

**KLASIFIKASI AKTIVITAS MANUSIA DENGAN
METODE *CONSENSUS-BASED ENSEMBLE LEARNING*
BERDASARKAN *CHANNEL STATE INFORMATION (CSI)***

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INTISARI

Klasifikasi aktivitas manusia atau *Human Activity Recognition (HAR)* berbasis Wi-Fi *Sensing* berbasis *Channel State Information (CSI)* merupakan pendekatan yang menjanjikan karena tidak memerlukan perangkat tambahan, non-invasif, dan tetap dapat beroperasi dalam kondisi *non-line-of-sight*. Meskipun demikian, tantangan utama dalam sistem ini terletak pada kompleksitas dan dinamika data CSI yang tinggi. Oleh karena itu, penelitian ini bertujuan untuk meningkatkan akurasi klasifikasi aktivitas manusia melalui penerapan metode *Consensus-Based Ensemble Learning*.

Data CSI yang digunakan berasal dari perangkat berbasis perangkat berstandar 802.11ax dengan konfigurasi 2x2 MIMO. Penelitian ini mencakup tiga tahapan utama. Pertama, penerapan model *boosting* standar yaitu *eXtreme Gradient boosting (XGBoost)*, *Light Gradient boosting Machine (LightGBM)*, *Categorical Boosting (CatBoost)*, dan *Adaptive Boosting (AdaBoost)*. Kedua, dilakukan optimasi parameter menggunakan *GridSearchCV*. Ketiga, diterapkan *ensemble* berbasis konsensus menggunakan *Voting Classifier* dengan pendekatan *soft voting*.

Hasil evaluasi menunjukkan bahwa optimasi meningkatkan performa model, dengan LightGBM mencapai akurasi 91,40% dan *F1-score* 91,49%. Penerapan *ensemble* berbasis *soft voting* lebih lanjut meningkatkan rata-rata akurasi menjadi 91,98% dengan waktu inferensi hanya 0,00023 detik per sampel. Klasifikasi aktivitas berjalan memiliki TPR (*True-Positive-Rate*) tertinggi sebesar 98,94%, sedangkan performa klasifikasi terendah adalah kelas ruangan kosong.

Kata kunci: Wi-Fi *Sensing*, Klasifikasi Aktivitas Manusia, *Channel State Information (CSI)*, *Machine learning*, *Ensemble Learning*

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**CLASSIFICATION OF HUMAN ACTIVITY RECOGNITION (HAR)
USING THE CONSENSUS-BASED ENSEMBLE LEARNING METHOD
BASED ON CHANNEL STATE INFORMATION (CSI)**

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ABSTRACT

Human Activity Recognition (HAR) based on Wi-Fi sensing utilizing Channel State Information (CSI) is a promising approach due to its non-invasive nature, the absence of additional hardware requirements, and its ability to operate under non-line-of-sight conditions. Nevertheless, the primary challenge of such systems lies in the high complexity and dynamic characteristics of CSI data. This study aims to improve the accuracy of human activity classification by implementing a Consensus-Based Ensemble Learning method.

The CSI data used in this research were collected using 802.11ax device with a 2×2 MIMO configuration. The study consists of three main stages. First, the application of standard boosting models, namely eXtreme Gradient Boosting (XGBoost), Light Gradient Boosting Machine (LightGBM), Categorical Boosting (CatBoost), and Adaptive Boosting (AdaBoost). Second, parameter optimization was performed using GridSearchCV. Third, a consensus-based ensemble was implemented using a Voting Classifier with a soft voting strategy.

Evaluation results indicate that the optimization process enhanced model performance, with LightGBM achieving the highest accuracy of 91.40% and an F1-score of 91.49%. The application of soft voting further improved the overall accuracy to 91.98%, with an inference time of only 0.00023 seconds per sample. Among the classified activities, walking achieved the highest TPR (True-Positive-Rate) at 98.84% while the lowest performing class is the empty-room condition.

Keywords: Wi-Fi Sensing, Human Activity Classification, Channel State Information (CSI), Machine learning, Ensemble Learning

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