PawPath: An IMU-Based Gait Detection and Disease Screening Tool for Canines

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PawPath is a non-invasive, risk-free gait monitoring device that assesses orthopedic and neurodegenerative diseases in canines. Gait abnormalities, which often signal conditions like arthritis, tendonitis, and ligament injuries, are traditionally diagnosed through visual inspection, a subjective method prone to errors. PawPath addresses this issue by using four Inertial Measurement Unit sensors mounted distally on each limb: between the hock and stifle joints on hind legs, and between the carpus and elbow joints on forelimbs. The system captures time-synced linear acceleration (gravity corrected using quaternion orientation derived from a Madgwick filter) and angular velocity along 3-axes for each leg, transmitting it using WiFi to a computer. A Theo Jansen Mechanism-based prototype was developed to simulate dog gait patterns and validate sensor accuracy. Comparative analysis revealed surface-dependent gait variation between grass and concrete; thus, data collection for disease classification was standardised to concrete. Over several months, gait data was collected from canines, with veterinarians helping to label the data for disease detection. Long Short Term Memory (LSTM) neural networks process this data to detect anomalies linked to disorders such as arthritis, ataxia, ligament injuries, and tendonitis, using stratified data and demographic covariates. After preprocessing, disease detection models were trained for Belgian Malinois, German Shepherd, Golden Retriever, Indian Pariah and Labrador Retriever dogs. All models achieved accuracies of over 90%. PawPath offers a low-cost, portable, and field-deployable solution, with generalizability to other quadrupeds and potential for research on areas like recovery monitoring and effectiveness of therapeutics.

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