ABSTRAK

Stroke merupakan salah satu penyebab utama disabilitas dan kematian secara global, dengan prevalensi tinggi di Indonesia termasuk Provinsi Aceh. Rehabilitasi pasca stroke, khususnya pemulihan fungsi tangan, kerap terhambat oleh keterbatasan akses fasilitas kesehatan dan subjektivitas penilaian manual menggunakan metode *Action Research Arm Test* (ARAT). Penelitian ini bertujuan merancang dan membangun sistem *hand wearable sensor* berbasis *Internet of Things* (IoT) yang mengintegrasikan algoritma *Random Forest* untuk memantau dan mengklasifikasikan gerakan tangan pasien pasca stroke secara *real time*. Sistem menggunakan mikrokontroler ESP32 dan dua sensor MPU6050 yang ditempatkan pada punggung tangan dan lengan bawah untuk merekam data *accelerometer* dan *gyroscope*, menghasilkan 12 sinyal mentah yang diproses menjadi fitur bagi model klasifikasi. Strategi *combined balancing* (*under-sampling* pada kelas *none* dan *RandomOverSampler* pada data latih) diterapkan untuk mengatasi ketidakseimbangan data tanpa menimbulkan *data leakage*. Hasil pengujian terhadap tujuh gerakan ARAT tiga gerakan *gross movement* (*Hand to Mouth*, *Hand to Tophead*, *Hand to Backhead*) dan empat gerakan *grip* (*Cup*, *Big Tube*, *Small Tube*, *Ring*) menunjukkan model *Random Forest* mencapai akurasi rata-rata 89% dan *F1-score* makro rata-rata 0,84. Akurasi tertinggi diperoleh pada gerakan *Hand to Backhead* (94%; *F1-score* 0,90), sedangkan akurasi terendah pada *Hand to Tophead* (84%) akibat variabilitas eksekusi gerakan. Hasil klasifikasi divisualisasikan melalui *dashboard* berbasis web yang menampilkan skor ARAT, riwayat aktivitas, dan grafik tren perkembangan rehabilitasi secara *real time*. Penelitian ini bersifat konseptual dan prototipikal, sehingga diharapkan menjadi dasar pengembangan sistem rehabilitasi neuromotorik yang lebih objektif, terjangkau, dan dapat diakses oleh pasien di daerah terpencil.

Kata kunci: *stroke*, rehabilitasi, *hand wearable sensor*, *Internet of Things*, *Random Forest*, *Action Research Arm Test*

ABSTRACT

Stroke is one of the leading causes of disability and death worldwide, with a high prevalence in Indonesia, including Aceh Province. Post-stroke rehabilitation, particularly recovery of hand function, is often hindered by limited access to healthcare facilities and the subjectivity of manual assessment using the Action Research Arm Test (ARAT). This study aims to design and build an Internet of Things (IoT)-based hand wearable sensor system integrated with a Random Forest algorithm to monitor and classify post-stroke patients' hand movements in real time. The system uses an ESP32 microcontroller and two MPU6050 sensors placed on the back of the hand and forearm to record accelerometer and gyroscope data, producing 12 raw signals that are processed into features for the classification model. A combined balancing strategy (under-sampling the "none" class and RandomOverSampler on the training set) was applied to address data imbalance without causing data leakage. Testing on seven ARAT movements three gross movements (Hand to Mouth, Hand to Tophead, Hand to Backhead) and four grip movements (Cup, Big Tube, Small Tube, Ring) showed that the Random Forest model achieved an average accuracy of 89% and an average macro F1-score of 0.84. The highest accuracy was achieved for the Hand to Backhead movement (94%; F1-score 0.90), while the lowest was for Hand to Tophead (84%) due to greater variability in movement execution. The classification results are visualized through a web-based dashboard that displays ARAT scores, activity history, and rehabilitation progress trend graphs in real time. As a conceptual, prototype-stage study, this research is expected to serve as a foundation for developing a more objective, affordable, and accessible neuromotor rehabilitation system for patients in remote areas.

Keywords: *stroke, rehabilitation, hand wearable sensor, Internet of Things, Random Forest, Action Research Arm Test*