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Intelligent Gesture Recognition System for IoT LED Output Using Deep Learning through Arduino and Python (Survey)

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Abstract:

This survey paper focuses on developing an Intelligent Gesture Recognition System that controls IoT-based LED outputs using deep learning techniques, Arduino microcontrollers, and Python programming. The paper explores the scope of gesture recognition in smart home automation, healthcare assistance, and IoT applications. The objective of this study is to analyze state-of-the-art methods for gesture classification, review deep learning models commonly used in real-time gesture recognition, and evaluate their performance. Major trends in literature show an increasing use of CNNs, RNNs, and hybrid deep learning models for achieving higher accuracy and faster inference. This paper concludes by identifying gaps in hardware integration and suggesting potential solutions for resource- constrained IoT devices.

Keywords: Gesture Recognition, IoT, Deep Learning, Arduino, Python, CNN

1. Introduction

Gesture recognition has emerged as a crucial research area in Human-Computer Interaction (HCI) and Internet of Things (IoT) applications. With the growth of smart devices, there is a need for intuitive and contactless interaction methods. This paper explores the problem of recognizing hand gestures accurately and mapping them to control IoT devices such as LEDs. The motivation behind this work is to enable efficient, low-cost, and user-friendly systems that enhance automation in daily life. The contribution of this survey lies in systematically classifying gesture recognition methods, analyzing their implementation with Arduino and Python, and highlighting deep learning approaches that can be adapted for IoT environments.

2. Related Work / Literature Review

Existing research on gesture recognition systems has employed a variety of approaches including computer vision techniques, wearable sensors, and deep learning-based classification models. Table 1 summarizes key works in this field along with their contributions and limitations.

Table 1: Summary of Existing Literature

Author & Year	Approach	Technology Used	Key Results	Limitations
Molchanov et al., 2016	3D CNN-based dynamic gesture recognition	CNN, Depth Camera	High accuracy for dynamic gestures	High computational complexity
Zhang et al., 2020	Hand landmark-based gesture recognition	MediaPipe, ML models	Real-time performance on edge devices	Limited accuracy for complex gestures
Kumar et al., 2021	Vision-based hand gesture recognition	OpenCV, ML classifiers	Good accuracy with low latency	Sensitive to lighting conditions
Banbury et al., 2021	TinyML for edge AI	Lightweight DL models	Low power consumption	Limited model capacity
Lee & Park, 2023	Gesture-controlled IoT automation	IoT, Computer Vision	Improved user interaction	Network dependency

Research gaps identified include a lack of lightweight deep learning models optimized for Arduino-class microcontrollers and real-time latency constraints.

3. Classification / Taxonomy

Gesture recognition systems can be broadly classified into three categories: (1) Vision-based systems, (2) Sensor-based systems, and (3) Hybrid systems. Vision- based systems rely on cameras and image processing, while sensor-based systems use accelerometers, gyroscopes, and wearable devices. Hybrid systems combine both for improved accuracy. Figure 1 shows the taxonomy.

4. Comparative Analysis

A comparative analysis of existing techniques shows that CNN-based models offer high accuracy but require optimization for low-power devices.

Sensor-based methods are computationally cheaper but may be less intuitive. Table 2 highlights the trade-offs between different approaches.

5. Open Research Challenges / Future Scope

Open research challenges include optimizing deep learning models for microcontrollers, improving gesture recognition under poor lighting conditions, reducing inference latency, and integrating multi-

gesture classification for robust control. Future work should explore TinyML frameworks, quantization, and edge AI techniques for deployment.

6. Conclusion

This survey consolidates research on gesture recognition systems for IoT LED control using deep learning techniques. It highlights the strengths and limitations of vision and sensor-based approaches and emphasizes the need for lightweight neural networks for real-time embedded systems. The study concludes that advancements in edge AI and Arduino-compatible ML frameworks will significantly improve future gesture-controlled IoT applications.

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References

1. Molchanov, P., et al., "Hand Gesture Recognition with 3D Convolutional Neural Networks," *IEEE CVPR Workshops*, 2016.
2. Banbury, C., et al., "Benchmarking TinyML Systems," *IEEE Micro*, 2021.
3. Rautaray, S., and Agrawal, A., "Vision-Based Hand Gesture Recognition for Human-Computer Interaction," *Springer*, 2015.
4. Lee, K., and Park, S., "IoT-based Smart Home Automation with Gesture Control," *Springer*, 2023