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),  Jingfei Zheng: [jingfei.zheng@hdr.qut.edu.au](mailto:jingfei.zheng@hdr.qut.edu.au) |
| Information Technology major(s) | Software Development, Computer Science and Data Science, Networks and cybersecurity |
| Project title | Smartphone-Based Real-Time V2P Safety System for Signalized Intersections |
| Brief description of the research problem, aims, method and expected outputs (100~200 words) | **Background:** Vulnerable Road Users (VRUs)—including pedestrians, cyclists, and scooter riders—face a disproportionately high risk of collisions at signalized intersections due to limited situational awareness and delayed warnings. While intelligent transport systems have improved vehicular safety, few solutions offer direct, real-time communication between roadside infrastructure and VRUs. The widespread adoption of smartphones, combined with reliable mobile broadband and comprehensive mapping services, presents an opportunity to bridge this gap. Leveraging Google Maps APIs for precise geolocation and high‐speed mobile data links, this project addresses critical safety challenges by empowering VRUs with actionable, context-aware alerts.  **Objectives:**   1. **Real-Time Positioning & Mapping:** Integrate Google Maps APIs to continuously track VRU location and intersection geometry. 2. **Safety Zone Detection:** Define dynamic zones around signalized intersections where collision risk is highest. 3. **Bi-Directional V2P Communication:** Enable two-way data exchange between VRUs’ smartphones and roadside units (RSUs) to broadcast signal phases and hazard warnings. 4. **Multimodal Alerts & UI:** Design a user interface that delivers visual, auditory, and haptic notifications tailored to VRU mode and risk level. 5. **Backend Computation:** Develop cloud‐based services to fuse position data, signal timing, and predictive models in real time. 6. **Validation:** Conduct bench and field trials to evaluate system performance under diverse traffic scenarios.   **Expected Outcomes:**  A minimum viable functional prototype will be developed and tested in both controlled and live environments to evaluate communication latency, positioning accuracy, and user acceptance. The project will demonstrate the practical use of a mobile application enabling real-time communication and interaction between devices in road environments. The findings will provide critical insights into the technical feasibility and design considerations for leveraging smartphones to enhance vulnerable road user (VRU) safety at urban intersections. In addition, the results will inform policy recommendations for the integration of vehicle-to-pedestrian (V2P) safety applications within existing transport infrastructure and networks |
| Key words | * Vulnerable Road User (VRU) Safety * Vehicle-to-Pedestrian (V2P) Communication * Real-Time Positioning & Mapping * Google Maps API Integration * Multimodal Alerts & Haptic Feedback * Mobile Broadband Connectivity |
| Answerable research questions for 3-5 students (desirable) | Research Questions:   * **How does the integration of Google Maps APIs affect in-field positioning accuracy for pedestrians, cyclists, and scooter users at signalized intersections compared to standalone GNSS solutions?** * **What spatial and temporal parameters for dynamic “safety zones” around intersections minimize false alarms while maximizing early detection of potential conflicts for different VRU modes?** * **How does end-to-end latency in bi-directional V2P communication with MQTT protocols—under typical mobile-broadband conditions—impact the timeliness and reliability of hazard warnings delivered to VRUs?** * **Which combination of visual, auditory, and haptic alert modalities yields the fastest response times and highest user acceptance among VRUs during live field trials?** |
| 3-5 key references (desirable) and website resources | 1. Anne, L., Nandan, T., Kunj, M. *et al.* MQTT-Based Android Chat Application for IoT. *SN COMPUT. SCI.* 3, 402 (2022). <https://doi.org/10.1007/s42979-022-01278-8> 2. [Andrew Fisher](https://arxiv.org/search/cs?searchtype=author&query=Fisher,+A),[Gautam Srivastava](https://arxiv.org/search/cs?searchtype=author&query=Gautam), [Robert Bryce](https://arxiv.org/search/cs?searchtype=author&query=Bryce,+R), MQTTg: An Android Implementation, <https://doi.org/10.48550/arXiv.1906.07162> 3. **Merdrignac, P., Shagdar, O., & Nashashibi, F.** “Fusion of Perception and V2P Communication Systems for the Safety of Vulnerable Road Users.” IEEE Transactions on Intelligent Transportation Systems, 18(7), 1740–1751, July 2017. 4. **Vourgidis, I., Maglaras, L., Alfakeeh, A. S., Al-Bayatti, A. H., & Ferrag, M. A.** “Use Of Smartphones for Ensuring Vulnerable Road User Safety through Path Prediction and Early Warning: An In-Depth Review of Capabilities, Limitations and Their Applications in Cooperative Intelligent Transport Systems.” Sensors, 20(4):997, Feb 2020. 5. **Zoghlami, C., Kacimi, R., & Dhaou, R.** “5G-enabled V2X Communications for Vulnerable Road Users Safety Applications: A Review.” Wireless Networks, 29, 1237–1267, Nov 2022. |
| 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:   * Proficiency in Android (Java/Kotlin) and/or iOS (Swift) for real-time location tracking, background services, and multimodal alerts. * Hands-on with MQTT (or HTTP/WebSocket) for publish/subscribe messaging. Understanding mobile broadband (4G/5G) characteristics and QoS tuning. * Skills in building scalable, real-time services (e.g. Node.js, Python) on AWS/GCP/Azure—API design, message brokering, spatial database (PostGIS). * Design of intuitive multimodal alerts (visual, audio, haptic), accessible interfaces for pedestrians, cyclists, scooter users, and usability testing. * Statistical analysis of positioning accuracy, near-miss reduction metrics, and user acceptance; designing and running bench-top and live trials. |
| **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. |