

**SCHOOL OF ELECTRICAL, COMPUTER AND TELECOMMUNICATIONS ENGINEERING**

# ECTE458 Project Proposal Form

*(maximum 8 pages on completion)*

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| **1. Candidate Details** | |
| **Name: Xin Xu** | **Student No: 6231196** |
| **Supervisor: Assoc.Prof Son Lam Phung** | |
| **Title of Project:**  Pedestrian Crossing Lane Detection using Deep Networks for Assistive Navigation | |
| **Brief Overview:**  For many people living with visual impairment or blindness, assistive navigation is important to help them build self-reliance and improve their quality of life. The pedestrian crossing lane is the place for pedestrians to cross the road where they are given priority. However, there is no existing tool to guide the blind people at the crossing road section.  This project aims to develop a vision system for detecting the pedestrian crossing lane using deep networks, including Fully Convolutional Network (FCN) and Semantic Segmentation Network (SegNet). FCN uses a convolutional neural network to transform image pixels into pixel categories. SegNet is a semantic pixel-wise segmentation based on the convolutional encoder-decoder. These methods can utilise low-resolution features and classify the different regions of an input colour image. In this project, the proposed system is developed to detect the walkable region of crosswalks. The expected outcomes are to provide a more accurate and stable system which can detect different types of pedestrian crossings, e.g. zebra crossing and pelican crossing. Therefore, the expected system can be used for assistive navigation in the future. The developed algorithms can also be applied for autonomous vehicles and intelligent robots. | |

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| **2. Project Description:** (One page maximum) | |
| **Research Problem:** This project aims to help blind people detect pedestrian crossing lane in the surrounding environment, and prevent them from misjudging traffic conditions when crossing the road due to limited vision.  There are a few traditional navigation aids for blind people, such as white cane or guide dog. These navigation systems are effective when the blind already know their surroundings and have a firm impression of the location and direction of the target. However, in most cases, a blind person cannot fully remember their surroundings and objects because of many uncertainties [1]. Consequently, a solution to detect the walkable area of the pedestrian crosswalk is required. In the complex traffic environment, if there is no such effective technology to help the blind, they are not able to navigate themselves or even put their lives in danger. | |
| ***Figure 1****:* Pedestrian crossing lane segmentation. *Top row:* Examples of input images with pelican crossing and zebra crossing. *Bottom row:* The corresponding ground-truth for input pictures, where white (1) indicates a walkable area of pedestrian crossing, and black (0) indicates the background.  **Related Work:** Several approaches for helping the blind navigate themselves have been proposed. There are two traditional auxiliary tools to help the blind, including white cane and guide dog. The white cane can be used to detect the distance of the target and send out an alarm to remind the blind as soon as it falls below a safe distance from the object. A guide dog can interact with a blind person and watch their every movement at any time. However, these auxiliary tools cannot guarantee safety in an unknown environment [2]. With the development of sensors, camera-based electronic travel aids (ETAs) has been designed as navigation aids to visually disabled persons or blind persons [3]. Sensors are generally large, expensive and have differing performances in indoor and outdoor scenes. Advances of deep learning based on the neural network have opened the possibility to solve these problems. By using deep learning, a semantic segmentation graph can be generated from a single colour image, which can classify the different components of one image. This method has been proved to be effective in object recognition but also performing effectively in whole-image classification.  **Methodology:** This project aims to detect the pedestrian crossing lane using FCN and SegNet. FCN has been widely developed in different areas, including image recognition, object detection and semantic segmentation [4], while SegNet is a semantic pixel-wise segmentation based on the FCN [5]. The first step is to apply this state-of-the-art technology on PC and test it on the custom dataset. The second step is to modify this network and improve its prediction accuracy on Jetson Nano embedded system with the existing methods. Jetson Nano is a small and powerful computer that allows developers to run multiple neural networks at the same time for applications such as image classification, objection detection, segmentation and speech processing [6]. The results are presented in a table, which contains the accuracy of the various metrics of the comparison. The errors present in the experiment will also be marked. Finally, after a comprehensive comparison, an efficient pedestrian crossing line detection system will be proposed.  **Project Outcomes:**   * A comprehensive literature review of different technologies contributes to pedestrian crossing lane detection. * A massive dataset and manually annotate the images for pedestrian crossing lane. * A detailed analysis of the accuracy differences on PC and Jetson Nano. * An expected system for detecting pedestrian crossing lane. * Thesis project reports, seminar presentations and posters. |

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| **3. Project Plan:** (Two pages maximum) |
| The project is conducted in two major stages: ECTE451 and ECTE458.  **Stage 1 (ECTE451):**   * + - Study assistive navigation for the blind and visually impaired(BVI).     - Conduct a literature review on deep networks (FCN, SegNet).     - Collect and annotate 500 photos for developing the deep network.     - Train and evaluate the network performance of pedestrian crossing lane detection.   **Stage 2 (ECTE458):**   * Collect more image data and segmentation ground-truth to support the training network, including the data used in ECTE 451. * Conduct a comparative analysis of the accuracy differences on PC and Jetson Nano system. * Create an expected system for pedestrian crossing lane detection.   **Validation of Experimental Results:**  A dataset of images is collected under various conditions. All the images are manually annotated for the pedestrian crossing regions. The machine outputs are compared pixel-wise with the ground-truth label to compute the accuracy. The five-fold cross-validation technique is used to measure accuracy and compare with other techniques.  **Project Timelines**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **ECTE451 Session** |  |  |  |  |  |  |  |  |  |  |  |  |  | | **Week** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | | Prepare project proposal |  |  |  |  |  |  |  |  |  |  |  |  |  | | Conduct a literature review |  |  |  |  |  |  |  |  |  |  |  |  |  | | Study deep convolutional neural network |  |  |  |  |  |  |  |  |  |  |  |  |  | | Study semantic segmentation |  |  |  |  |  |  |  |  |  |  |  |  |  | | Collect and annotate image data |  |  |  |  |  |  |  |  |  |  |  |  |  | | Train and test learning network |  |  |  |  |  |  |  |  |  |  |  |  |  | | Prepare ECTE451 seminar |  |  |  |  |  |  |  |  |  |  |  |  |  | | Prepare ECTE451 thesis report |  |  |  |  |  |  |  |  |  |  |  |  |  |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **ECTE458 Session** |  |  |  |  |  |  |  |  |  |  |  |  |  | | **Week** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | | Revise project proposal |  |  |  |  |  |  |  |  |  |  |  |  |  | | Update literature review |  |  |  |  |  |  |  |  |  |  |  |  |  | | Acquire images & ground-truth |  |  |  |  |  |  |  |  |  |  |  |  |  | | Improve deep learning system |  |  |  |  |  |  |  |  |  |  |  |  |  | | Test and evaluate system |  |  |  |  |  |  |  |  |  |  |  |  |  | | Implement system on PC & Jetson Nano |  |  |  |  |  |  |  |  |  |  |  |  |  | | Prepare ECTE458 poster and seminar |  |  |  |  |  |  |  |  |  |  |  |  |  | | Prepare ECTE458 thesis report |  |  |  |  |  |  |  |  |  |  |  |  |  | |

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| **4. Adaption of Supervisor and Examiners feedback in the ECTE451 report:** (Half a page maximum) |
| **Supervisor:**   * Complete project tasks as early as possible: revise project specifications, collect data, conduct experiments, and write final reports. * Use the resources provided to thesis writing.   **Examiners:**   * Write and revise the report more carefully for clarity and conciseness. * Evaluate the proposed method for pedestrian crossing detection and compare with other methods. |

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| **Student Signature**  ***Declaration by the student: I have understood the feedback provided to me by the supervisor.*** | | |
|  | **Signature** | **Date** |
| **Student Name:**  **Xin Xu** |  | **18/08/2020** |

**A marked assessment rubric will be appended once completed**

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| **5. References:** |
| [1] S. S. Suny, S. Basak, and S. M. Mazharul Hoque Chowdhury, "Virtual vision for blind people using mobile camera and sonar sensors"*, in Intelligent Systems and Computing*, 2020, pp. 1044-1050.  [2] A. Khan, A. Khan, and M. Waleed, "Wearable navigation assistance system for the blind and visually impaired," *in International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies,* 2018.  [3] P. S. Ranaweera, S. H. R. Madhuranga, H. F. A. S. Fonseka, and D. M. L. D. Karunathilaka, "Electronic travel aid system for visually impaired people," *in International Conference on Information and Communication Technology (ICoIC7)*, 2017, pp. 1-6.  [4] E. Shelhamer, J. Long, and T. Darrell, "Fully Convolutional Networks for Semantic Segmentation," *IEEE Transactions on Pattern Analysis and Machine Intelligence,* Article vol. 39, no. 4, pp. 640-651, 2017.  [5] V. Badrinarayanan, A. Kendall, and R. Cipolla, "SegNet: A Deep Convolutional Encoder-Decoder Architecture for Image Segmentation," *IEEE Transactions on Pattern Analysis and Machine Intelligence,* Article vol. 39, no. 12, pp. 2481-2495, 2017.  [6] L. Barba-Guaman, J. E. Naranjo, and A. Ortiz, "Deep learning framework for vehicle and pedestrian detection in rural roads on an embedded GPU," *Electronics,* Article vol. 9, no. 4, 2020. |