

Classifying Gait Data using different machine learning techniques and finding the optimum technique of classification

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Outline

GAIT/ Human GAIT

Problem Statement

Proposed Solution

AIM

Proposed work and Methodology

Data Collection & Demos

Classification of gait data using KNN, SVM, ANN(Back Propagation), Classifier fusion

Result analysis

Conclusion

What is GAIT?

Gait

➤ **Gait refers to the manner in which a person walks, and is one of the few biometric traits that can be used to recognize people at a distance.**

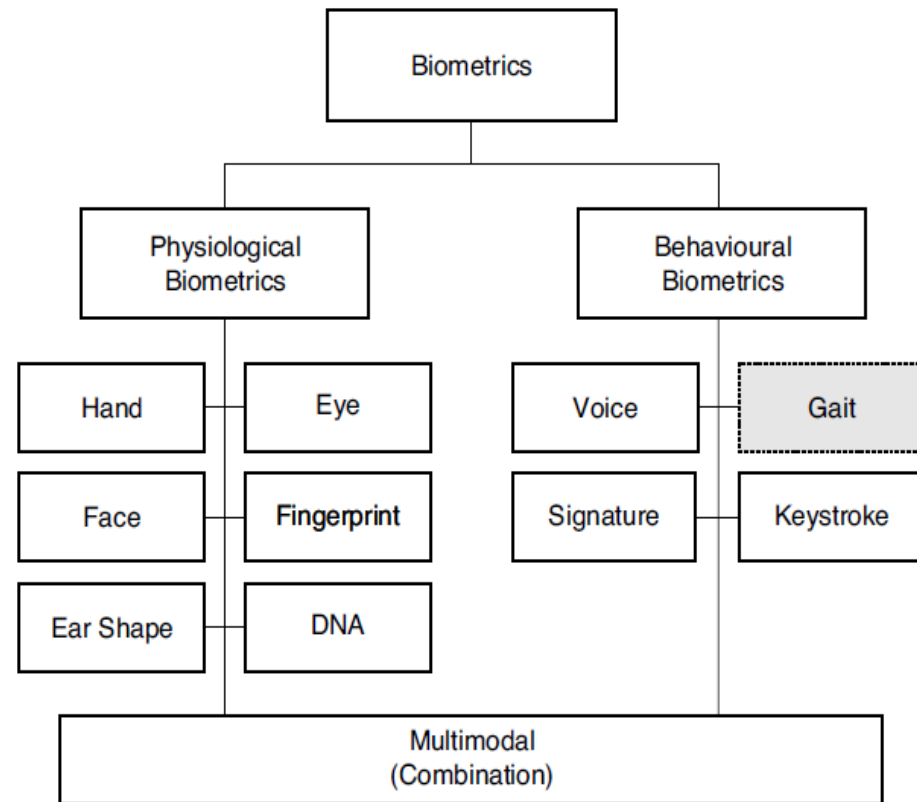
➤ **Therefore, this trait is very appropriate in surveillance scenarios and gait recognition system.**

Human gait

- Human gait analysis refers to the study of human locomotion.
- Applications are in a large variety of domains, including entertainment, healthcare and pedestrian navigation.
- The act of walking involves the coordination of different human body parts, such as the skeleton, the muscle and the neural systems.
- Various factors can affect the complex interaction between the body parts, for example any pathological nature will require a distinction between — **normal gait** and **pathological gait**.
- Normal gait refers to the naturalistic and general human walking parameters without differentiating the age, sex or individual physical parameters.
- Conversely, —pathological gaitll refers to an abnormal gait, for example affected by pathologies such as muscle weakness or skeleton deformities.

Problem Statement

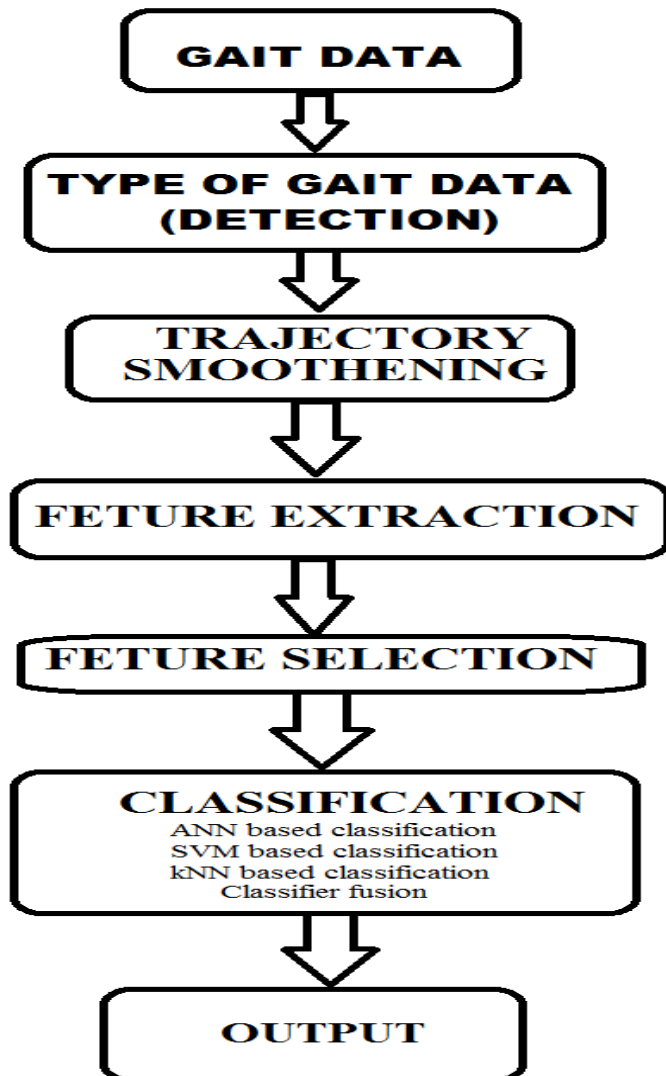
- To verify/validate the identity of people is called as authentication.
- And now a day's authentication is becoming very popular to check whether a person is authentic or not.
- Previously authentication was done with secret passwords or PIN codes. The disadvantage of such authentication systems was anyone could crack the password or PIN codes.
- So, biometric (in fig.) technology came to existence where authentication is done using a particular body part like fingers, iris etc. But now a days these biometrics are not user friendly as people dislike accessing finger print machine or avoid iris scanner as it may weaken or damage their vision.



Proposed Solution

- Identifying normal or pathological human gait poses many challenges. Therefore a robust method for detecting and capturing the body, face and/or gait of each individual person has to be found.
- Human gait is supposed as unique biometric identification like thumb print. So in GAIT analysis to examine the human walking moment we collect and analyze the data. Human gait can be utilized to identify people for diverse security reason and exercised before to detect many abnormalities.
- The GAIT data can be useful to help in walking of old people and is used in pattern analysis and classification of different walk.

Proposed Solution



We have developed the computational model for prediction, formal verification and analyses of bipedal locomotion using machine learning technique for modelling.

AIM



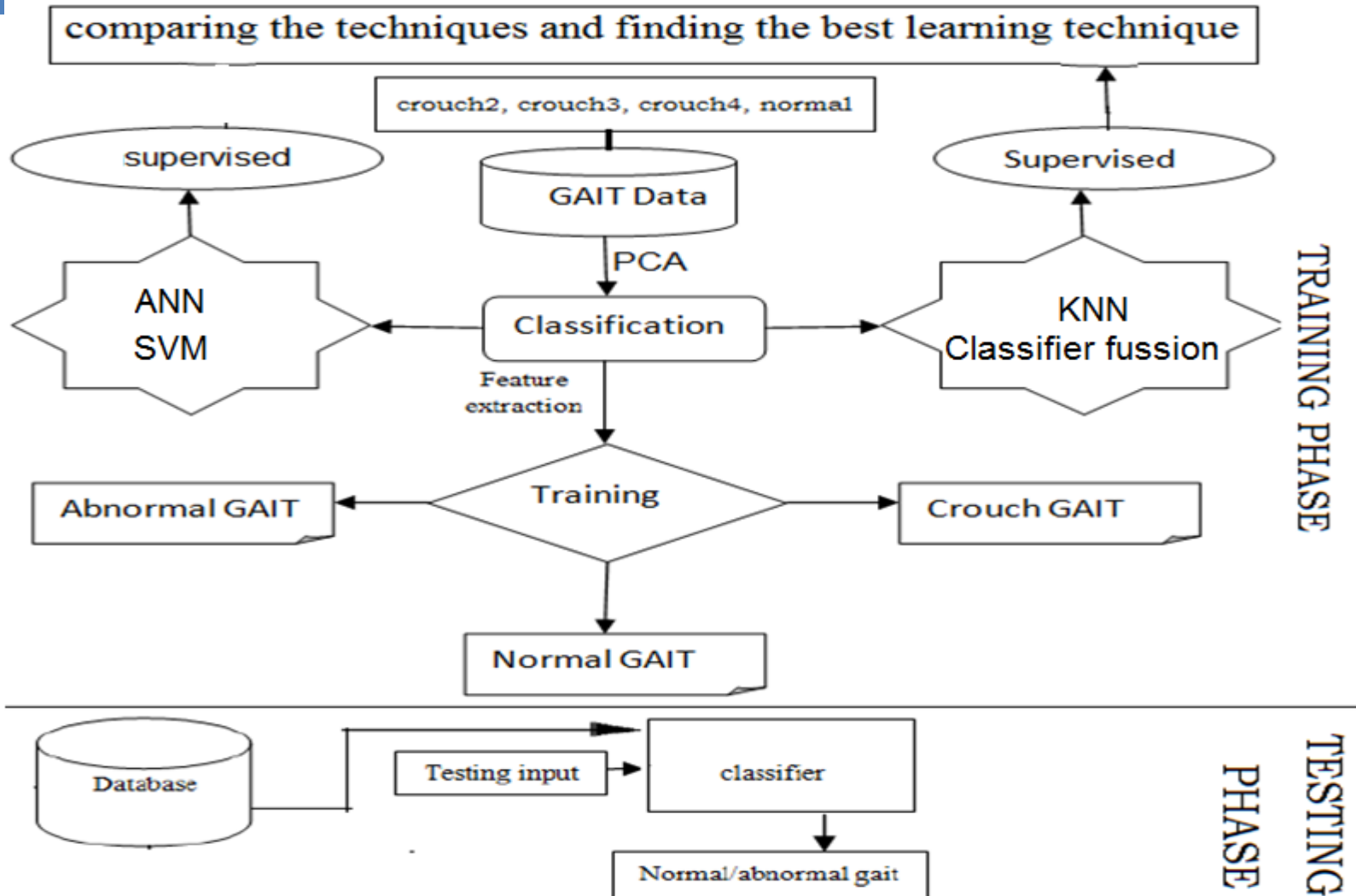
- The aim of this paper is to evaluate and implement a sufficiently robust and accurate method for human to identify whether it's a **normal gait** or **pathological gait** and to improve the speed and accuracy of classification in the presence of category hierarchies.

METHODOLOGY

Thursday, May 14, 2026

Proposed Work

10



METHODOLOGY

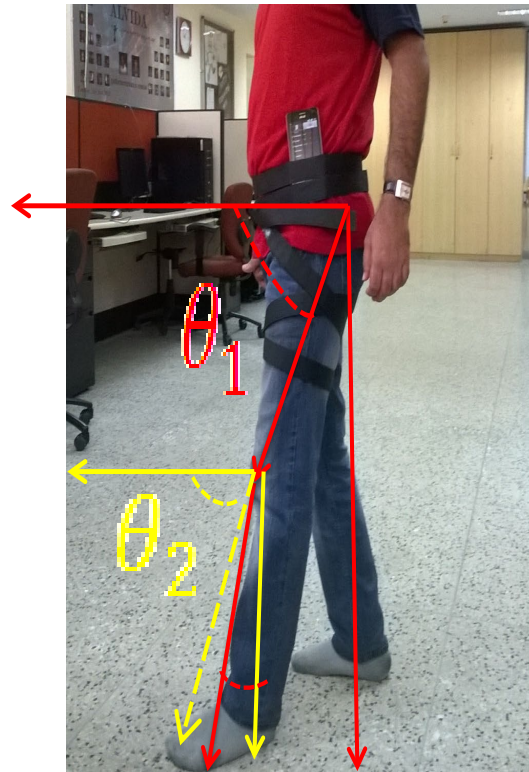
- Firstly we collect the GAIT data then features are extracted and we classify the GAIT dataset.
- Training and testing of system is done.
- After the classification is done result is shown as normal or pathological GAIT.
- Then 10 fold cross-validation test is also conducted to validate the statistical significance of the results.

Data Collection

12

- **HMCD**
- To capture the human data we use HMCD. From this device different joint angles (knee, hip, and ankle) are captured to get the human GAIT data.

Empirical Study of Gait by HMCD



5/14/2026

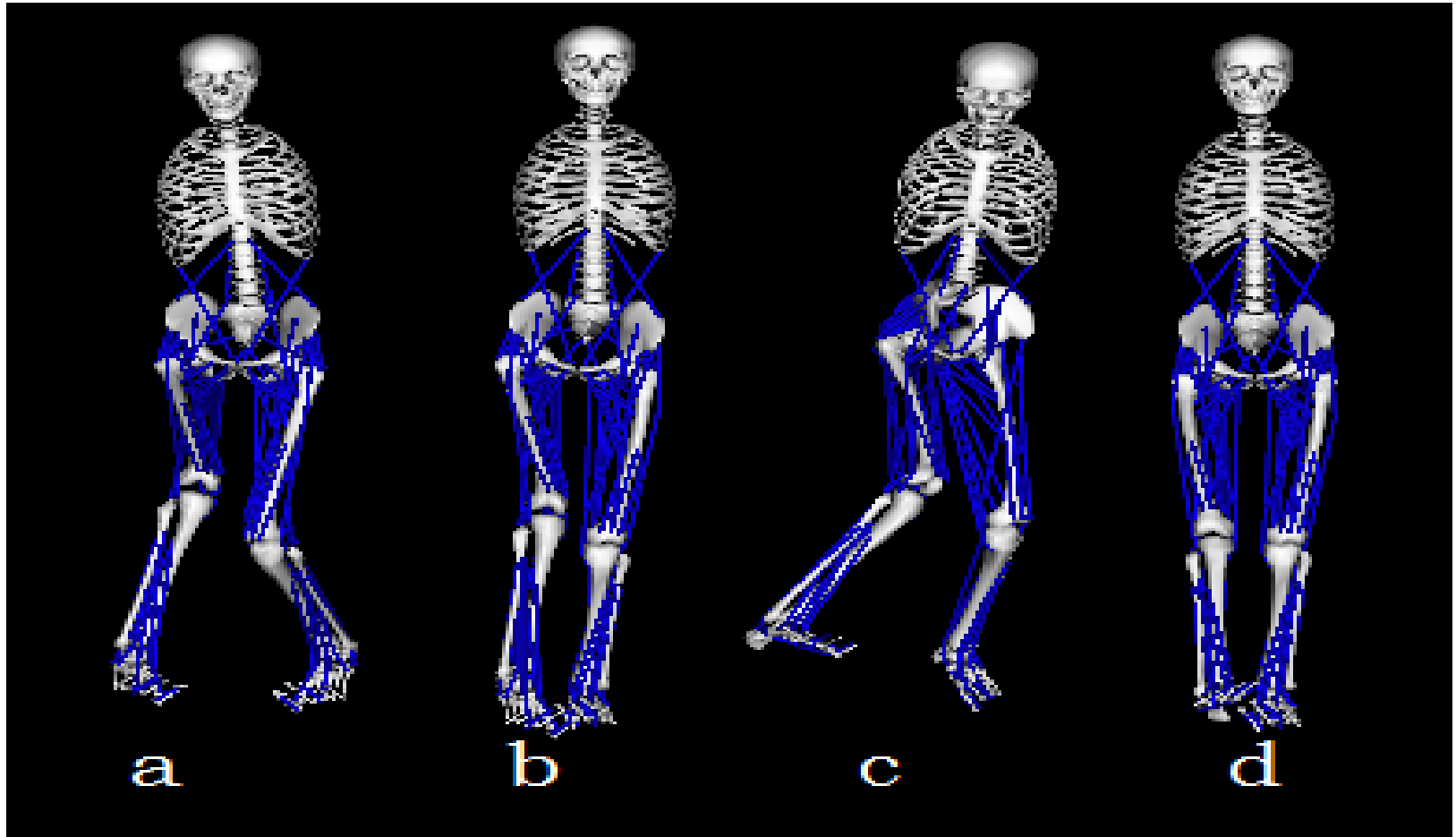
Analysis of dataset

14

When the dataset is simulated, then the coordinates of the human GAIT data set is captured and shown in figure for crouch2, crouch3, crouch4, normal datasets respectively.

Simulation of dataset in openSim

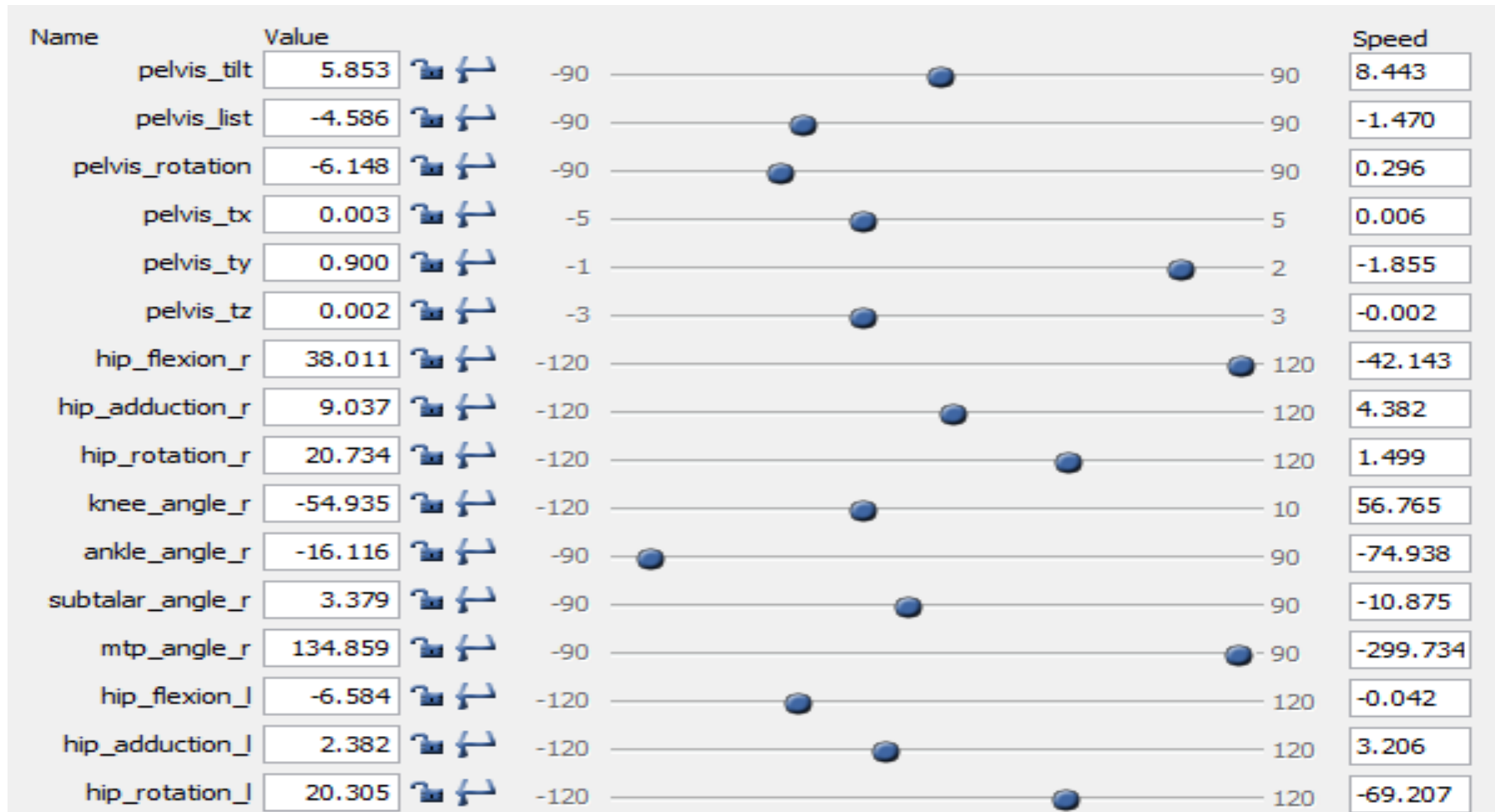
15



Thursday, May 14, 2026

Values of crouch2 dataset

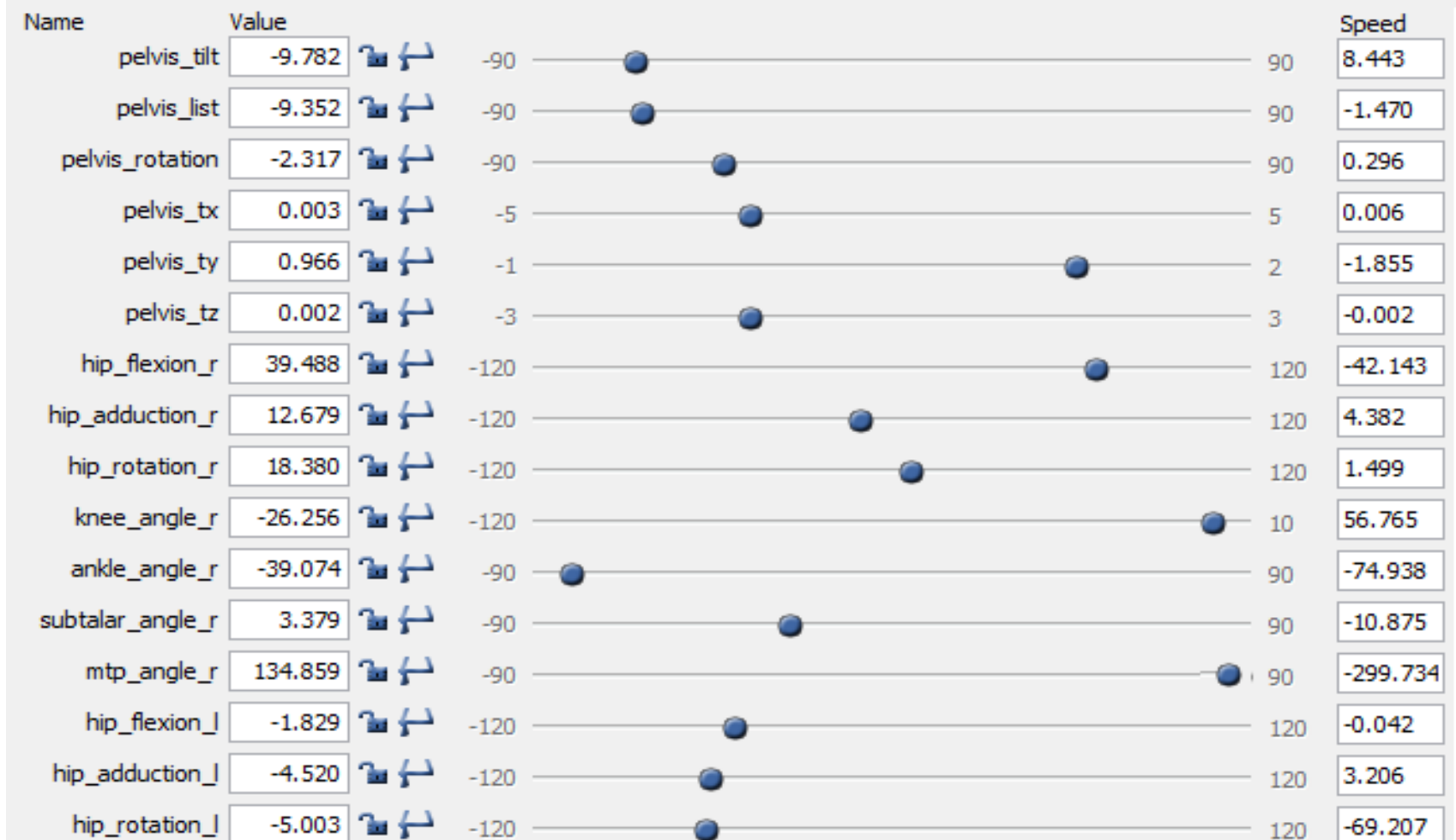
16



Thursday, May 14, 2026

Values of crouch3 dataset

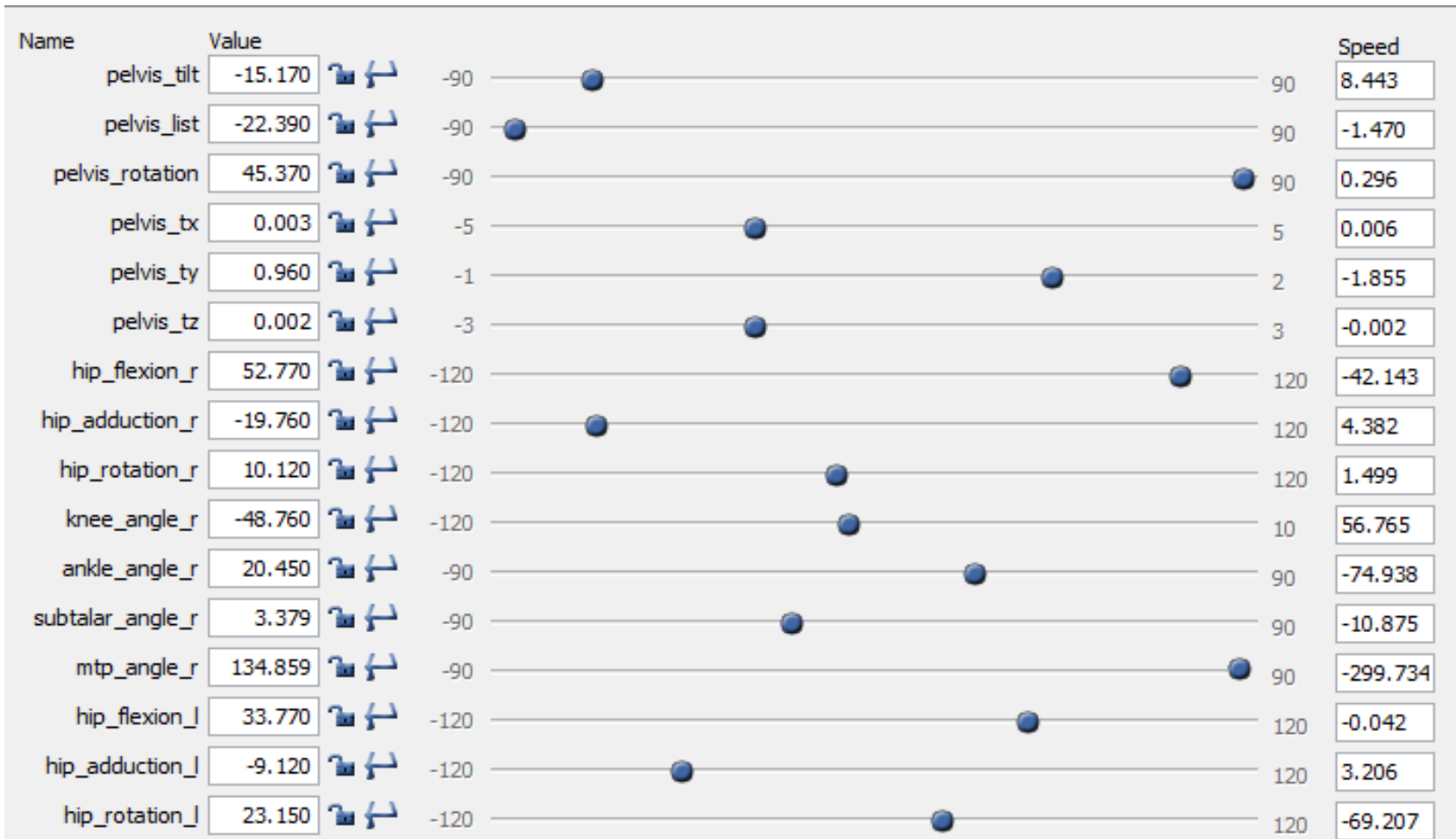
17



Thursday, May 14, 2026

Values of crouch4 dataset

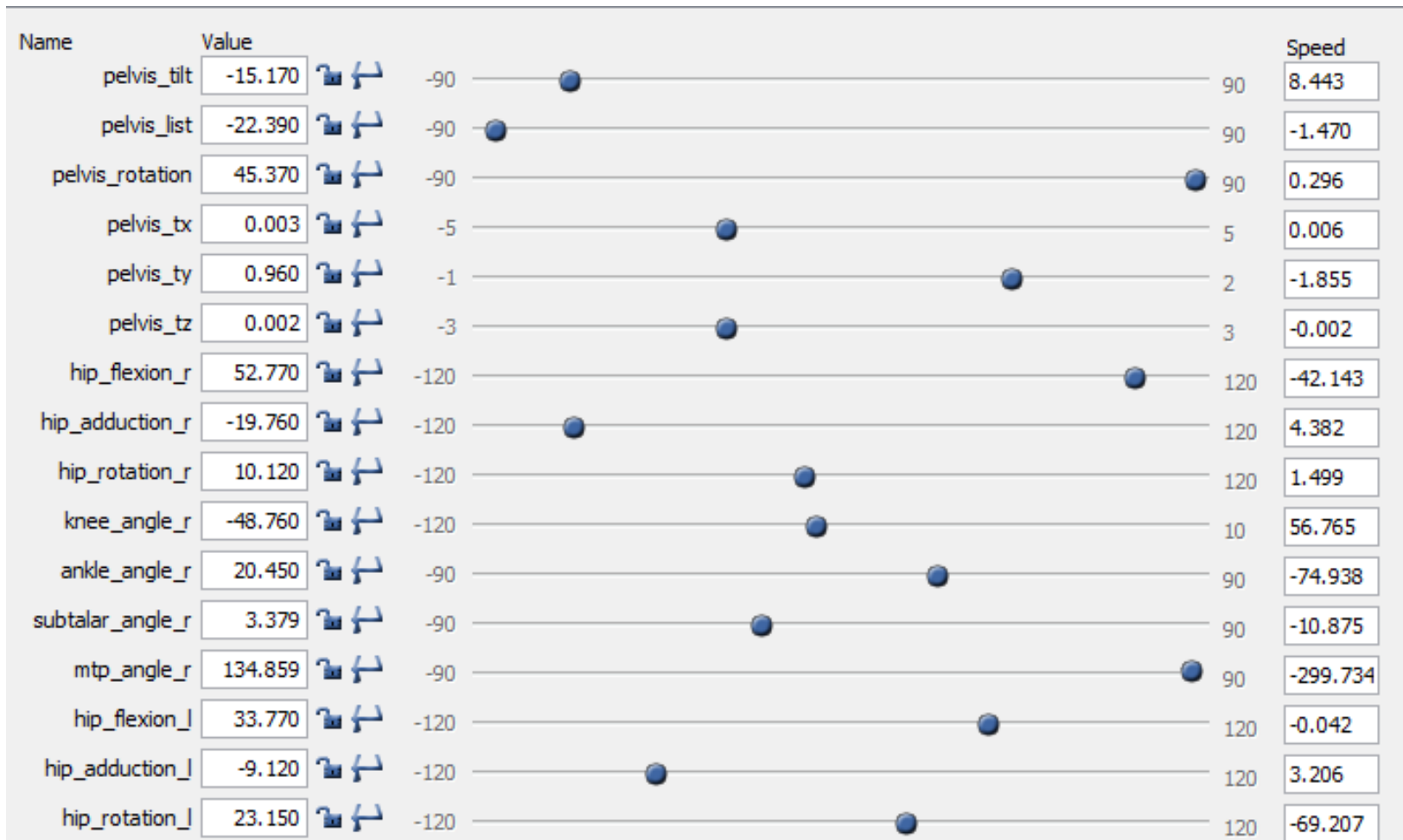
18



Thursday, May 14, 2026

Values of normal dataset

19



Thursday, May 14, 2026

Feature Selection

Feature Category	Feature Name
F1	Pelvis_tilt
F2	Pelvis_list
F3	Pelvis_rotation
F4	Pelvis_tx
F5	Pelvis_ty
F6	Pelvis_tz
F7	hip_flexion_r
F8	hip_adduction_r
F9	hip_rotation_r
F10	knee_angle_r
F11	ankle_angle_r
F12	ankle_angle_l
F13	knee_angle_l
F14	hip_flexion_l
F15	hip_adduction_l
F16	hip_rotation_l

CLASSIFICATION

KNN, ANN, SVM, fusion classifier

Classification

22

- Classification is a collection of different methods for categorizing data.
- To correctly classify the data one wishes to find features that separate each group of data into clusters.

Classification

23

- Classification of GAIT data is done through two following techniques:
- KNN
- ANN
- SVM
- Classifier fusion

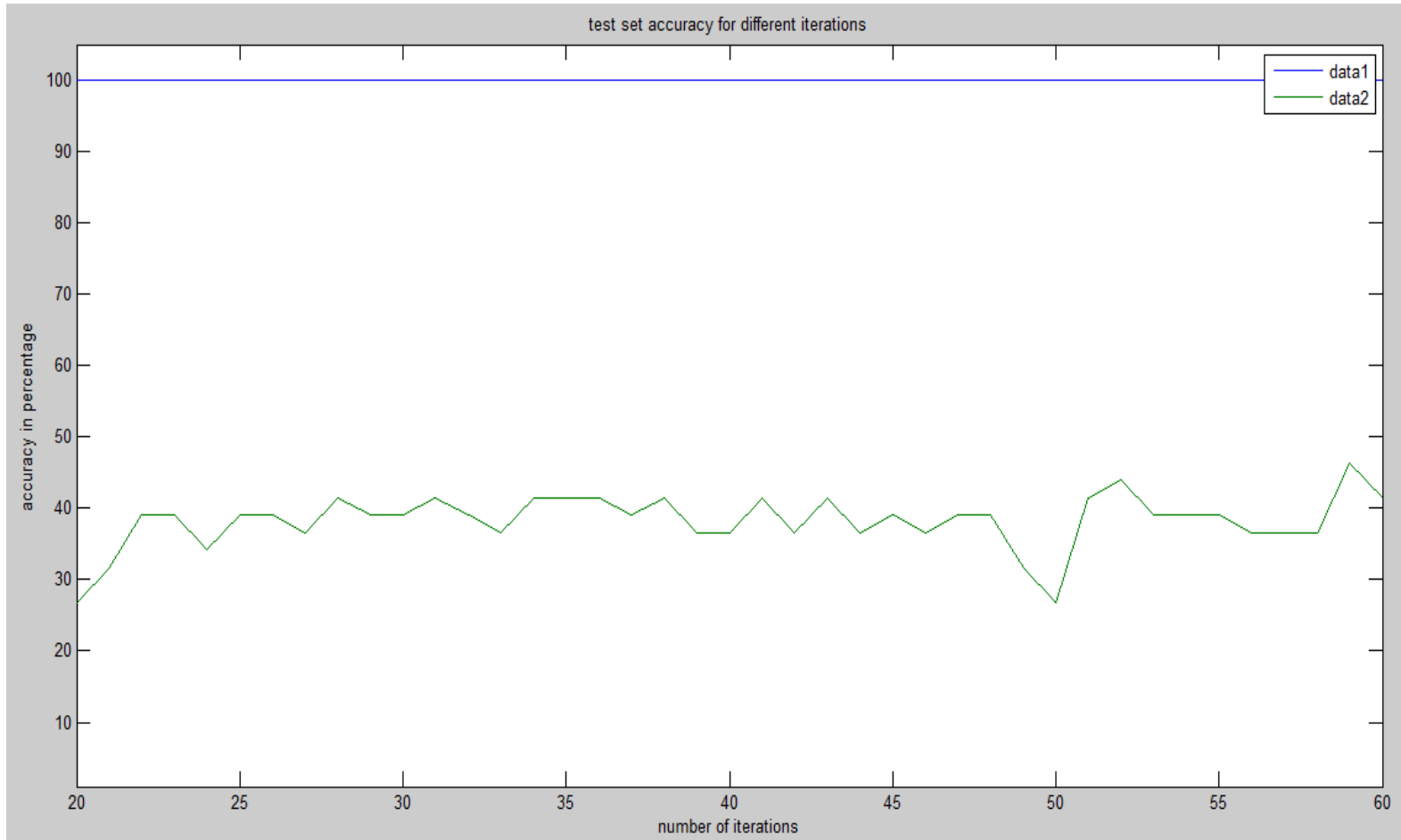
Artificial Neural Network (Back Propagation)

24

- Back propagation, an abbreviation for "backward propagation of errors", is a common method of training artificial neural networks.

Result

25



Thursday, May 14, 2026

Result

26

Exp. No	Iterations	Training accuracy (%)	Test accuracy (%)
1	100	84	80
	500	86	80
2	100	86	80
	500	90	82
3	100	86	82

Thursday, May 14, 2026

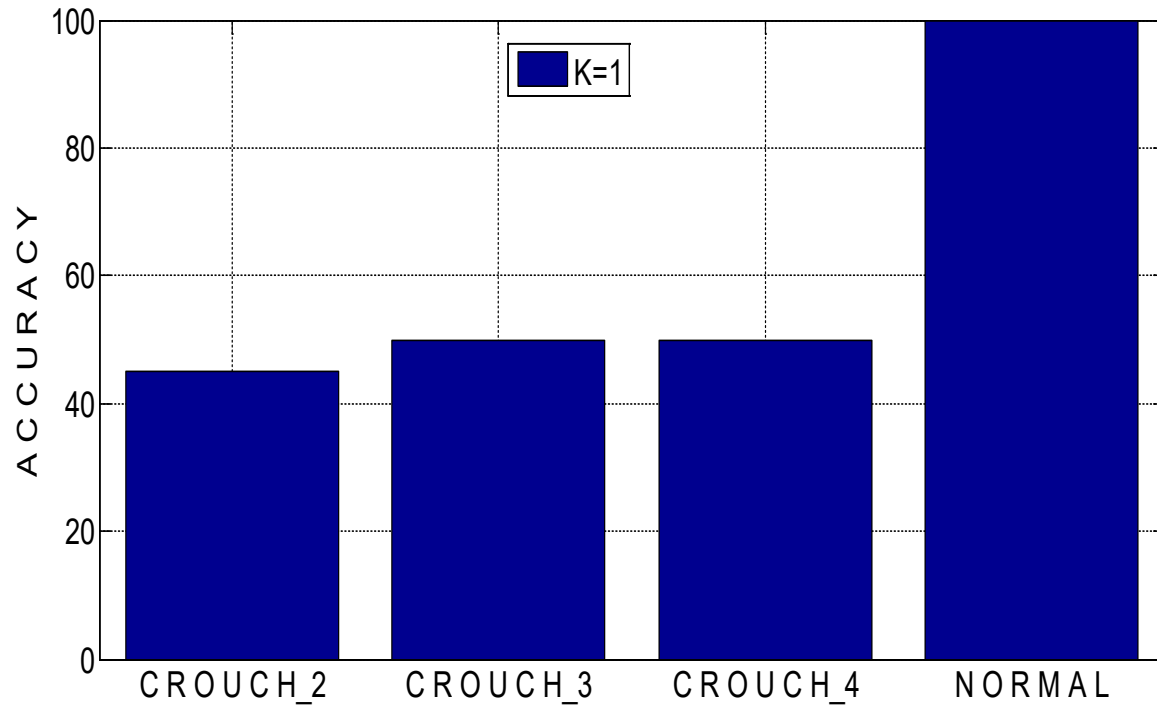
KNN

27

- K-Nearest Neighbours algorithm (or k-NN for short) is a non-parametric method used for classification. In this, the input consists of the k closest training examples in the feature space. The output depends on whether k-NN is used for classification:
- In k-NN classification, the output is a class membership. An object is classified by a majority vote of its neighbours, with the object being assigned to the class most common among its k nearest neighbours (k is a positive integer, typically small). If $k = 1$, then the object is simply assigned to the class of that single nearest neighbour.

KNN Result

28



Thursday, May 14, 2026

KNN Result

29

Exp No.	K	Training accuracy (%)	Testing accuracy (%)
1	3	74	70
2	5	79	80
3	7	78	74
4	9	84	81

SVM

- In machine learning, support vector machines are supervised learning models with associated learning algorithms that analyze data used for classification. Given a set of training examples, each marked for belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other, .

Result

31

Exp No.	Function Kernel	Training accuracy(%)	Test accuracy (%)
1.	Linear function	68	71
2.	Quadratic function	70	76
3.	Polynomial function	84	84
4.	Radial Basis Function	88	84

Classifier Fusion

32

- Classifier fusion combines many classifiers and provides the result by combining the results of the individual classifiers.
- In this paper, we have combined the results of ANN, SVM and KNN models to achieve the classifier fusion result.
- Thus, the performance of classifier fusion is likely superior than the individual classifiers used in isolation.

Result

33

Expt#	ANN classifier Accuracy (%)	SVM classifier Accuracy (%)	kNN with k=5 Accuracy (%)	Classifier fusion Accuracy (%)
1	89.67	91.62	80.76	89.67
2	92.91	91.92	78.89	90.75
3	87.82	88.52	91.82	87.82
4	93.60	85.60	90.40	89.60
5	91.01	89.21	92.21	86.75

Comparison of success rate by different classifier using 5-fold cross validation

34

Classifier	Rate of Success (%)
ANN	82.58
SVM	80.11
KNN	87.72
Classifier fusion	93.56

Conclusions

It was noted that from all the other individual classifiers for various feature set performed the performance of the classifier fusion is best. Therefore we get the highest overall accuracy of 93.56% by using the combination of optimal features and classifier fusion as compared to other feature and classifier combinations.

Conclusion

- The proposed system can be used for developing a gesture controlled hexadecimal keyboard making human-computer interaction easier.
- The results of the three individual classifiers were combining to provide the classifier fusion results.
- After this, 5-fold cross validation was used to provide overall accuracy of the system.
- Overall accuracy was observed to be 82.58, 8.11%, 87.72% and 93.56% using the ANN, SVM, KNN and classifier fusion respectively.

Questions?

37

Thursday, May 14, 2026

Thank you

38

Have a great day
ahead

Thursday, May 14, 2026