Sitting Posture Monitoring System using Image Classification

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Abstract - *The objective of the application is to provide a way to improve sitting posture of users by detecting their posture using image classification method. The project will introduce a new system which will make use of posture detection. The covid pandemic has resulted in a considerable increase in the number of individuals working from home, often without necessary ergonomic tools and infrastructure. Misaligned desk heights, lack of proper desktop chairs and excessive use of laptops pose real challenges to the wellbeing and health of the users. Bad sitting posture is a major cause of back pain, neck pain, headaches, and discomfort in the spine which can lead to spinal dysfunction and make it difficult to work for long hours. The number of patients with lower back pain is increasing over the years but never found decreasing. In addition, this sort of maladies affects close to 20% of the population and especially the workers who belong to the software industry. The knowledge generated here can be used by the responsible peoples to come up with their strategies to reduce the issues of back pain in the country more effectively. As a solution the proposed project uses a model that classifies and detects the posture of a user in real-time using the system webcam and accurately classify their sitting posture so that people get a quick suggestion based on the result.*

Key Words: **Sitting Posture correction, Deep Learning Model, web interface, webcam, image classification**

1. INTRODUCTION

Health care is the preservation or development of health via avoiding, diagnosis, and medical care of diseases, sickness, injury, and other physical and mental debilitate in human being. These days, due to the covid pandemic a greater number of people are working from home and using their laptops/desktops for long hours. It has been noticed that the workers do not use the necessary ergonomic tools or infrastructure to set up their work area. The use of misaligned desk heights, lack of proper desk chairs and excessive use of laptops by sitting in a bad posture can pose real challenges to the workers. Back discomfort, neck pain, headaches, and even spinal dysfunction might result from this. The number of people with back problems is developing step by step however never decreases. In addition, this sort of maladies affects 20% of the population and is a reason for concern for employees in the software industry. The proposed project helps to solve all these problems by providing a web interface solution which can detect posture of the user in real time and based on the image classification model the system will detect the posture and give a visual result to the users. They can use this website during their work to quickly correct their posture and reduce chances of back pain. The sedentary and monotonous lifestyle of some professions can lead to many health problems and along with an unhealthy diet, it can be a challenging and difficult problem to handle.

2. RELATED WORKS

In paper [1] The author developed a method that merged computer-assisted posture tracking with behavior modification strategies and wearable health equipment. Wearable health devices are a relatively new phenomenon in healthcare, and they are continually being developed with the goal of being incorporated into medical health systems. On the market, there are certain personal monitoring gadgets that can analyze and transmit single parameters in real time. The primary value potential of WHDs, on the other hand, is to combine a broad range of biosensors, cognitive processing, and alarms to enable medical applications while connecting with healthcare personnel, using technology that is now only available in research. Long-term stability, robustness, and biocompatibility will be three primary characteristics of sensor technology that will be given special emphasis. Washing cycles in textile-based sensors can cause mechanical, chemical, and thermal deterioration, therefore more robust sensors must be developed to counter the stress induced by lengthy durations of usage. Another critical requirement for expanding the usefulness and mobility of WHDs is smaller sensors, which are tied to electronics development. Wearable sensor sensitivity is an essential quality that should be thoroughly investigated. Instead of developing devices and software for particular diseases, it is critical to investigate user requirements in order to establish an integrated strategy in health and wellness services. There's also the issue of privacy, and sensitive data being leaked, causing people to lose trust in these gadgets and resulting in ethical issues. Hence, this approach is still at an early stage and these devices are impractical and unaffordable to the general public.

In paper [2] The author presents a method for recognising human actions that is based on informative joints. The author used the method of joint locations with differential entropy to analyse the average contributions of different joints for different action classes, which is similar to how the human vision works. The majority of the activities differ significantly, and the ratio of contribution is highly consistent with simple inferential knowledge. The author introduces a new method called skeletal context for measuring posture similarity and using it for action detection. The level of familiarity is determined for each relevant joint by obtaining the multi-scale position distribution which is taken pairwise. The feature sets are then assessed using linear CRFs in a bag-of-words approach. The approach is then validated on two public action datasets and the experimental findings are reported. The suggested technique is used to differentiate comparable human actions and for their identification and suitable for variation that is within the same class, according to the findings of experiments. So far, skeleton-based methods have performed with lower accuracy methods that use the depth map or methods that use a combination of features.

In paper [3] The author presented a system that consists of an Arduino-equipped chair, an application based on android that can assess the posture of the user, and a server that can assume the seated user's position and allow them to monitor their own posture. To begin, the values of a sensor which measures the pressure and another sensor for sensing the ultrasonic waves were used to determine what posture the user was sitting in by taking into account the entire body. Using deep Convolutional Neural Networks and Lower Balanced Check Network, the author improved the performance in predicting user posture. A novel and diversified dataset of human sitting postures is presented. Furthermore, the system differs from earlier works in that it checks the balance of the entire body and not just a section of the body. Finally, the system's remarks, which employs the keyword matching algorithm is used to instruct the users on how to adjust their sitting posture. Besides that, users' incorrect posture habits can be corrected by sending alerts on their app and suggest videos based on the measured posture. The method will try to improve the work productivity and have a good impact on health for today's people who spend the majority of their time seated.

In paper [4] data from three tri-axial accelerometers is used to investigate posture categorization. The data was obtained from seven distinct participants in nine different sitting and standing positions. For classification, 3 different models are used. FCN or Fully Convolution Network and the LTSM or Long short term memory, and a combination of the above 2 models is used for classification. Among the three models, the integrated network has the greatest overall accuracy of 99.91 percent. To confirm that there is no overfitting, the loss during the training phase and testing phase is plotted against the epoch. Among the three models, the combined model is the most suitable because it has highest number of parameters than can be trained. This model, on the other hand, requires a training period that is equivalent to that of a neural network that is fully convolutional. The time taken for suggesting the labels for the 3 different models is less than 5 seconds on average, making them ideal for real-time applications. This work will be expanded in the future to gather a bigger dataset and a cheap posture monitoring system for employees and college students.

In paper[5] the author suggested a new method for detecting the posture of a skeleton by using 3-dimensional convolution neural network. The body of the subject is normalised using bounding-box-based normalisation to remove coordinate disparities caused by different recording environments and posture displacements. To depict posture configurations, Gaussian voxel modelling for the skeleton is used. The constructed 3D features are then classified using a simple but powerful 3D PostureNet based on 3-dimensional neural network. A huge dataset for posture while writing comprising thousands of samples from a sizeable number of people in 15 postures was collected to test the efficacy of our technique. Experiments on the dataset which contains posture of users while writing, the MSRA is a dataset for detecting gestures of the hand, and the body pose dataset reveal that our system outperforms other methods in skeleton-based human detection of posture and hand posture detection tasks.

3. PROPOSED SYSTEM

Step 1: Data Collection

When the record button is pressed, the Media Capture and Stream API is utilised to display a live webcam stream and to record photographs. After deploying the app, we need an SSL certificate to use this API. If a domain name is available, Amazon Lightsail offers a simple method to get started. A good posture, a bad posture leaning forward, and a bad posture leaning backward are the three sitting posture patterns employed. The photograph is delivered to the back-end, along with some metadata (a unique random session id, posture mode, and image index). The images are saved as objects (in an Amazon S3 bucket), and the metadata is saved in a database (PostgreSQL). The data collected is stored in AWS cloud and its only accessible by the admin to prevent privacy issues or data leaks. Amazon S3 or Amazon simple storage service is a NoSQL database used for storing unstructured data.

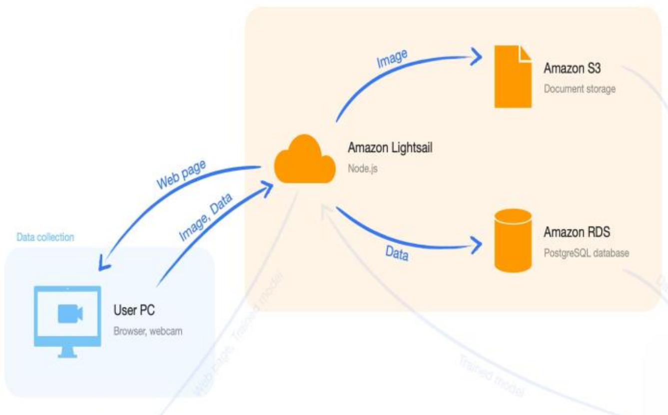

Fig 1.1: Data Collection

Step 2: Data Preprocessing

The webcam photos are pre-processed with a face detection pipeline to achieve optimal data efficiency. The purpose is to provide consistent input photos to the sitting posture classification model in terms of size and face position. This makes the posture model's job easier since it doesn't have to deal with variable scales (a face moving closer or farther away from the webcam) or locations of the face on the webcam picture. The MediaPipe API is used to access an off-the-shelf face detection model. The crop around the face in the webcam image is determined using the bounding box coordinates. The crop's centre is at the bottom of the enclosing box, and the square crop's side is the geometric mean multiplied by a factor of four. The cropped image depicts the face, neck, and shoulders, which are the important areas to consider while determining sitting posture. When information is lost due to the recognised face being too close to the webcam image's edge, zero (black) padding is added.

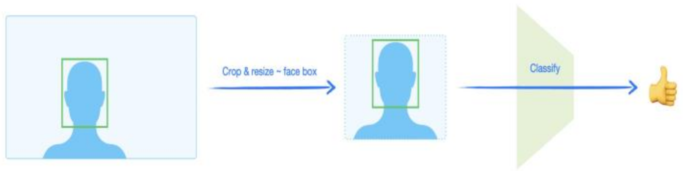

Fig 1.2: Data Preprocessing

Step 3: Training Model

The preprocessed photos would be used to estimate a sitting posture score using a pretty simple image classification algorithm. While generating train / validation / test splits we must ensure that the same individual is present only in one group. The training will be for 30-40 epochs. The Adam optimizer is used for optimizing stochastic gradient descent. If training is done for many epochs, the model might overfit the training set.

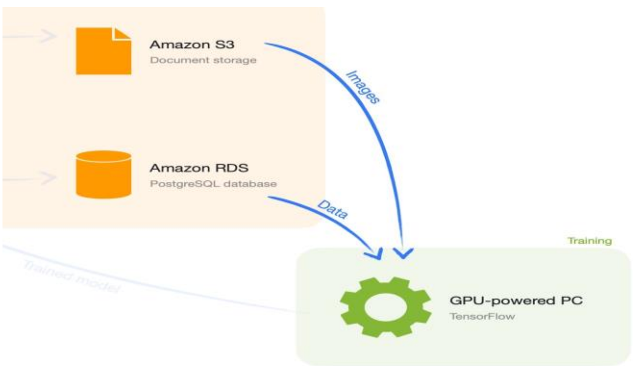

Fig 1.3: Training Model

Step 4: Inference

The trained model is stored as a TensorFlow.js model, which can be executed in a browser. The inference web page, which is available through the node.js back-end, uses this model. To collect webcam photos, it once again uses the Media Capture and Stream API. These photos are preprocessed in the same way as the tagged images were, before the model was trained. To detect the user's face, the default TensorFlow blazeface model is utilised. This is the exact same model that was used in the preprocessing pipeline, which was immediately accessible via the MediaPipe API. Cropping and rescaling have to be converted to JavaScript as well, which was accomplished using the CanvasRenderingContext2D API. The resulting image is sent to the TensorFlow.js model. The resulting posture score is used to update the UI by changing the color of the website to green if the posture is correct and to red, if the posture is incorrect.

Fig 1.4: Inference

4. CONCLUSIONS

In this work, we proposed a web based method to detect sitting posture of users and help them improve their posture. Sitting posture detection and correction is necessary for employees who work from home to prevent back pain and work for long hours on their laptop/desktops. This system does not need additional infrastructure and can be used only via the system webcam. The proposed project helps to solve all these problems by providing a web interface solution which can detect the user's posture in real time and based on the image classification model the system gives a visual result. By making use of MediaPipe API we are able to detect the faces easily and the CNN algorithm is used for the image classification. The knowledge generated here can be used by the responsible peoples to come up with their strategies to reduce the issues of back pain more effectively.

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