

Annex A2

RESEARCH COLLABORATION OPPORTUNITY

Research Collaboration Opportunity Ref No.: RCO-CUGE-2018-02

Project Title: Radar Technology: Enhancing Sensing and Imaging for Subterranean Diagnostics

1. Key Challenges and Objectives

- 1.1 The result of economic advancement and urbanisation had led to greater conflict between greenery and infrastructure. Space constraints and the competition for land space between green and grey infrastructure will continue to be a problem that does not necessarily have straightforward, immediate solutions, but the association with technology may be the most prolific approach to address this issue. Leveraging on technology can potentially lead to a more sustainable green environment; enhancement of lifestyles, and standards of living.
- 1.2 This research must have an arboriculture focus with objectives set to improve maintainability and productivity of tree care management processes. The aim will be to address the challenge on space limitations in Singapore's highly urbanised city through the use of advanced imaging technology to visualise the subsurface without any destruction to surface conditions. This will allow for characteristic assessment of conflict between tree roots and infrastructure serving as a strategy to address spatial conflict, and thereby enhancing tree care management approaches and conservation efforts.
- 1.3 The current effort employs the use of the ground penetrating radar (GPR) for non-destructive imagery of tree roots. However, the outcomes of the technology lacks accuracy, and the imagery output lacks contrast. More importantly, the software put forth images that are difficult to interpret and in 2-dimensional forms. Trained and experienced personnel is required to interpret a GPR response. Additionally, the system requires that the terrain is flat and does not work well on clay or high moisture conditions. In fact, most urban soils are highly conductive hence, unsuitable for GPR mapping.
- 1.4 The objectives of this research will be to develop novel non-destructive radar imaging systems that can overcome the existing limitations whereby subsurface imaging can:
 - a) Improve in detection accuracy (to include improvements in depth and positional data)

- b) Improve in output imagery (to include better colour contrast and 3D imagery of entire root systems, ease of interpretation, non-trained personnel must be able to read and understand a GPR output.)
- c) Works on a variety of terrains from flat ground to slopes (to include equipment portability, ease of set up, quick to map subsurface)

1.5 The board is not looking for commercial off-the-shelf units. Neither is the board seeking out incremental improvements from current off-the-shelf products. The board's intent is to develop an advanced hardware and software that can overcome existing challenges encountered with commercial GPR units. The outcomes from this research should leverage on automatic processing approaches able to give clearer, clever and more stable and interpretable reconstructed images working with the raw-data as the building blocks. Incremental improvements from current GPR output will not be considered as suitable rather innovative and efficient mapping methods and enhanced visualisation effects (preferably in 3D forms) will be the key factors of consideration in this research. These improvements should not be cumbersome for the end users but rather easily accessible and user-friendly.

2. Minimum Project Deliverables

The deliverables described here represent the minimum outcomes arising from the proposed project. Additional relevant deliverables that are proposed will be favourably considered during project evaluation.

- (i) The board expects the deliverables (hardware and software) to be robustly tested prior to submission (at the end of the project). Theoretical studies and simulations, laboratory experiments and field trials must be conducted to prove the concept works especially for the 3D data processing, interpretation and output, and the efficiency of subterranean mapping necessary for raw data acquisition.
- (ii) The board is looking for proposals that will suggest potential technologies that the hardware and software will leverage on. There will be the need to explain the benefits of using such technologies and the effectiveness of such technologies for the purpose of tree root mapping.
- (iii) The board is also seeking out simplicity in the utilisation of such technologies. Therefore, hardware and software that are user-friendly, with greater degree of automation, efficiency and productivity will be looked upon favourably.
- (iv) The board will give priority to proposals that can add value to the research. For example, if the proposer is able to develop a technology beyond just root systems and suggest sensors (IOTs) or systems that help the board combat the effects of stem failure (e.g. trunk monitoring technology pertaining to the identification of stem decay, etc.) that may pose a threat to public safety.
- (v) Progress reports are due on a 6-monthly basis, and a final report at end of project.

3. Budget Limits

3.1 The proposed budget cannot exceed \$800,000.00. Proposals that exceed this limit will not be considered. Please note that this amount is simply an indication of budget availability, not an estimate of expected project cost.

3.2 The project duration should also not exceed 3 years. Proposals requiring more than 3 years can be considered, but with strong justification.

3.3 Please note that NParks' decision on the funding support to be awarded for the project is final.

4. Submission Instructions

Proposals for the Research Collaboration Opportunity as stated above must be submitted to Dr Genevieve Ow at genevieve_ow@nparks.gov.sg by 5th November 2018, 1200 hrs.

5. Enquiries

For transparency, all enquiries and associated clarifications will be published (without details on the identity of the person making the enquiry) on the Research Collaboration Opportunity page on the CUGE website. We regret that phone enquiries will not be entertained.

For enquiries, please contact Dr Genevieve Ow at genevieve_ow@nparks.gov.sg for enquiries.