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Image Processing for Human Body Weight Prediction

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***Abstract*—This work describes a method to determine body weight from the way that human body photographs seem visually. The human age, height, width, circumferences are directly related with the weight. This information is utilized to train a Machine Learning model and forecast the person's potential weight using Image processing techniques.**

***Index Terms*— Prediction, Computer Vision, Support Vector Machine, weight, age and Validation.**

I. INTRODUCTION

People are documenting their life in form of images, videos on social platforms. Social networks are prevalent in modern life and serve a variety of purposes, including blogging, job searching, and image sharing. Pupil color, gender, height, weight, age, and other hard and soft biometric data are all included in a great deal of social network photos. It is possible to identify specific people using such biometric data. One of these can be Body weight and fat percentage identification which are effective markers of health among the soft biometric measurements.

A. Need

People in present-day are busy with their digital dynamic lives, with all the advancements of technology in human life everything is within hands and quick. Adapting to the improved technology most of the daily chores are made faster and easier. All the tasks, moments are captures and shared through social media making a pile of biometric and non-biometric data. This kind of information, pictures, videos can be used in many other ways with the forthcoming data analysing techniques. People can actually make use of it to predict their physical health conditions and take probable measures to become fit and healthy. One of the main factors of healthy lifestyle is the body weight and without using any measuring instruments, orthodox style of knowing person weight we can easily know the weight from a simple picture of the person. This advancement saves the time and can be used further to know useful routine according to the condition of the person. In this paper a possible algorithm to predict the weight of person using simple image and an external parameter age is discussed.

B. Technology and concepts used

The collected images are first margined towards the person in picture. To carry out computer vision, deep

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learning, and machine learning tasks, a number of packages are now accessible. The most effective module for such complex issues so far is computer vision. Different programming languages, including R, Python, etc., support it. It presumably functions on the majority of operating systems, including Windows, Linux, and macOS. To identify the person in image OpenCV HOG descriptor is used. In this process initially, the image is taken and there can be a possibility of multiple faces present in our image. So, the faces are identified and then clustering is applied to cluster the objects in image, later similarity detection is applied to classify the faces among all the faces present using the reference face of the person given prior. After detecting the correct person image can be margined towards that particular person and further process can be implemented.

C. Preparation of model

The model is trained with 70 images of different persons having different parameters of age, height, width, shoulder width, age, hip width, arm muscle, side profile width, thigh width, diagonal width. Having 3 divisions of age, a support vector machine algorithm the cluster of weight the person belongs to are predicted. The model is measured using the Mean squared error of the actual and predicted weight. Before predicting the weight model collects all the parameters from the image of a person which is the benefit of this algorithm.

The person is clustered according to the age first, and then all the other face detection , height, width calculations are made. The reason behind clustering initially is to reduce the time complexity of predicting by providing a range of weight for each age cluster such as 2-15 years(20-50kg), 16-30 years(30-120kg), 30-70 years(40-100kg), above 70years(40-90kg). This can further be sub clustered as Female and Male to reduce complexity even more. The method used is partitioning clustering that divides data into non-hierarchical groups. The dataset is split up into a set of k pre-defined groups, where K refers to the number of groups. The cluster centre is designed so that there is a minimum distance between data points in one cluster and the centroid of another cluster.

II. LITERATURE SURVEY

Initially there are recent journal articles on animal weight prediction based on RGB image, from different morphometric measurements. One of the Research journals by Iqbal et al[2], Zeeshan et al[2] and others was estimating weight of kajli lambs. The data of 109 female and 105 male lambs was collected which is segregated into three different age groups. Only three body measurements were considered in each group of both male and female lambs to predict the weight. The parameters considered are weighted according to the correlation of their respective weights. Such positive and substantial ($P<0.05$) connections between weight and physical characteristics were found. The regression analysis showed a linear connection between live weight and body measurements at 0–3 months of age (wither height, body length, and heart girth; P-values = 0.0001, 0.0001, and 0.0001). Males were observed to be heavier and longer than females in the first two age groups during the current investigation ($P<0.05$). To verify the coefficient of determination, stepwise multiple regression analysis was performed. Several studies have looked into calculating a person's body weight or BMI using parameters, 3-dimensional (3D) body data, and RGB-D body photos. Velardo Caramelo [5] and Jean Luc et al[5] conducted research on body weight using anthropometric data (body measurements) collected by NHANES. The data were examined using an anthropometric regression model. For the predicting of many soft biometrics, including weight and gender.

There are few more ways to forecast weight by employing Body mass Index, BMR, food calorie calculations, and a neural network developed by A. K. Gopalakrishna et al[8]. Based on BMI, the RWPS(Recommended Weight Prediction System) calculates the days required for a person to reach their normal weight. The algorithm determines a person's weight value based on their BMI value, where a person with a normal Body Mass Index has a weight value of zero. The Needed Calorie of a person is computed using the BMR, and the DNC, weight value, and DFI are used to determine how many days it will take for a person to reach a "normal" BMI condition. When a person under 30 is being considered who is underweight, the same could be said to apply. In the latter scenario, the BPNN would examine the subject for any eating disorders before using the system's day prediction component on them. The experimental findings demonstrated that the suggested strategy may be a useful method for anticipating the presence of any eating problems and the time required for a person to return to a normal BMI.

People offered comprehensive definitions for a wide range of anthropometric feature measurements. Velardo [5] studied weight estimation using 3D human body data using the same anthropometric features as in their earlier research. Velardo [5]. accurately predicted a person's weight to within 3% of the actual number from a low-cost Kinect RGB-D camera output using 2D and 3D data obtained. They proposed a weight estimator using visual

color cues, depth cues, and gender information based on single RGB-D pictures. In order to calculate a person's BMI, Nahavandi et al[5] demonstrated a Kinect system without a skeleton. Pfitzner et al. recently discussed how to estimate a person's body weight in three different poses when they are in front of an RGB-D camera: lying, sitting, and standing. Other use cases like predicting the mortality in premature infants, include prediction models experimented by Medlock.S et al[10], Ravelli ACJ et al[10], Tamminga et al[10], Mol BWM et al[10], Abu-Hanna A et al[10] in recent years. The predictive performance of a model in a very preterm or very low birth weight population were included. Population, variables, aim, prediction performance, and the count of times each model was validated were all documented for each development research. For development studies, minimum methodological standards and reporting quality standards were defined and evaluated.

Using an Active Shape Model, facial feature extraction is carried out in order to be used in various regression techniques to calculate BMI. By using face landmarking, Barr et al.[9] were able to determine adiposity, or "facial fatness," which is positively connected with a person's weight. This strategy, however, performs less well in some severe cases of obesity and underweight. Support vector machine regression was the model that was applied. By using facial landmarking and spatial scaling, Windhager et al.[12] showed that it is possible to determine how the shape of the face relates to different body characteristics like height and weight. Convolution neural networks and ANN were recently employed by Haritosh et al. [15] to estimate the weight using the facial image retrieved using the Viola-Jones detector. A few research have looked into determining human body weight or BMI from the information about the body, including measurements, 3D body data, and RGB-D body photographs. Jiang et al[3] .'s analysis of data from the ProgressPics Reddit page included photos of the full front body. They calculated the weight based on those traits and used anthropometric measures from contour segments of body to estimate BMI. [1], [11], [13] are the references for previous works of predicting weights using data integration. [4], [6], [7], [14], [16], [17], [18], [19] are the approaches of image processing and deep learning methods to identify morphometrics/ anthropometry/ height/ facial data/ soft biometrics to predict the weight.

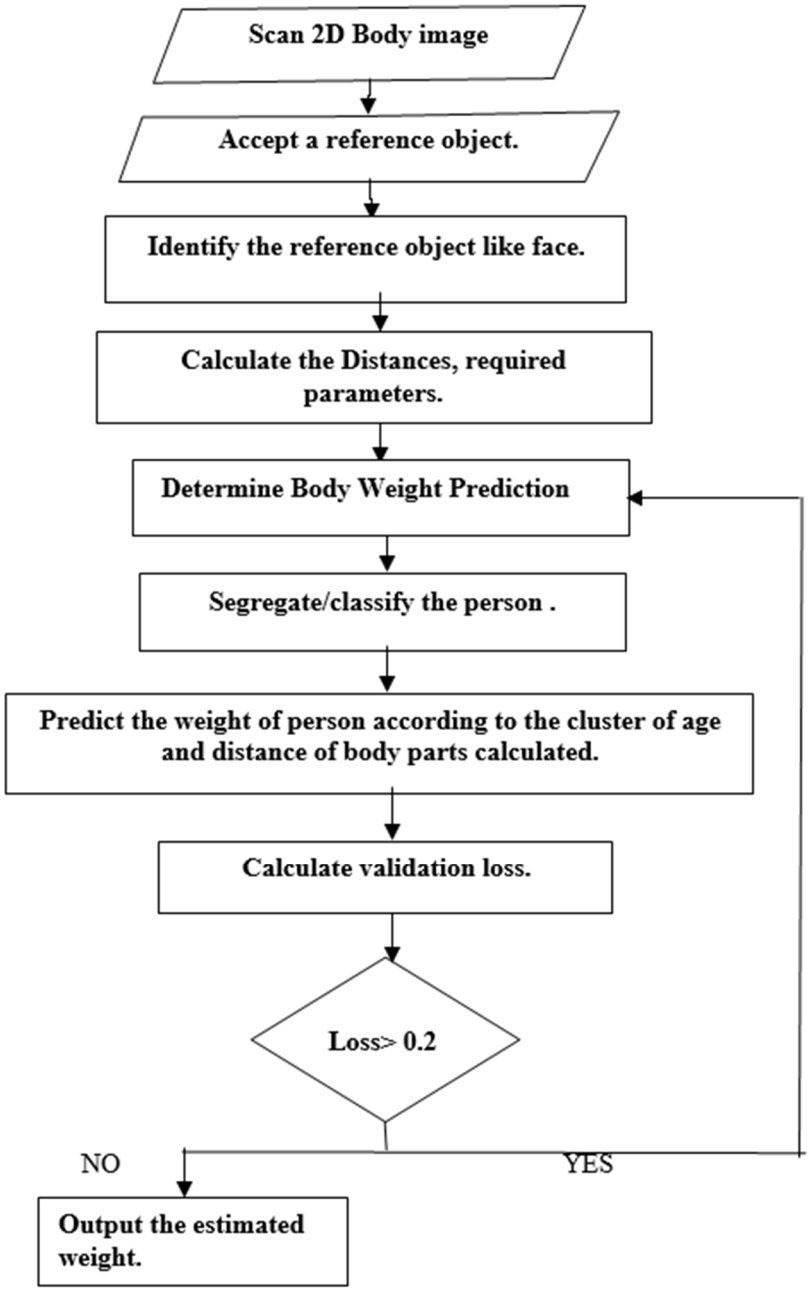
III. Problem domain and definition

Instead of using orthodox methods to know our weight we can employ image processing to identify core points in our body and calculate weight. This makes it easy to estimate weight, save time and give regular updates on our medical health in a comfortable manner. There are several previous methods to predict the weight but our method give the best accuracy in lesser time complexity as the person is clustered according to age and range of possible weights are predefined according to data analysis techniques based on previous collected data of weight and age. This method reduces the complexity at the initial stages by identifying height, width of every part of body and calculate weight based on pre classified range of person using Support Vector machine.

The tracking of nutritional illnesses, energy consumption, clinical situations, drug dosages, and infusion rates involves the use of height and weight data. Anthropometric methods can be used to estimate it roughly in circumstances when accurate estimation or measurements are not possible due to the fact that many patients are not mobile or may be unable to talk. Various organisations have put forth various linear or non-linear equations, the coefficients of which are determined by utilising a single or multiple linear regressions.

The SVM Classifier, that is employed to address both regression and classification tasks, is one of the most used supervised learning techniques. The SVM algorithm's goal is to specify the optimum decision border that can adequately represent the n-dimensional space, enabling subsequent data points to be quickly assigned to the appropriate category. The hyperplane is an ideal decision boundary. The extreme points and vectors are chosen by SVM to construct the hyperplane. The name of the Support Vector Machine approach comes from support vectors, which are utilised to depict these extreme occurrences.

IV. DESIGN



V. METHODOLOGY

A. Proposed solution

The desired person from scanned image was identified using OpenCV techniques. Age is taken as an external parameter to cluster the person and get the range of weight to reduce the complexity and possible error of prediction. Later getting the image and bordering the person height, width, side profile width, shoulder length, hip size, thigh width, diagonal width was calculated and given as parameters to the Support vector machine model which is pre-trained with 70 full length images. The range of weights for each age cluster are divided as such 2-15 years(20-50kg), 16-30 years(30-120kg), 30-70 years(40-100kg), above 70years(40-90kg).

In order to calculate the height of the person a reference with pre known measurements are considered. With the help of that measurements the height of person is determined. For example, if there is a T-shirt worn by the specific person the identification of person is done with this reference. After identifying the person, the distance from face to that shirt is calculated and similarly distance between leg and shirt, using these values the height of person is calculated. All of this is implemented using OpenCV, Hog descriptor, face detector. The distance calculation is a simple mathematical application of Euclidean distance. Width, hip , shoulder lengths are also calculated using the above algorithm only.
After getting all the nine attributes (height, width, shoulder width, age, hip width, arm muscle, side profile width, thigh width, diagonal width) weight is predicted by establishing the most effective decision border or line that can partition n-dimensional space into classes, allowing for fast categorization of new data points. SVR considers in matching best line between threshold which is the distance from boundary line to hyperplane. To scale samples approximately sized around few tens of thousands is a difficult task because of its complexity for more than quadratic number samples.

B. Mathematical Formulation

The ages are divided using distance between themselves and the hyperplane defined by SVM
||D|| is assumed to be the distance which is Manhattan distance.

$$||D(p1,p2)|| = |x_1 - x_2| + |y_1 - y_2| \quad --(1)$$

An optimal plane equation is that which divides points of different clusters at maximum margin.
Equation of hyperplane is,

$$w.\ x_i + b >= T \quad --(2)$$

Here, x_i is the input data, w is the vector normal perpendicular to hyperplane and b is offset
The value of T(threshold) decides the classification of input.

C. *Validation metric*

The average of square of the errors is what the validation loss(MSE/MAE) is. The larger the number returned the larger the error is. To overcome the error concept of gradient descent is applied i.e., until the error is reduced to its minimum the model is back propagated. The difference between the anticipated values and the observed values is the error.

$$MSE = (pred(yn) - yn)^{**} 2 \quad --(3)$$

VI. RESULT ANALYSIS

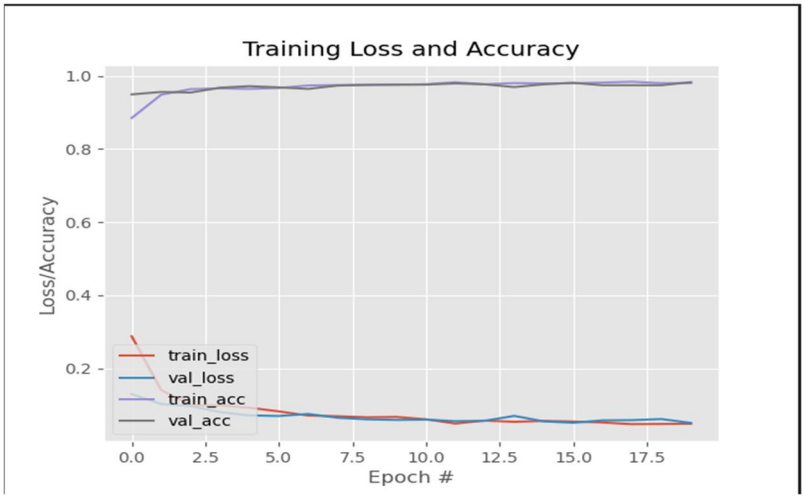


Figure I. Training, Validation Loss Graph

The training loss and accuracy are displayed above testing with new and already present information of person height , width from scanned image. At the starting iterations validation and training loss are high which are gradually decreased in further epochs. The vice versa happened with accuracy also.

VII. Data Model

All the length/width metrics are in cm.

TABLE I. SAMPLE DATA

AGE	HEIGHT	WIDTH	SHOULDER	width(HIP)	width(ARM)	width(THIGH)	WEIGHT.actual(kg)	WEIGHT.pred(kg)
16	152.2	71	68.7	71	32	54	48.5	50.08
20	160	76	74	75	41	58	78.3	75.5
44	157.97	75	74	73	44	60	65.8	66.82

VII. Comparison of Results

TABLE II. COMPARISON TABLE

Previous proposed Models	Validation Used
Body weight for the non-ambulatory elderly	The cross-validation sample was considered to independently get validity and accuracy; the mean signed discrepancies between the predicted and actual weights ranged from 0.1 to 1.8 kg.
Deep Learning Techniques for animal Body Weight Prediction	Validation used is MAE with a result of 23.19kg variation.
Weight prediction in early fossil hominids	Upper limb bones yield converging results for giant hominids(above 50 kg), while other predictors produce convergent body weight estimations (BWEs) for a variety of size ranges.
Kajli lambs weight prediction	Correlation and Root mean squared error of multiple linear regression analysis
Recommended weight prediction system(RWPS)	BMI, BMR, calorie consumption, and neural network-based weight prediction.
Height and weight estimation from virtual visuals	Mean Absolute difference is used to measure the algorithm. Between the projected and actual values, there was an average absolute height discrepancy of 6.9 cm and a weight difference of 3.2 kg.
Our Model	Considering the age as extra parameter our algorithm give RMSE of 1.2kg and the time to compute is 2seconds at highest.

VIII. Conclusion and Future Scope

In this work the height and width of person are calculated by scanning and taking a reference object from the image whose height is known. Identifying the nearest person to the reference object and calculating their height weight ratio is done. The suggested method outperforms existing algorithms for facial image analysis in most situations. Additionally, when it comes to estimating BMI, our anthropometric features perform noticeably better than the VGG-Net feature. The ability to visually assess human body weight from the scanned body images is promising based on all experimental findings. Pre clustering age of person and defining the possible range of weight make the model more accurate and less complex. Further implementations of the project can be a Mobile application that takes a2D image of a person and estimate the weight of the person. This can also be used to further discover required measures to be taken by a person to overcome overweight/ underweight by calculating BMI. The mobile application built can be used to recommend nearby treatment centers, medicines, best doctors, etc., for overcoming the possible diseases due to abnormal weights that are been estimated.

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