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Enhancing GPS Data Accuracy in SAP Systems Using IMU Sensors and Machine Learning

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This study addresses the challenge of improving accuracy in fitness tracking data, particularly when using GPS and high-frequency IMU sensors. GPS data is often noisy, leading to issues such as false paths, where users appear to have travelled through buildings or bodies of water. To tackle this, the study proposes using accelerometers, gyroscopes, and magnetometers—components of an Inertial Measurement Unit (IMU)—to counteract inaccuracies in both high-frequency IMU sensors and low-frequency GPS data. The research explores two correction strategies: real-time correction during the activity, which demands computational efficiency for immediate data processing, and post-activity correction, which leverages both previous and future sensor data for more accurate estimations. The study compares two approaches: the Kalman Filter, a traditional method from the 1960s that performs a reverse pass post-activity to improve estimations, and Recurrent Neural Networks (RNNs), including Gated Recurrent Units (GRUs) and Long Short-Term Memory (LSTM) Networks, which use built-in memory modules to learn patterns in sensor data without requiring sensor variance information. The findings suggest that RNNs outperformed the Kalman Filter in producing more credible results, especially in handling the noisy and low-frequency nature of the data. However, inconsistent ground truth data made it difficult to perform a reliable quantitative evaluation of the models. While RNNs showed promise due to their ability to remember long-term dependencies and learn from sequential data, the Kalman Filter still provided value, particularly with its post-activity reverse pass. The study concludes that further research is needed to address the issue of ground truth data inconsistency and to explore hybrid approaches that combine the strengths of both methods. Future investigations could also focus on more robust real-world testing to improve the accuracy and reliability of these techniques for fitness-tracking applications.