IFN712 Research Project Form

(Submitted to [y.feng@qut.edu.au](mailto:y.feng@qut.edu.au) by 30 June 2025)

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| Project agency (school, industry, ) | School of Computer Science/NRSAG project |
| Industry/project supervisor and contact emails | Dr Zhenguo Shi, [zhenguo.shi@qut.edu.au](mailto:zhenguo.shi@qut.edu.au) |
| Academic Supervisor name(s) and contact emails | Yanming Feng [y.feng@qut.edu.au](mailto:y.feng@qut.edu.au),  Zhenguo Shi, [zhenguo.shi@qut.edu.au](mailto:zhenguo.shi@qut.edu.au) |
| Information Technology major(s) | Software Development, Computer Science and Data Science, Networks and cybersecurity |
| Project title | Smart Intersection Localization for Pedestrians Using Bluetooth and Deep learning |
| Brief description of the research problem, aims, method and expected outputs (100~200 words) | **Background:** Vulnerable Road Users (VRUs), such as pedestrians, cyclists, and scooter riders, are at greater risk of accidents at signalized intersections due to limited line of sight and slower reaction times from drivers. While camera and LiDAR-based detection systems have been used to improve safety, these solutions are often expensive, require complex infrastructure, and raise privacy concerns. In contrast, Bluetooth Low Energy (BLE) technology offers a low-cost and privacy-friendly alternative for short-range localization. However, RSSI-based positioning with BLE is known to suffer from signal fluctuations caused by multipath effects, obstructions, and environmental variability. This project addresses these challenges by building a real-time VRU positioning system using multiple BLE locators based on the nRF5340 platform. By applying deep learning methods such as LSTM and CNN, the system aims to improve the stability and accuracy of RSSI-based localization. Performance will be evaluated in both lab and semi-field settings to assess its suitability for real-world deployment in smart transport infrastructure.  **Objectives:**   1. RSSI Data Collection: Deploy multiple nRF5340-based BLE devices at a simulated intersection to collect RSSI readings from VRUs under different conditions, including obstructed and unobstructed paths. 2. Localization Model Development: Build and train deep learning models, such as LSTM, BiLSTM, or CNN, to estimate the position of VRUs using sequences of RSSI data, with a focus on improving accuracy and consistency. 3. Signal Preprocessing and Feature Extraction: Apply filtering, smoothing, and statistical feature extraction techniques to the raw RSSI data to reduce noise and support robust model training across varying environments. 4. System Integration: Combine BLE broadcasting, RSSI acquisition, and model inference into a single positioning system capable of running in real time. 5. Performance Evaluation and Validation: Test the system in lab and semi-field conditions to evaluate positioning accuracy, latency, and reliability, and assess its potential for deployment at real-world intersections.   **Expected Outcomes:**  The project will deliver a functional prototype that demonstrates RSSI-based localization using nRF5340 Bluetooth devices and deep learning techniques. The system will be tested under controlled and semi-field conditions to evaluate positioning accuracy, robustness, and latency. Comparative analysis will be conducted between traditional trilateration methods and learning-based approaches to assess performance gains. The outcome is expected to provide a practical, low-cost, and privacy-conscious solution for detecting VRU locations at intersections, offering a potential path toward real-world deployment in intelligent transport systems. |
| Key words | * Bluetooth RSSI Localization * Vulnerable Road User (VRU) * Deep Learning for Positioning * Intersection Safety Systems * Noise-Robust RSSI Estimation |
| Answerable research questions for 3-5 students (desirable) | Research Questions:   * **How can deep learning models mitigate the noise and instability of Bluetooth RSSI signals for accurate real-time localization?** * **What is the trade-off between number of beacons and positioning accuracy in the BLE-based intersection setup?** * **Which neural network architecture (e.g., CNN vs. LSTM) performs best for time-series RSSI localization?** * **How does the positioning performance degrade in high-multipath environments or when BLE devices are moving?** * **Can we generalize the trained model across different intersection geometries?** |
| 3-5 key references (desirable) and website resources | 1. Faragher, R. & Harle, R. “Location Fingerprinting With Bluetooth Low Energy Beacons.” IEEE Journal on Selected Areas in Communications, 2015. 2. nRF5340 Bluetooth Direction Finding Development Kit. <https://www.nordicsemi.com/Products/nRF5340> 3. Matlab. Bluetooth LE Positioning with Deep Learning. https://au.mathworks.com/help/bluetooth/ug/bluetooth-le-positioning-with-deep-learning.html 4. Wang, Y. et al. “DeepFi: Deep Learning for Indoor Fingerprinting Using Channel State Information.” WCNC, 2015. 5. **Zafari, F., Gkelias, A., & Leung, K.K. “A Survey of Indoor Localization Systems and Technologies.” IEEE Communications Surveys & Tutorials, 2019.** |
| Required major of studies, desirable skill sets, knowledge, and speciality | Software development and computer science majors. It is desirable if students have or willing to develop skills in the following areas:   * Embedded C/C++ or Zephyr RTOS development. * Python and deep learning frameworks (e.g., PyTorch or TensorFlow) * It is desirable if students have some background in data processing and Bluetooth RSSI-based localization algorithms.Experience with real-time data collection and MQTT or serial data protocols * Strong hands-on skills in setting up experiments, troubleshooting embedded systems, and evaluating system performance in real-world scenarios. |
| **Industry-based project: Student IP Agreement.** This is the IP model agreed between the parties. Please note that it is QUT policy that where possible students should be allowed to keep their IP. If students are asked to assign their work, then please **provide a brief rationale** as additional permissions are needed by QUT to approve. | Project IP vests in the student with a license back to Industry Partner **(licence)**  OR  Project IP vests in the Industry Partner/Project owner with a licence back to the student **(assignment)**  OR  Academic project (No IP agreement needed) |
| Number of students | 5 |
| The message from supervisor(s) about the acceptance for this project |  |
| Student name(s)  (Print your name and submit this form by the end of Week 2) |  |
| Date |  |
| Remarks on conditions of offer | This research is conducted as part of a government-funded project. Participating students will be required to sign an Intellectual Property (IP) agreement with the QUT project owners. The supervising team will shortlist candidates following the application process. |