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Real - Time Air Writing Recognition A Comprehensive Survey

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Abstract: *Air-writing recognition has emerged as a promising touch-free interaction method with applications in human–computer interfaces, assistive technologies, authentication, emergency response systems, and virtual/augmented environments. Existing research spans diverse sensing modalities—including webcams, RGB cameras, depth sensors, radar, wearable motion sensors, and even EEG signals—to accurately capture and interpret characters written in free space. Vision-based systems leverage convolutional neural networks and spatio-temporal models for fingertip tracking, gesture segmentation, and unconstrained character-sequence recognition, achieving real-time performance and high accuracy. Sensor-based approaches utilize accelerometers, gyroscopes, and FMCW radar to extract motion trajectories, while recent studies address signal variability using interpolation and time-series modeling. Novel frameworks such as FMHash enable user identification through deep fuzzy hashing, and NeuroAiR introduces EEG-driven air-writing recognition for hands-free interfaces. Literature reviews highlight persistent challenges, including intraclass variation, background noise, inconsistent gesture patterns, and lack of standardized datasets. Overall, advancements across machine learning, deep learning, and multimodal sensing demonstrate rapid progress toward robust, lightweight, and adaptive air-writing systems suitable for next-generation touchless interaction.*

Keywords: *Air-writing*

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