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A Hybrid Posture Detection Framework: Integrating Machine Learning and Deep Neural Networks

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Abstract: The posture detection received lots of attention in the fields of human sensing and artificial intelligence. Posture detection can be used for the monitoring health status of elderly remotely by identifying their postures such as standing, sitting and walking. Most of the current studies used traditional machine learning classifiers to identify the posture. However, these methods do not perform well to detect the postures accurately. Therefore, in this study, we proposed a novel hybrid approach based on machine learning classifiers (i. e., support vector machine (SVM), logistic regression (KNN), decision tree, Naive Bayes, random forest, Linear discrete analysis and Quadratic discrete analysis) and deep learning classifiers (i. e., 1D- convolutional neural network (1D-CNN), 2D-convolutional neural network (2D-CNN), LSTM and bidirectional LSTM) to identify posture detection. The proposed hybrid approach uses prediction of machine learning (ML) and deep learning (DL) to improve the performance of ML and DL algorithms. The experimental results on widely benchmark dataset are shown and results achieved an accuracy of more than 98%.

Keywords: *Hybrid Posture detection, UAV images, SVM, KNN, CNN, Deep Learning, Machine Learning, LSTM, BiLSTM, Benchmark Dataset*

I. INTRODUCTION

The posture detection is used in different applications suchashealthcare, surveillance, virtual environment, indoor and outdoor monitoring, the reality for animation and entertainment. In addition, the posture detection can be used in framework of home-human interface. With the increased number of elderly population and limited healthcare resources, it is important to propose atechnology which can support the remote monitoring of elderly and vulnerable people to live more independently. Maintain the good posture is significant to lead the healthy life. The posture is about how the people hold their body and position the limbs. Within the advancement of the technology, the human has chosen the sedentary lifestyle which leading to less physical activity and movement. The long time sitting during the work or study leads to decrease in muscle strength. negative impact on body human, not caring about correct posture or fault posture can lead pain in neck, back and shoulder. Considering the need, the paper reports three major contributions that are outlined as we implemented novel CNN and LSTM architecture for automatically identify the posture detection. It is worth to mention, the deep learning classifiers unlike machine learning algorithms do not require handcrafted features. In addition, a novel hybrid approach based on DL (1DCNN, 2D-CNN, LSTM, BiLSTM) and ML (random forest, KNN, Naive Bayes, decision tree, LDA, QDA and SVM) methods developed to identify the posture.

1.1Objective

The objective of this study is to detect the posture which is received by lots of attention in the fields of human sensing and artificial intelligence. Posture detection can be used for the monitoring health status of elderly remotely by identifying their postures such as standing, sitting and walking. Maintain the good posture is significant to lead the healthy life.

Within the advancement of the technology the experimental results on widely benchmark dataset are shown and results achieved an accuracy of more than 98%.

II. LITERATUREREVIEW

1. A Hybrid Posture Detection Framework Integrating Machine Learning and Deep Neural Networks

This study proposes a hybrid posture detection framework that integrates machine learning (ML)techniques such as SVM, decision trees, and logistic regression with deep neural networks (DNN) like LSTM and CNN. The objective is to improve the accuracy and robustness of posture detection, particularly in dynamic environments. The framework is validated on several datasets and demonstrates superior performance compared to traditional methods.

2. Hybrid Posture Detection Framework: Connecting Deep Neural Networks and Machine Learning

The authors propose that hybrid systems combining both traditional ML and cutting-edge DNN can improve posture recognition in complex environments. The system showed high accuracy in detecting multiple postures, including standing, sitting, and walking, even with noisy sensor

data. This framework is especially useful in applications like health monitoring and human-computer interaction. The research highlights the flexibility and adaptability of hybrid models in real-world scenarios. This paper focuses on the integration of machine learning classifiers (such as SVM, decision tree, and Naive Bayes) with deep learning models like LSTM and bidirectional LSTM for posture detection.

3. Hybrid InceptionV3-SVM-Based Approach for Human Posture Detection in Health Monitoring Systems

This paper proposes a hybrid model that combines the InceptionV3 deep convolutional neural network (CNN) with an SVM classifier to detect human posture, especially in the context of health monitoring systems. The model was tested on a diverse dataset, and the results showed that the hybrid approach outperformed standard CNN or SVM models in terms of detection accuracy. The research highlights how combining deep learning and machine learning techniques can improve posture detection, enabling real-time analys is for health applications such as rehabilitation and elderly care. The study's results emphasize the advantages of hybrid models in complex and noisy environments.

4. Hybrid Approach for Human Posture Recognition Using Anthropometry and BP Neural Network Based on Kinect V2

This study explores a hybrid approach to human posture recognition that integrates anthropometric data with a back propagation neural network (BPNN). The authors use Kinect V2 for capturing human posture data, and the system processes this information to recognize a variety of postures. The study demonstrates that combining biometric data (such as body measurements) with neural networks enhances the accuracy of posture detection. The approach is particularly valuable in applications requiring precise motion analysis, such as fitness tracking and virtual reality. The research also shows how hybrid models can be applied in both static and dynamic settings, improving robustness. A Comprehensive Review on Human Posture Recognition Techniques: From Conventional to Deep Learning Models

The authors analyze methods such as template matching, statistical analysis, and the shift to more complex approaches like CNNs and LSTMs. The review also highlights the challenges faced in different domains, such as ergonomics, healthcare, and surveillance. The paper evaluates the strengths and limitations of various posture detection techniques and provides insights into future research trends, including multimodal and hybrid approaches to improve detection accuracy.

III. PROPOSEDMETHODOLOGY

Proposed System

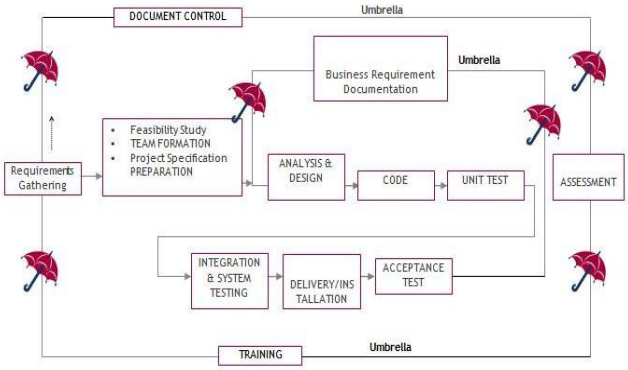
In this paper, we implemented a novel CNN and LSTM architecture for automatically identify the posture detection. It is worth to mention, the deep learning classifiers unlike machine learning algorithms do not require handcrafted features. In addition, a novel hybrid approach based on DL (1D-CNN,2D-CNN,LSTM,BiLSTM) and ML(random
forest, KNN, Naive Bayes, decision tree, LDA, QDA and SVM) methods developed to identify the posture. There is an extensive comparative experimental results that are conducted with state-of-the-art approaches to evaluate the performance of our proposed approach

Advantages

1. High Accuracy.
2. Less Time Taken.

Procedure Model used with justification

The SDLC (Umbrella Model)



SDLC is nothing but Software Development Life Cycle. Itis a standard which is used by software industry to develop good software.

Stages in SDLC:

• Requirement Gathering, Analysis, Designing, Coding, Testing, Maintenance.

IV. STEMDESIGN

UML Diagram:

1. Class Diagram:

The class diagram is the main building block of object oriented modelling. It is used both for general conceptual modelling of the systematic

of the application, and for detailed modelling translating the models into programming code. Class diagrams can also be used for data modelling. The classes in a class diagram represent both the main objects, interactions in the application and the classes to be programmed. In the diagram, classes are represented with boxes which contain three parts:

2. Use case Diagram:

A use case diagram at its simplest is a representation of a user's interaction with the system and depicting the specifications of a use case. A use case diagram can portray the different types of users of a system and the various ways that they interact with the system. This diagram is typically used in conjunction with the textual use case and will often be accompanied by other types of diagrams as well.

3. Sequence diagram:

A sequence diagram is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development. Sequence diagrams are sometimes called event diagrams, events cenarios, and timing diagrams.

4. Component Diagram:

In the Unified Modelling Language, a component diagram depict show components are wired together to form larger components and or software systems. They are used to illustrate the structure of arbitrarily complex systems.Components are wired together by using an assembly connector to connect the required interface of one component with the provided interface of another component. This illustrates the service consumer - service provider relationship between the two components.

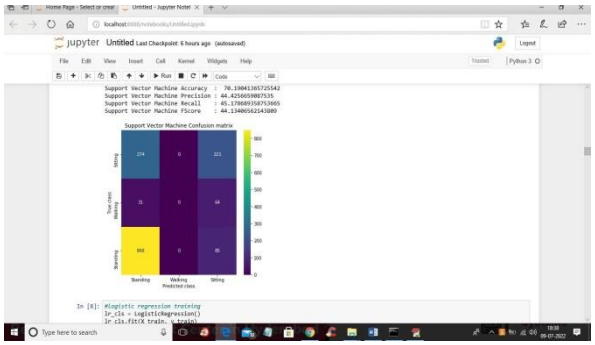
5. Activity Diagram:

Activity diagram is another important diagram in UML to describe dynamic aspects of the system. It is basically a flow chart to represent the flow form one activity to another

activity. The activity can be described as an operation of the system. So the control flow is drawn from one operation to another. This flow can be sequential, branched or concurrent

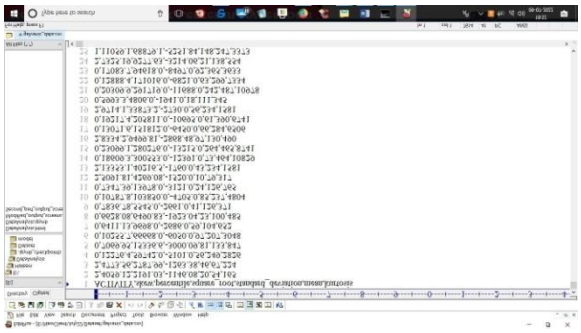
6. Data Flow Diagram:

Data flow diagrams illustrate how data is processed by a system in terms of inputs and outputs. Data flow diagrams can be used to provide clearer presentation of any business function. The technique starts with an overall picture of the business and continues by analyzing each of the functional areas of interest. This analysis can be carried out in precisely the level of detail required. The technique exploits a method called top-down expansion to conduct the analysis in a targeted way. As the name suggests, Data Flow Diagram (DFD) is an illustration that explicates the passage of information in a process. A DFD can be easily drawn using simple symbols. Additionally, complicated processes can be easily automated by creating DFDs using easy-to-use, free downloadable diagramming tools. A DFD is a model for constructing and analyzing information processes. DFD illustrates the flow of information in a process depending upon the inputs and outputs. A DFD can also be referred to as a Process Model. A DFD demonstrates business or technical process with the support of the outside data saved, plus the data flowing from the process to another and the end results

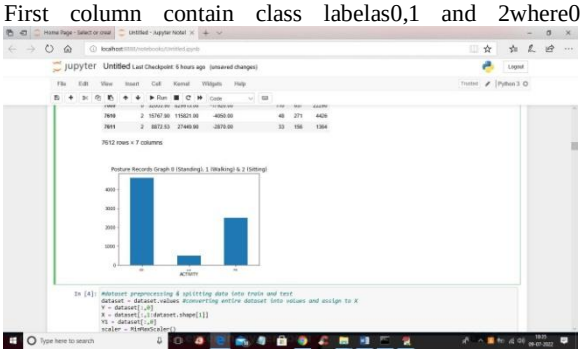


V. EXPERIMENTALANALYSIS

To implement this project author has GALVIN sensor dataset to predict 3 different postures such as Walking, Sitting and Standing.
Below is the dataset screenshot.

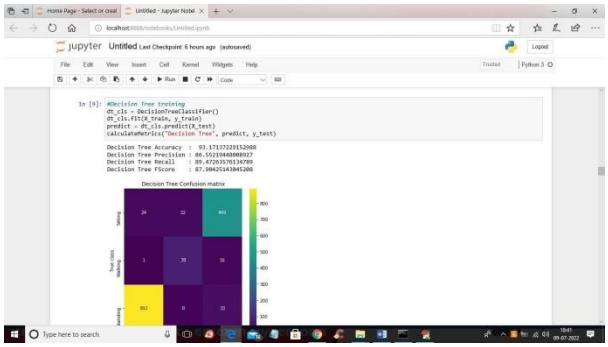


First column contain class labelas0,1 and 2where0 means (Standing) and 1 means (walking) and 2 means (sitting).

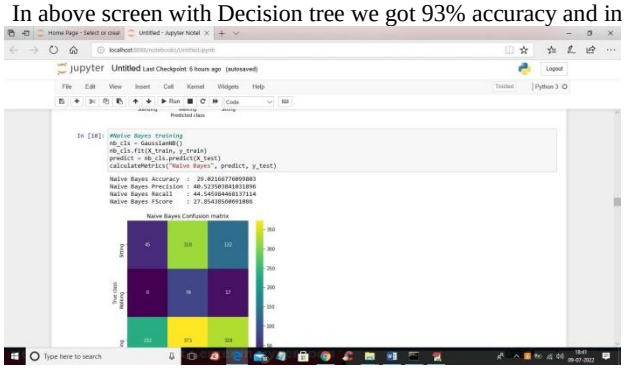


In above two screens we are loading and displaying dataset and then plotting graph with different classes in X-axis and number of records in that class in Y-axis.

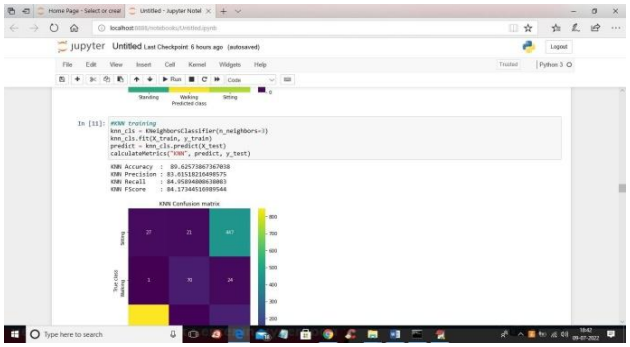
In above screen we are training SVM to predict the test data and then calculate the accuracy of confusion matrix. We get 70% accuracy with SVM.



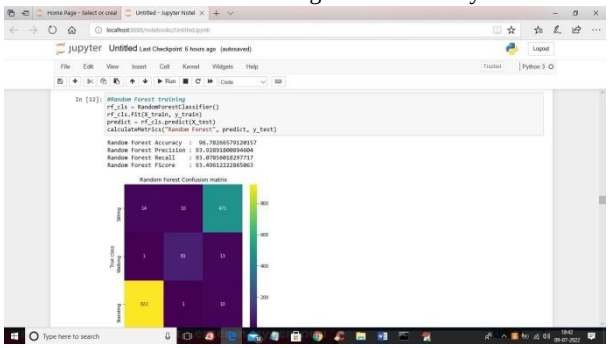
In above screen with Decision tree we got 93% accuracy and in below screen we can see Naive Bayes output.



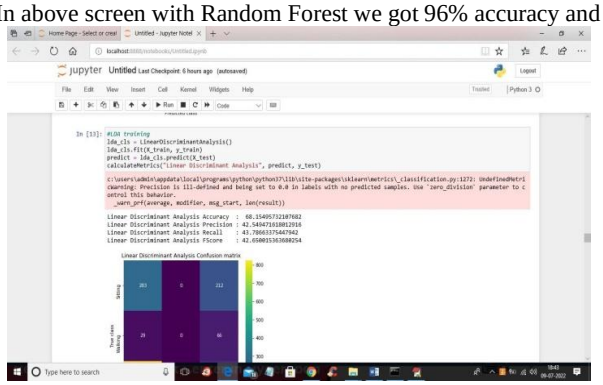
Inabovescreen withNaiveBayeswegot29%accuracy and in below screen we can see KNN output.



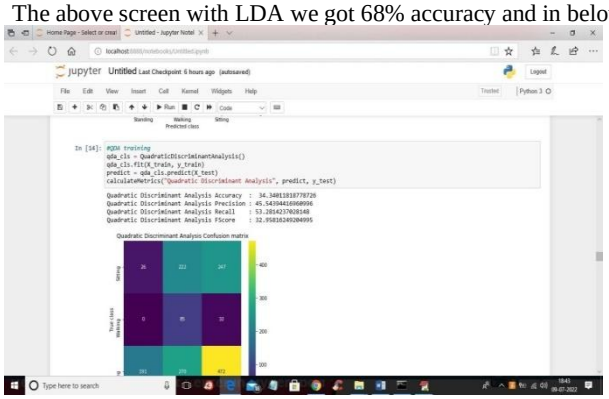
In above screen with KNN we got 89% accuracy and in below screen showing output for Random Forest.



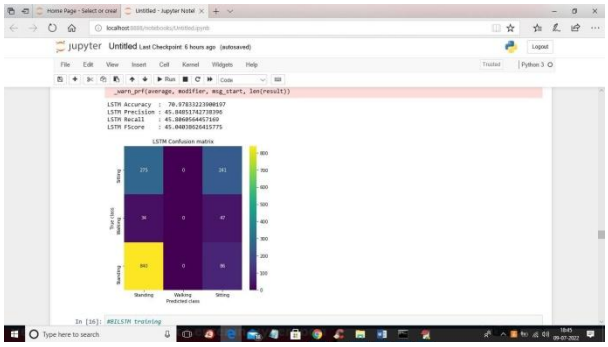
In above screen with Random Forest we got 96% accuracy and in below screen showing output for LDA.



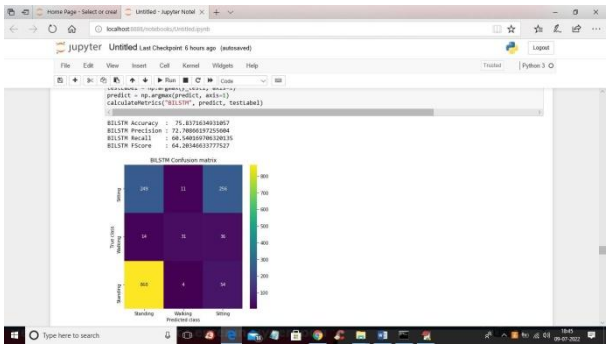
The above screen with LDA we got 68% accuracy and in below screen showing output for QDA.



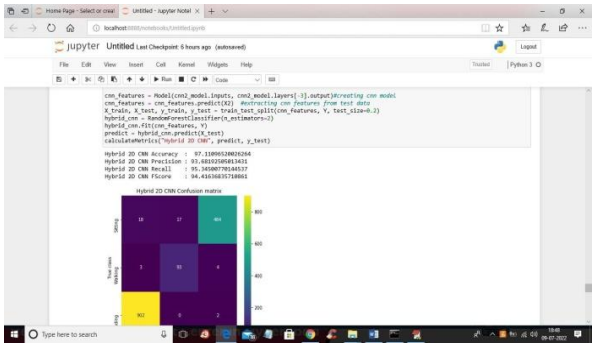
In above screen with QDA we got 34% accuracy and in below screen showing output for LSTM.



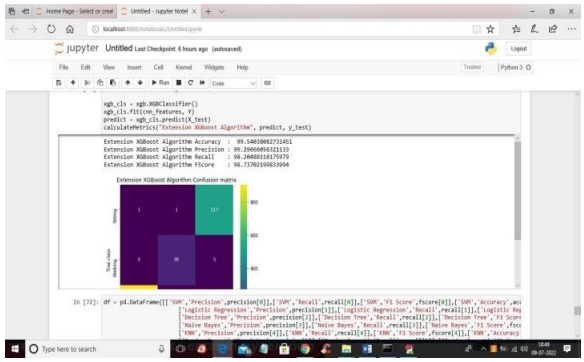
In above two screens showing output for LSTM and with LSTM we got 70% accuracy and in below screen showing output for BILSTM.



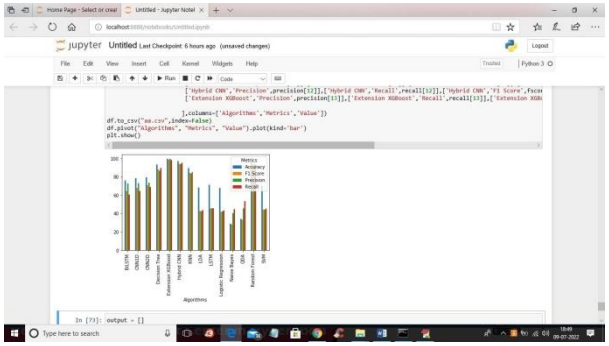
In above screen with BILSTM we got 75% accuracy and in below screen showing output for CNN output.



In above screen with CNN we got 97% accuracy and in below screen showing output for Extension XGBOOST algorithm.



In above screen with extension XGBOOST we got 99% accuracy and in below screen showing comparison for all algorithms.



In above graph extension XGBOOST has got high accuracy and other metrics values. In below screen showing comparison table of all algorithms.

V. CONCLUSION

The remote health monitoring is important for providing independent living to elderly and vulnerable. Therefore, in this paper, we proposed a novel architecture based on deep learning classifiers to identify posture including standing, sitting and walking. In addition, the novel hybrid approach are developed based on the DL methods to identify the posture prediction. The hybrid approach contains different Prediction of machine learning and deep learning to train the meta-learning. The experimental results show that the proposed hybrid approach achieved better performance as compared to DL and ML methods .By integrating XGBoost with DNNs, hybrid models canleverage XGBoostspeed for feature boosting and decision-making, while utilizing the deep learning model for feature extraction.

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