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Sensor Based Human Activity Recognition using Machine Learning

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Abstract- This paper presents a sensor-based Human Activity Recognition (HAR) system using machine learning techniques to classify six physical activities cycling, resting, running, swimming, walking, and yoga. The proposed model employs a Random Forest classifier trained on features such as heart rate, step frequency, distance traveled, and step entropy. Experimental results show that the Random Forest model achieved an accuracy of 85%, outperforming a Decision Tree baseline (76.5%). Feature importance analysis revealed heart rate and step frequency as key indicators for activity classification. The system also includes a real-time activity prediction module, demonstrating its applicability in fitness tracking, health monitoring, and wearable technology. This study highlights the potential of integrating sensor data with predictive models to enable intelligent, personalized wellness and healthcare solutions.

Keywords — Human Activity Recognition, Machine Learning, Random Forest, Sensor Data, Wearable Technology.

I. INTRODUCTION

Human Activity Recognition (HAR) is an emerging field that focuses on identifying and classifying physical activities using sensor-generated data. With the growth of wearable devices and IoT-based systems, HAR has become a key component of modern applications in healthcare, fitness, and smart environments. By analyzing signals such as heart rate, step frequency, and distance traveled, HAR systems can provide valuable insights into human behavior, lifestyle, and overall health status.

The objective of this study is to develop a machine learning–based HAR system capable of recognizing six common activities walking, running, cycling, swimming, resting, and yoga. The proposed system utilizes features including heart rate, step entropy, steps per minute, and distance traveled to train Decision Tree and Random Forest classifiers. Comparative analysis shows that the Random Forest model achieves higher accuracy and generalization, outperforming the Decision Tree baseline.

II. METHODOLOGY

The proposed Human Activity Recognition (HAR) system employs machine learning to classify six activities Walking, Running, Cycling, Swimming, Resting, and Yoga using features derived from wearable sensor data. The dataset, simulating readings from devices such as Fitbit and Apple Watch, includes approximately 8,000 entries with attributes like heart rate, steps per minute, step entropy, distance, and calories burned.

Data preprocessing involved cleaning, encoding, and normalization to ensure consistency and remove noise. Feature engineering focused on variables representing activity intensity and variability. Correlation analysis and Random Forest feature importance identified heart rate and step frequency as the most significant predictors.

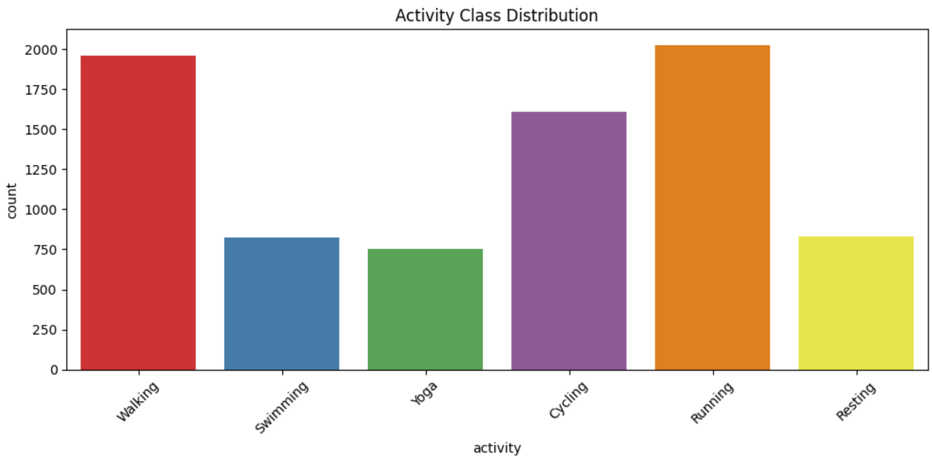
Two models were trained and evaluated: a Decision Tree and a Random Forest classifier. While the Decision Tree offered interpretability, the Random Forest achieved superior generalization with 85% accuracy. Evaluation metrics included accuracy, confusion matrix, and classification report.

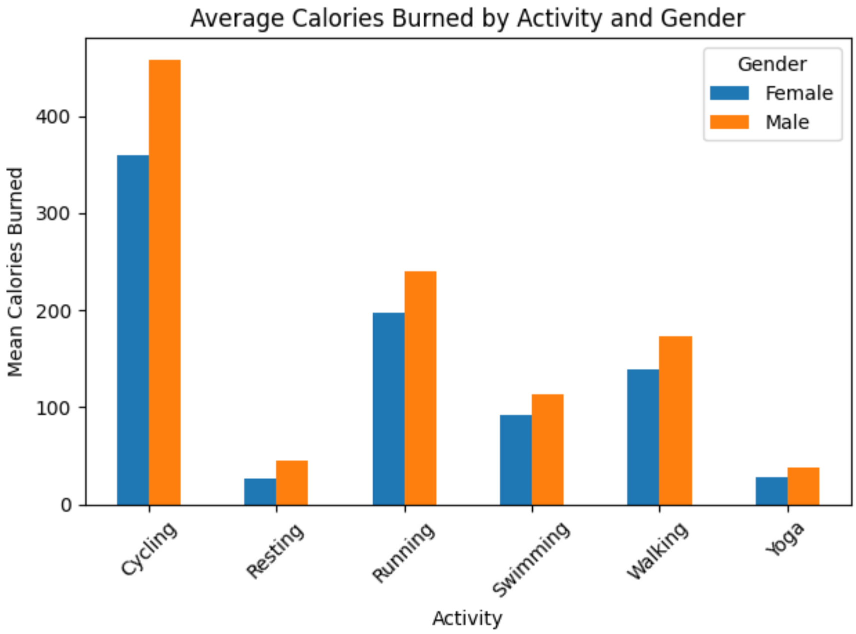
A real-time user input module was developed to predict activities from manually entered sensor data, demonstrating the system's practical applicability. The complete pipeline from data processing to prediction shows the potential of lightweight, interpretable models for real-time activity recognition in fitness and healthcare applications.

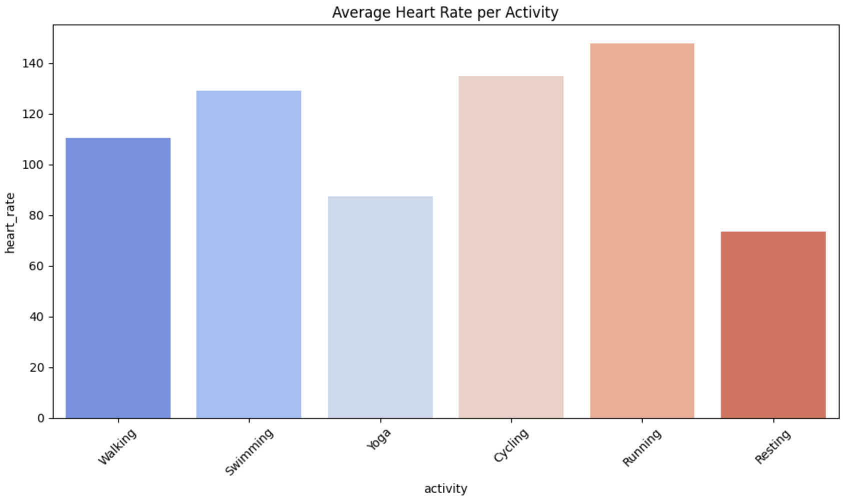
III. RESULTS AND DISCUSSION

The Random Forest model achieved an overall accuracy of 85%, outperforming the Decision Tree baseline (76.5%). Precision and recall were highest for Running, Cycling, and Resting, indicating consistent and reliable classification. Feature importance analysis identified heart rate and steps per minute as the most influential predictors, effectively capturing activity intensity and pace. The confusion matrix showed improved differentiation between Walking and Running, with minimal misclassification across other categories.

Resting achieved near-perfect accuracy due to its distinct low heart rate, while Yoga and Swimming remained challenging because of overlapping signal patterns. Compared with existing HAR studies, the proposed model delivers competitive performance using a simple, interpretable feature set. The Random Forest approach balances accuracy, efficiency, and transparency, making it suitable for real-time fitness and health monitoring applications.







IV. CONCLUSION

This study presents a sensor-based Human Activity Recognition (HAR) system using machine learning to classify six activities Resting, Walking, Running, Cycling, Swimming, and Yoga. The Random Forest classifier achieved the highest accuracy of 85%, outperforming the Decision Tree baseline while maintaining strong interpretability. Feature analysis identified heart rate and steps per minute as the most significant predictors, confirming their relevance to activity intensity.

The proposed system demonstrates that lightweight, interpretable models can effectively recognize human activities using wearable sensor data. Its modular design enables real-time prediction and potential integration into fitness trackers and health monitoring platforms. Future work may focus on expanding sensor modalities, enhancing low-intensity activity detection, and deploying the system in real-world IoT environments.

REFERENCES

[1] D. Anguita, A. Ghio, L. Oneto, X. Parra, and J. L. Reyes-Ortiz, “A Public Domain Dataset for Human Activity Recognition Using Smartphones,” *Proc. 21st Eur. Symp. Artif. Neural Netw., Comput. Intell. Mach. Learn. (ESANN)*, 2013.

[2] L. Breiman, “Random Forests,” *Mach. Learn.*, vol. 45, no. 1, pp. 5–32, 2001.

[3] F. Pedregosa, G. Varoquaux, A. Gramfort, V. Michel, B. Thirion, O. Grisel, et al., “Scikit-learn: Machine Learning in Python,” *J. Mach. Learn. Res.*, vol. 12, pp. 2825–2830, 2011.

[4] D. Ravi, C. Wong, B. Lo, and G. Z. Yang, “Deep Learning for Human Activity Recognition: A Resource Efficient Implementation on Embedded Devices,” *Proc. IEEE Int. Conf. Wearable Implantable Body Sensor Netw. (BSN)*, 2016.

[5] Microsoft Learn, “Introduction to Machine Learning with Python,” 2023. [Online].

[6] M. Zhang and A. A. Sawchuk, “USC-HAD: A Daily Activity Dataset for Ubiquitous Activity Recognition Using Wearable Sensors,” *Proc. ACM Conf. Ubiquitous Comput.*, 2012.