IoT-Enabled Smart Pet Tracking and Identification Using GPS, Geofencing, and QR Codes

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Abstract

Pet loss remains a significant concern among pet owners due to the limitations of conventional identification and tracking methods. This study presents the IoT-Enabled Smart Pet Tracking and Identification Using GPS, Geofencing, and QR Codes. The system integrates a GPS-enabled smart tag, QR code identification, geofencing, cloud-based data management, and an Android mobile application to support near-real-time location monitoring, boundary alerts, and rapid access to pet identification information. The developed system was evaluated in terms of GPS positioning accuracy, device-to-server location consistency, geofencing performance, QR code identification, IoT communication, and system response time. Results showed that the GPS module achieved a Mean Absolute Error (MAE) of 18.28 m, Root Mean Square Error (RMSE) of 22.36 m, and Standard Deviation (SD) of 14.08 m. Across three prototype devices, the reported overall MAE, RMSE, and SD were 6.041 m, 8.363 m, and 6.938 m, respectively. The system achieved a 96.67% geofence detection rate and a 96.67% QR scanning success rate, while IoT communication achieved a 97.00% transmission success rate with a 3.00% packet-loss rate. Mean response times were 4.4 s for geofence breach alerts, 7.0 s for QR profile retrieval, and 9.0 s for cloud/application notifications, with a mean end-to-end latency of 8.6 s. These findings demonstrate the feasibility of integrating GPS, IoT communication, QR code identification, and geofencing into a unified system for pet monitoring and recovery, particularly in environments with adequate GPS signal and mobile-network coverage.

Keywords: Geofencing, GPS Tracking, Internet of Things (IoT), Pet Identification, QR Code