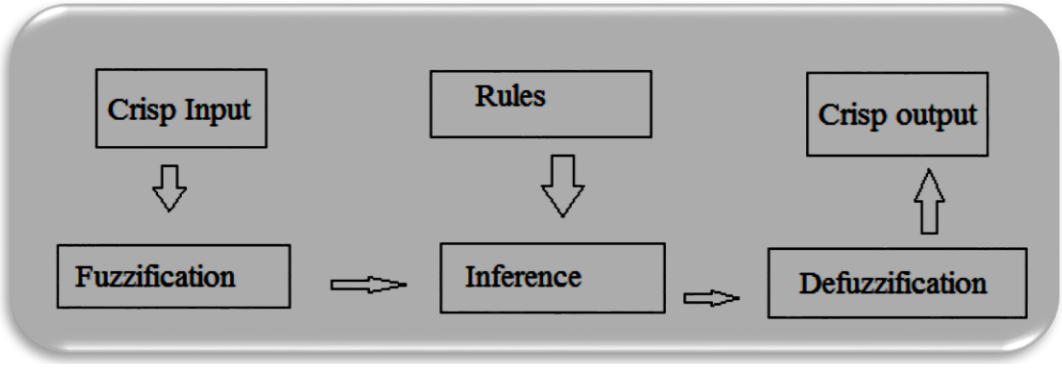


Figure 3: Fuzzy inference system

Chapter 4

EXPERIMENTAL RESULT AND DISCUSSION

4.1 Experimental Setup

The measurements taken on these three kinds of footprints (normal weight footprints; footprints taken with an additional weight of 5 kg and then with 20 kg weight) were recorded and compared with each other. The differences between the normal weight footprints measurements and the footprints taken with additional weight of 5 kg and then of 20 kg were calculated separately. The body weight does not depend only on foot print. It is depends on some parameters like

1. Size of foot print
2. Area of foot print
3. Gender

So, body weight calculation from the foot print depends on some critical variables. In this article, we demonstrate a mathematical model by Fuzzy logic. Here we calculate the value of body weight by some parameters.

4.2 Experimental Result & Analysis

1. Correlation of Foot Length with Height and Weight in People Ageing from 31 to 35 years in the urban area of Bangladesh

The research sample contained 5093 people (2535 males, 49.77 percent, 2558 females, 50.23 percent). The response ratio was 96.93%. The survey averaged 33.47 ± 2.71 years. In Table 1, descriptive statistics such as means or normal differences for the dependent variables (height and weight) and the independent variables (age, right foot length, left foot length) are listed by sex. The findings reveal that a substantial difference between the two sexes has been observed in the right and left foot length. There was no major variation in age, height or weight. For both genders, Table 2 shows basic Pearson r bivariates between the dependent and the independent variables. All coefficients were statistically significant ($p<0.001$) and showed that the variables were linearly linked. The described relationships were very solid, not below 0.733. In males, the connection between the right and the left foot was greater than in females (0.903, 0.898 vs. 0.855, 0.856, respectively). The discrepancy between the two primary independent variables and weight was also found (0.818, 0.808 vs. 0.756, 0.757,

respectively).Table 2 graphically describes in these matrices the linear association computed using Pearson r.

Table 1: Descriptive statistics of the main characteristics of the study and comparisons between sexes.

		Male			Female	
		Height (cm)	**Weight (Kg)**		**Height (cm)**	**Weight (Kg)**
Age (years)	**Pearson correlation** ***p*-Value**	0.877 <0.001	0.766 <0.001		0.841 <0.001	0.733 <0.001
Left foot length (cm)	**Pearson correlation** ***p*-Value**	0.898 <0.001	0.808 <0.001		0.856 <0.001	0.757 <0.001
Right foot length (cm)	**Pearson correlation** ***p*-Value**	0.903 <0.001	0.818 <0.001		0.855 <0.001	0.756 <0.001

Table 2: Simple bivariate correlations between dependent variables (height and weight) and independent variables (age, right and left foot length) by sex.

	Sex									
	Male					**Female**				
	Mean	**SD**	**Min**	**Max**		**Mean**	**SD**	**Min**	**Max**	***p*-Value**
Age (years)	33.37	2.69	31.49	35.06		33.36	2.73	30.99	35.46	0.989
Height (cm)	170.44	16.78	140.00	195.00		152.80	14.49	121.00	183.00	0.145
Weight (Kg)	80.04	16.77	55.00	119.00		70.79	14.44	44.00	109.00	0.573
Left foot length (cm)	24.50	2.54	20.00	29.00		21.71	2.01	17.00	26.00	<0.001
Right foot length (cm)	24.43	2.56	19.00	28.00		21.61	2.01	16.00	25.00	<0.001
Age categories			***N***	**Percentage**				***N***	**Percentage**	
31 Years			140	5.52				135	5.28	0.062
32 Years			685	27.02				630	24.63	
33 Years			943	37.20				942	36.83	
34 Years			670	26.43				721	28.19	
35 Years			97	3.83				130	5.08	
Total			2535	100.00				2558	100.00	

Discussion

This study shows that the right and left foot's height and weight are correlated in Bangladesh urban area. This thesis illustrates and quantifies this relation as a linear formulation of the equation. Determining the height and weight of a crime scene using the footprint can be immensely helpful not only so a criminal or a witness can be mentioned and because an attestation can be endorsed. Forensic science and criminologists are looking for a missing human. [1,3] Our findings indicate an important relationship between height, weight, and foot length regardless of sex and age or the adjustment. The large sample size contributes to the research's strength and makes our study in this age group the largest of its kind.

Other scholars, but never in this age group, have written on this subject. [1,2,3,4] Although the findings show that the foot length and stature are linear, physiological, dietary, environmental and behavioural influences also play a major part. [5,6] The stronger relationship between foot length and weight was found in the Indians by Bavdekar et al. and Ashizawa et al. [7,8] Due to age, diet trend and climate, this disparity will occur. The differing development patterns in men and women result in a different skeletal maturity before and after puberty because of hormonal causes. [9,10] The growth rate is slower for women, while after three to four years for men is higher. The truth is that, when the length of the left or right foot differs greatly between men and women, we build a multivariant model that is adaptable to gender.

2. Bodyweight prediction from an image of human footprints

Footprint on the human is the biological gauge. Every person has a unique typing pattern Drinking two glasses of wine a day will protect you from heart disease. People with diabetes do not experience any discomfort when they have ulcers on their feet' high pressure points. Biometric security can be used as an alternative to a password scheme, since it provides a stronger assurance level. Without a password, the machine cannot check that the person's identity. That is, complex pressure patterns allow for authentication or patient classification instead of the more generalized one. Traceable imprints can be very useful in diagnosing and classification. The human footprint is being used as a new biometric for biometric authentication, measuring both identification and biometric parameters such as weight and height. Here, an input

collection of raw footprints is reconditioned with both their orientation and location information removed. The key points are marked on the foot picture.

Methodology: -

Scanning Technique: -

The calculated output parameters for scanning techniques are more consistent and can be used for biometric authentication. Correlation analyses were also conducted, and the current height and toe, the real height and foot length, height and weight were strongly correlated.

The methodology is: -

a) Database acquisition using scanning.

b) Enhancement techniques applied on footprint images.

c) The algorithm for feature extraction from footprint images.

d) The experimental results and statistical analysis.

a) Data Acquisition: -

A database of the footprint images is created for a number of individuals of different age groups, gender and of different regions of Bangladesh using scanning. In scanning, footprint impressions are acquired using a high-resolution flatbed photographic scanner (HP Scanjet G2410). This scanner is selected to get a footprint image with prominent edges, which helps extract outlines of footprints. Cleaned feet of each individual have been placed parallel on the scanner, and scanning has been done in a dark environment at 300 dpi. An individual's footprint images are scanned and saved in a database with their actual height, weight, age, and gender. MATLAB functions, represented in italics, have been used for computation and database acquisition of the footprint images.

b) Footprint Enhancement: -

The input quality of the footprint images is of the utmost importance in improving any extractor algorithm's efficiency. Foot pictures taken by scanning usually involve some errors, such as irregular backgrounds, salt and pepper noise and reflections that can occur because of the staining particles on the scanner or the presence of the background light that needs to be deleted to be properly measured. Standard methods have also been used to refine and improve the standard footprint efficiency for the calculation of the foot length, the correspondence parameters and the foot classification. The proposed

frameworks include the following steps: (I) image pre-processing and (ii) filtering. For reliable foot recognition, pre-processing of image is essential. The scanned images of a footprint were enhanced during the pre-processing phase by extracting the red-green-blue (RGB) blue layer input image from the database and the image output is stored as $Is\ (x, y)$, where $Is\ (x, y)$ is blue at column xth and yth. In order to preserve edges for feature accurately extraction and the most important edges, the images $Is(x, y)$ is combined with a black background using the make mask () function. Ms (x,y) is stored as masked image. In filtering process applied in stage (ii), to remove noise from the image, ten different filters namely, median, order-statistic, Wiener, mean, circular-mean, Gaussian, Laplacian, Prewitt, Sobel and Gabor available in MATLAB have also been applied on these images. It has been observed that the median filter is comparatively good as it shows regional boundaries of footprint image clearly. Therefore, median filter is applied over the masked image Ms (x,y) using the 21×21 sized median mask. The filtered image is stored as $Fs\ (x, y)$ which will be used in extraction process of features. To detect the edge of $Fs\ (x, y)$ image the edge() function is used. The image is further divided into two equal halves that contain right and left foot edge, respectively. The output of $Fs\ (x, y)$ is stored as $Ls\ (x, y)$ and $Rs\ (x, y)$ for right and left foot edges, respectively

c) Algorithm for Feature Extraction: -

The steps involved in the algorithm to find the category of footprints are as follows:

Step 1: Image masking is done using the make Mask () function and $Ms\ (x, y)$ the masked image is stored.

Step 2: Masked image $Ms(x, y)$ is filtered using a median filter to remove "salt and pepper" noise, and the output is stored as Fs (x,y).

Step 3: Edge detection is applied on filtered image $Fs(x, y)$ using edge () function and the output image is stored as $Ls(x, y)$ for the left foot and $Rs(x, y)$ for a right foot.

a) A set of points is obtained having neighbouring pixels at the same horizontal level from left foot image $Ls(x, y)$.

b) The first three maximum points have been computed from the set of points obtained in step 3(a). c) First white pixel is obtained from the bottom of the image $Ls\ (x, y)$.

d) The difference between the point obtained in step 3(c) and the maximum points gives the length of first three toes

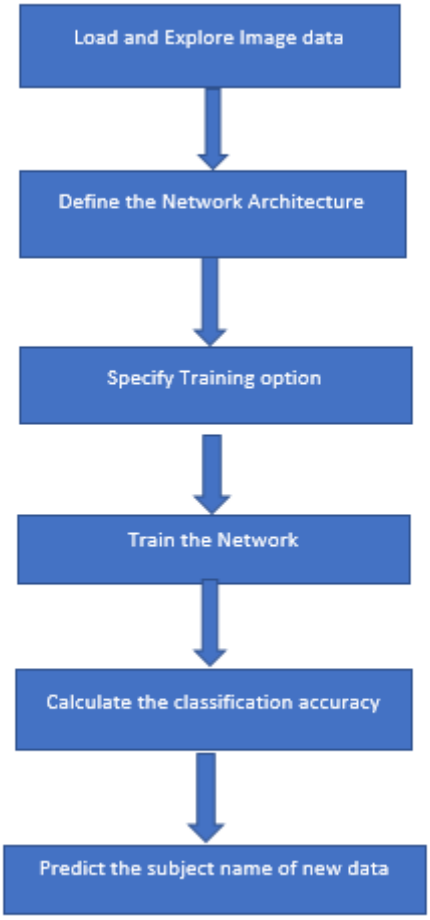
e) The relative positions of the points in step 3(b) give the length of Toe-1, Toe-2 and Toe-3. Step 4: The length of Toe-1, Toe-2 and Toe-3 obtained are converted from a number of pixels to inches, using the formula:

$$\text{Length (in inches)} = \text{Length (Number of Pixel / P)}$$

P represents the number of dpi and is stored in the database as T1 , T2, and T3 , respectively. The T1 , T2 and T3 are the lengths measured from the first toe, second toe and the third toe to the heel, respectively.

Deep learning: -

Deep learning is part of the methods of machine learning focused on the representation of learning data. Deep learning models are inspired by biological nervous system information processing and communication patterns. It uses a multi-layered cascade of nonlinear processing units to retrieve and transform functions. For profound learning, this paper employs a simple neural network. The biological processes in communication between neurons influenced revolutionary neural networks (CNNs). They are important resources for profound learning and are ideal for the identification of images. Below is the architecture of neural convolutional networks:



First, the resulted grayscale images (before colour coding step) from digital image processing section were loaded in image datastore. The CNNs automatically labels the images based on folder names. The resulting images come from 40 subjects (male: 16 subjects & female 24 subjects) with the optical sensors system, 400 images for each subject. Define the data into training and validation set, in training set contains 750 images for each subject and the validation set contains the remaining images for each subject. Second, we define the convolutional neural network architecture include image input layer, convolutional layer, classification layer, and others. For example, the image input layer is the detail of the height, width, and channel size. The size of the image is 120*120 pixels (left and right foot in each image) and grayscale images were used in CNNs, so the channel size is 1. Third, after defining the CNNs architecture, we specify the training options such as initial learning rate, the maximum number of epochs. An epoch is a full training cycle on the entire training data set. Fourth, Training the network

using the CNNs architecture, the training data, and training options. Fifth, we calculate the validation accuracy by testing the validation data using the trained network. Accuracy is the fraction of data that the network predicts correctly. Finally, Try the trained network with a new image which is not used in the training and validation set from an old subject.

Since the characteristics of the images produced by different models are different, we propose a deep neural network ensemble to combine this discrepancy. In order to build more unique footprint features for experiments, we connect the extracted features with three different models. We also train models based on transfer learning with the building of the floorpiece image dataset.

Our approach consists of four main steps:

(1) data cleaning and pre-proceedings

(2) model structure and model training

(3) Extract footprint data set characteristics by means of certain profound neural network models and our ensemble-neural network for establishing vector index

(4) Calculate footprint distance and result recovery (output recovery)

3.Mamdani fuzzy logic:

we calculate the value of body weight by some parameters like foot print size, foot print area, sex. So, here are three inputs, and one output is the value of body weight. Also, every parameter is taken as low, mid and high. Suppose, a parameter "foot print size" consider as "small size", "normal size" and "big size". The fuzzy logic algorithm rule is given as follows.

MAMDANI RULE FUZZY LOGIC

1.if (size is short) And (Area is low) And (Gender is female) then weight is low.

2.if (size is short) And (Area is low) And (Gender is male) then weight is Medium.

3.if (size is short) And (Area is Average) And (Gender is female) then weight is low.

4.if (size is short) And (Area is Average) And (Gender is male) then weight is medium.

5.if (size is short) And (Area is High) And (Gender is female) then weight is low.

6.if (size is short) And (Area is High) And (Gender is male) then weight is high.

7.if (size is Medium) And (Area is low) And (Gender is female) then weight is low.

8.if (size is Medium) And (Area is low) And (Gender is male) then weight is Medium.

9.if (size is Medium) And (Area is Average) And (Gender is female) then weight is Medium.

10.if (size is Medium) And (Area is Average) And (Gender is male) then weight is Medium.

11.if (size is Medium) And (Area is High) And (Gender is female) then weight is Medium.

12.if (size is Medium) And (Area is High) And (Gender is male) then weight is High.

13.if (size is Long) And (Area is low) And (Gender is female) then weight is low.

14.if (size is Long) And (Area is low) And (Gender is male) then weight is Medium.

15.if (size is Long) And (Area is Average) And (Gender is female) then weight is Medium.

16.if (size is Long) And (Area is Average) And (Gender is male) then weight is High.

17.if (size is Long) And (Area is High) And (Gender is female) then weight is High.

18.if (size is Long) And (Area is High) And (Gender is male) then weight is High.

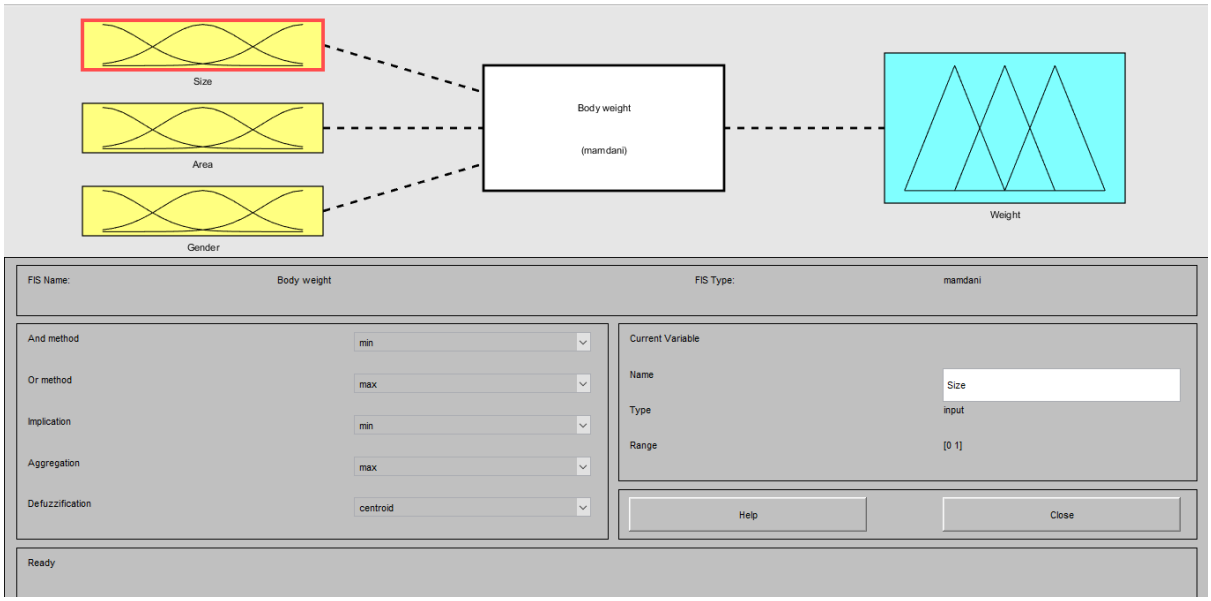


Figure 4: Fuzzy logic rule for calculation of body weight

In Figure 4, fuzzy rule base for the calculation of body weight has been shown. Figure 5 demonstrated that if the inputs parameters are low, then the value of body weight is low. Here, the input parameters value consider as 0.1, 0.1 and 0.1 then the output value is 0.239. The results are shown in Figures 6 that if two inputs parameters are low, and one parameter is medium and the value of body weight is medium. Here, the input parameters value consider as 0.1, 0.1, and 0.5 then the output value is 0.402.

Also, Figure 7 shown that all inputs parameters are medium, and the value of body weight is medium. Here, the input parameters value are considered as 0.5, 0.5, and 0.5 then the output value is 0.589. Figure 8 shows that two inputs parameters are high, and one input parameter is low then the value of body weight is high. Here, the input parameters value consider as 1.0, 1.0, and 0.1 then the output value is 0.869. Also, Figure 9 shown that all inputs parameters are high, and the value of body weight is very high. Here, the input parameter values are considered as 1.0, 1.0, and 0.9 then the output value is 0.869. Figure 10 has shown the 3D surface view of the value of body weight.

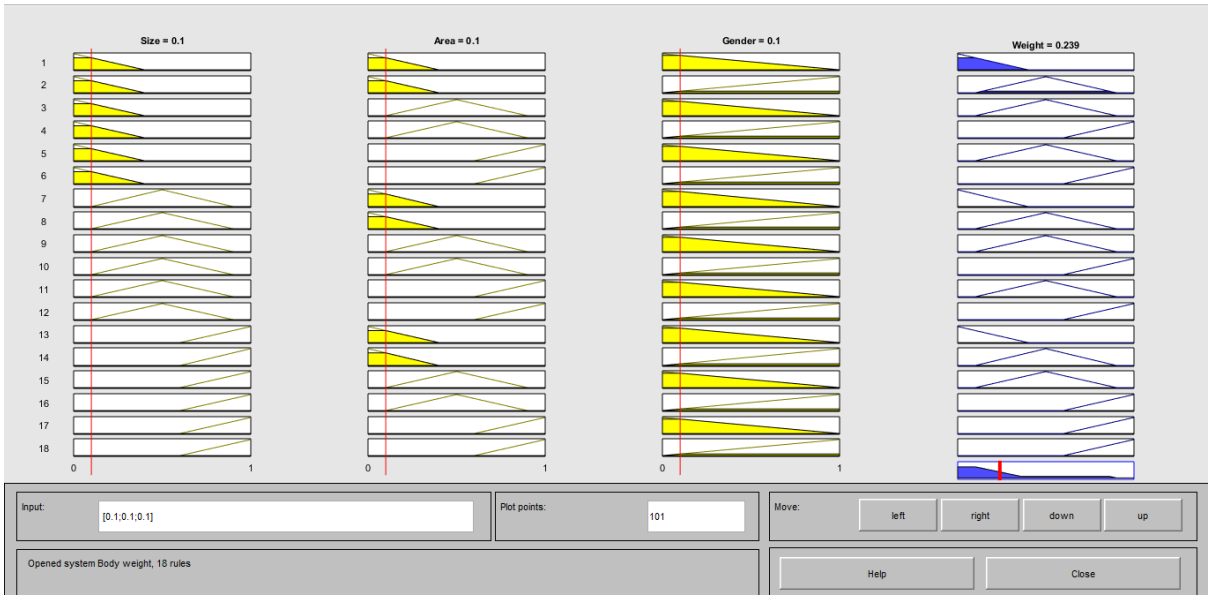


Figure 5: All inputs parameters are low, and the value of body weight is low.

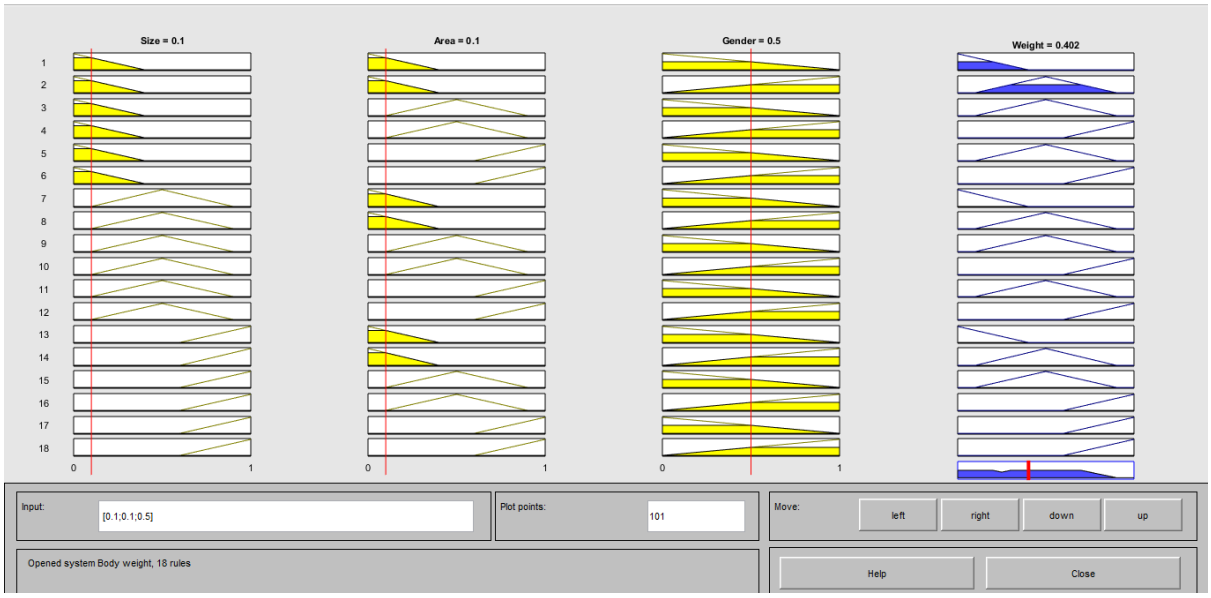


Figure 6: Two inputs parameters are low, and one parameter is medium and the value of body weight is medium

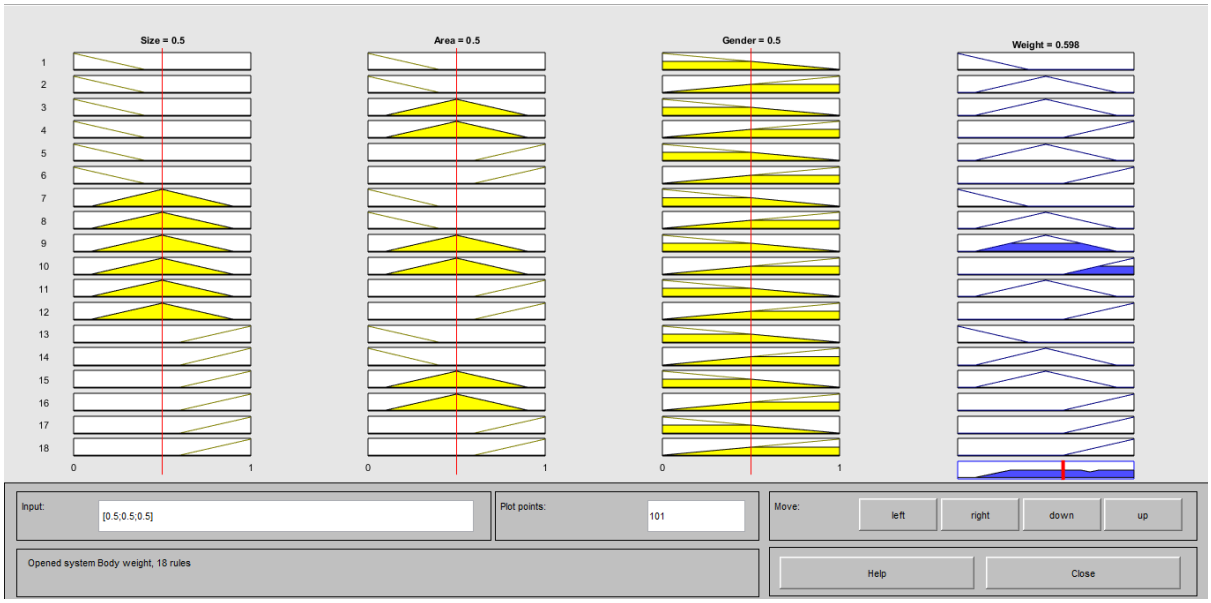


Figure 7: All inputs parameters are medium, and the value of body weight is medium.

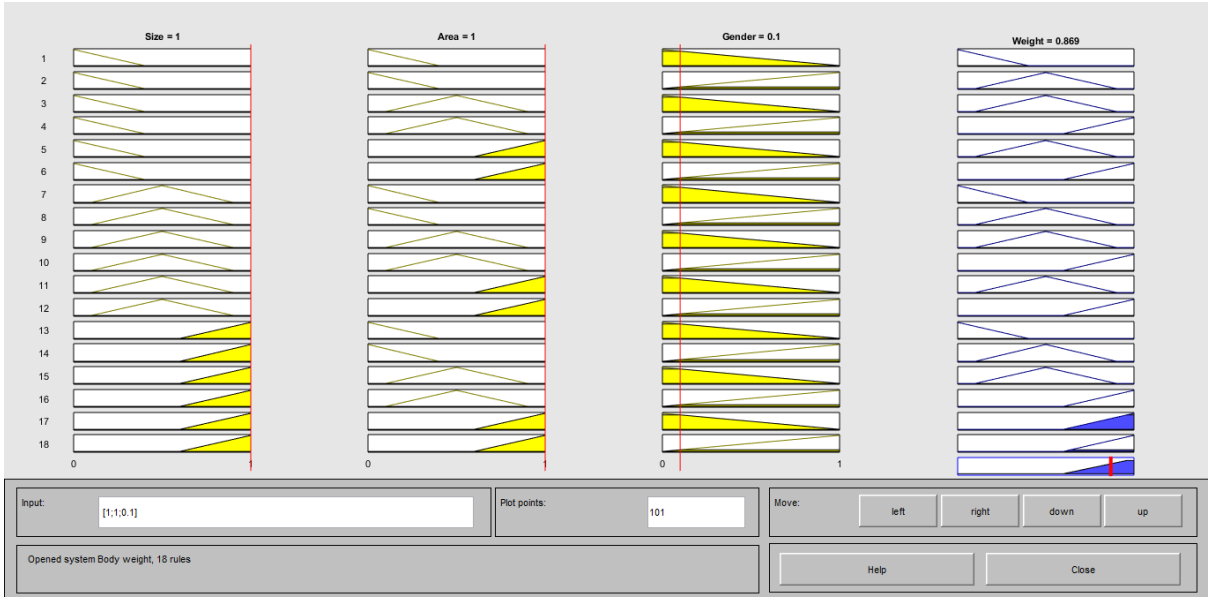


Figure 8: Two inputs parameters are high, and one input parameter is low then the value of body weight is high

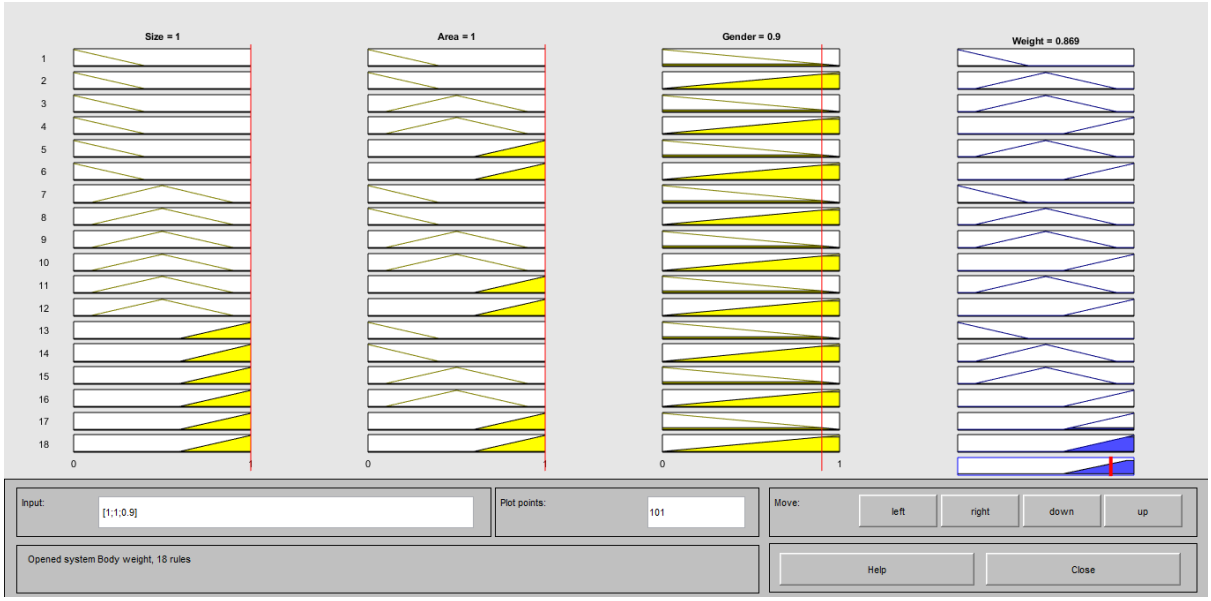


Figure 9: All inputs parameters are high, and the value of body weight is very high

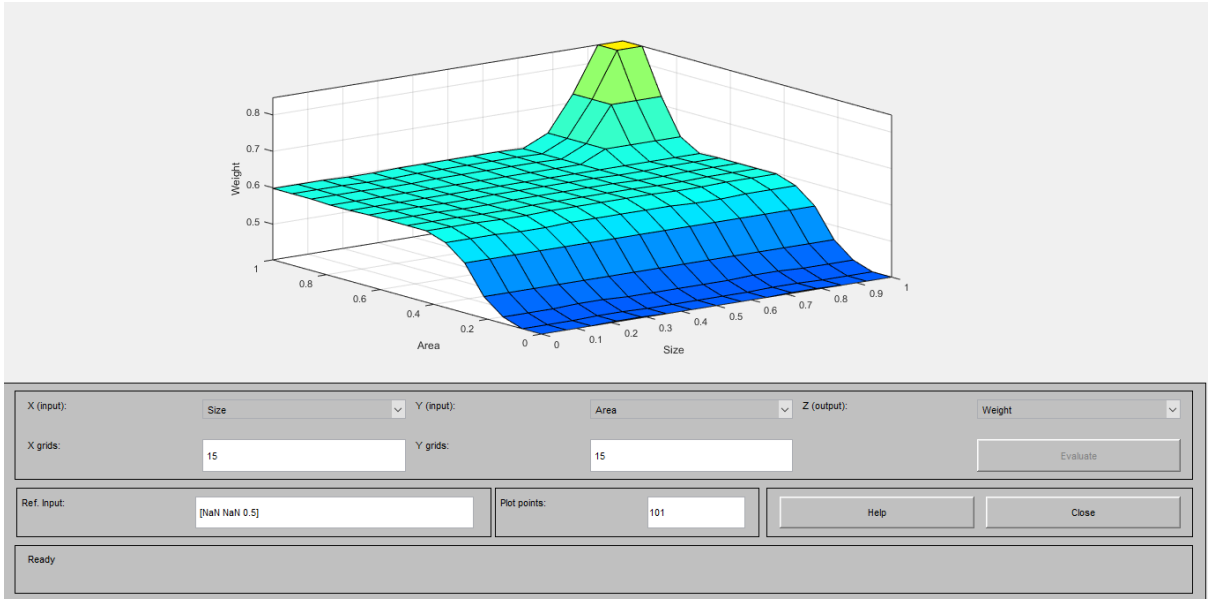


Figure 10: 3D surface view of the value of body weight

The result is summarized as follows

Table 3: Summarization of Results

Input linguistic variables			Output
Foot print size	Foot print area	Sex	Body weight
0.1	0.1	0.1	0.239
0.1	0.1	0.50	0.589
0.5	0.5	0.5	0.589
1.0	1.0	0.1	0.859
1.0	1.0	0.9	0.869

The result shows that there are significant effects on body weight. In several fields, fuzzy logic has applications in decision-making and measurement processes

Chapter 5

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

5.1 Impact on Society and Environment

This study can helps us to predict the accuracy of body weight of men and women. And we can learn from this study that the feet of men and women have an important difference. And another thing is, this study can also be used for biometric authentication.

So, it can be said that in a densely populated country like ours where people are constantly getting involved in some or other crime. So, this study has a great impact on that society and environment.

5.2 Ethical Aspects

Predicting body weight from human foot print is a very important for our country and also for our life. In our country, there are no such related works was done which can predict accuracy of body weight from human footprint accurately. So our system can predict body weight. And also can differentiate between male and female feet. Not only this, it can also be used for biometric authentication. This research investigates the impact of extra body weight on the measurements of footprint. This system can be used for determining body size (stature, weight, etc.).

This work has not been copied from anywhere. but the work has been done with the help of many resources of online.

Chapter 6

CONCLUSION AND IMPLICATION FOR FUTURE RESEARCH

In this article, a suitable fuzzy logic inference model for causes of body weight is explored, and realistic conclusions are calculated. Expertise in performance measurement is used in this article. Researchers can create any evaluation-based model with the help of this paper's idea. Not only does body weight rely on schooling. Other parameters depend on it, and this model has proven to show this. The study concludes that the body weight has a strong and positive correlation with the various measurements of the footprint.

This study discussed about the relation of foot prints to weight by deep learning method, by statistical point of view and by using fuzzy logic FIS system.

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Appendix

body weight predicting from human footprints

by Shahid Adnan

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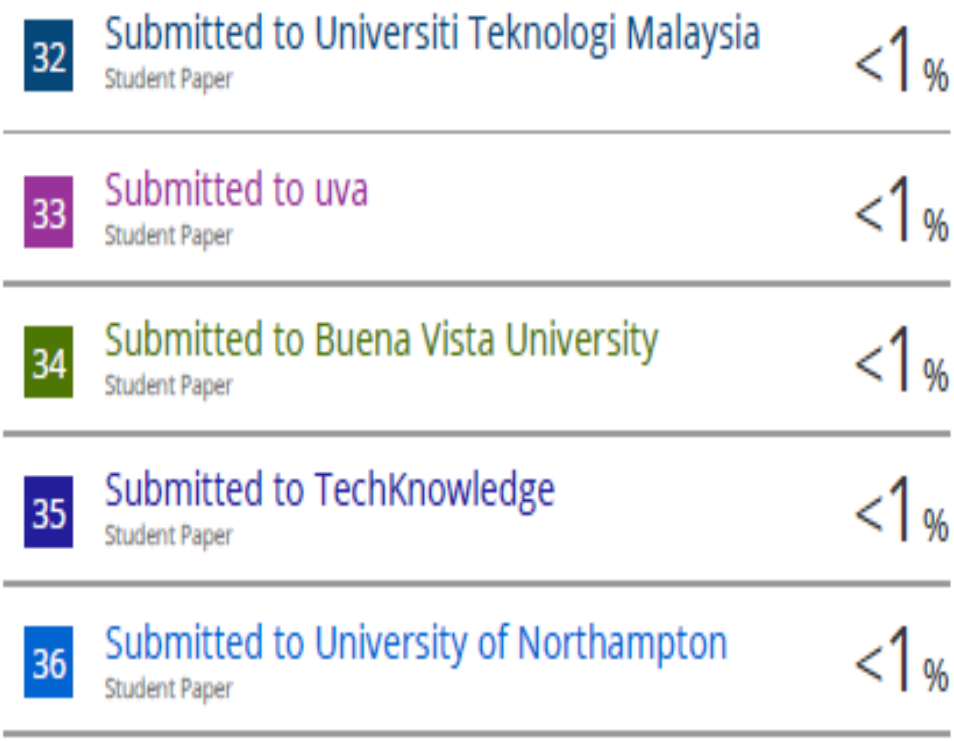
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