WAM-V Platform Proposal:

RobotX Competition 2022 - The UTS Team

3rd of May 2021

Jonghyuk Kim
Robotics Institute, Faculty of Engineering and Information Technology
University of Technology Sydney
Email: jonghyuk.kim@uts.edu.au
Phone: 02 9514 4492

List of Supporting Academic Members:

	Name	Affiliation
1	A/Prof Jonghyuk Kim	Robotics Institute, FEIT, UTS
2	Dr Marc Carmichael	Robotics Institute, FEIT, UTS
3	A/Prof Teresa Vidal-Calleja	Robotics Institute, FEIT, UTS
4	A/Prof Adrian Bishop	Biomedical Engineering/CSIRO, FEIT, UTS
5	Dr Fatma Al-widyan	Faculty of Engineering and IT (FEIT), UTS, Director of FEIT's Undergraduate Teams
6	Prof Sarath Kodagoda	Robotics Institute, FEIT, UTS, Director of RI

1. Technical Approach and Justification

The UTS RobotX Competition team will develop a fully autonomous WAM-V system that can achieve each task required in the RobotX 2022 competition. Our team's technical approach is to develop the system in multiple stages depending on the level of autonomy needed:

- Stage 1 on the remote-pilot controlled system,
- Stage 2 on the autopilot system with collision avoidance,
- Stage 3 on the task (mission) specific payload systems, and
- Stage 4 on the system integration and competition.

- In Stage 1, A remote-pilot controlled system will be developed and tested. This stage is the lowest level of autonomy as the system is controlled by a remote operator. It is, however, a crucial stage to ensure the safe control of the platform with a minimal control system, such as a motor controller using electronic speed controllers (ESCs) with a microcontroller, communication to the remote-control system, and a ground station.
    - An Atmel or PX4 microcontroller with two electric motors will be considered for the actuation, which can generate thrust and yaw motions (thus similar to the two-wheel robot actuation). This microcontroller also needs to create a heartbeat message to the ground station which is required in the competition.
    - A ground monitoring system (GMS) needs to be developed in this stage, which is required to monitor the vehicle's critical status and provide an emergency stop measure.
    - The successful outcomes of this stage will be controlling the vehicle in water interfacing with the ground station and an operator. UTS Rowing Club facility in Sydney will be utilised to launch and recover the platform. The system will also be used to support Stages 2 and 3 by collecting task-specific datasets, such as Lidar/camera data, to detect obstacles, entry/exit gates, and docking platforms.

- Stage 2 will be built upon the system developed in Stage 1 and focus on integrating an autopilot system with the collision avoidance capability.
    - We will consider the PX4 controller, which has been widely used as a drone autopilot system. This system provides an interface to the remote-control receiver, motor interfaces and serial interface to a guidance computer. One critical technical issue can be optimising the PX4 control parameters suitable for WAM-V platform, as the dynamics and actuation are different from those of conventional drones. If necessary, the hydrodynamic and sideslip model of the vehicle can be obtained from a field experiment to tune the control parameters. The inbuilt GPS and inertial measurement unit (IMU) has the autopilot capability with waypoints inputs.
    - For collision avoidance, we will consider developing a guidance control computer (GCC) that will be equipped with 2D/3D lidar or stereo camera sensors. The GCC will process the lidar scans to generate safe paths, which will consist of a set of waypoints or Bezier control points for smoothed trajectory. Depending on the task scenario, the trajectory will combine segments such as waypoints and arc. As the PX4 only takes a maximum of 5 waypoints or control points, the GCC needs to update the information frequently. The GCC will extensively utilise the ROS Mavlink node package, which provides the ROS interface to the PX4, thus significantly reducing the workload.
    - The successful outcomes of this stage will be the demonstration of the autopilot system with the GCC system under obstacles. The GCC system can be tested on a drone which simplifies the field experiment. Also, a UAV drone is part of the

competition. A field demonstration will be performed on the WAM-V vehicle in water with mock-up obstacles.

- Stage 3 will develop mission-specific Payload Control Systems (PCSs) to complete six tasks in the competition. We take the modular approach as much as possible so that each PCS can be developed parallel to Stages 1 and 2. For each task,
    - T1 – Sonar detection system: This task requires the vehicle to process a sonar beacon to detect an open entry gate. The autopilot system then needs to generate a trajectory avoiding any collision with the gate. The PCS will consist of an acoustic receiver and pass the beacon's location to the GCC for trajectory generation.
    - T2 – Path following with UAV: The PCS in this task is a UAV system equipped with a camera to detect the path-guiding markers, whose locations can be mapped by using GPS and planner scene geometry. The geolocations will be transmitted to the GCC to generate a smooth trajectory further. There can be potential technical issues in operating the UAV on the USV Bridge, such as charging the battery automatically and limited space for taking off and landing. The task description was not clear whether or not the UAV needs to launch from the USV. If the UAV can be launched from the GMS site, those issues can be resolved straightforwardly.
    - T3 – Detect/avoid wildlife: The PS requires a UAV-borne hyperspectral camera to detect the spectral signature of the wildlife. Based on the geolocation and type of the animal, the GCC can generate clockwise or counter-clockwise circular trajectories. A potential issue is the availability of a UAV-mountable hyperspectral camera. Currently, UTS:RI has only an infrared camera that can detect a heat signature. Potentially a hyperspectral can be borrowed for the sponsoring partners, or the infrared camera needs to be negotiated with the hosting Robotnation.
    - T4 – RGB Colour pattern detection: The PCS requires an RGB colour camera to detect the sequence of the RGB lights and report it back to the Ground station. The GCC needs to approach the lights and moor in front of it for sequence detection.
    - T5 – Docking and delivery: The PCS consists of a projectile mechanism to shoot four balls into two holes. Besides, the 3D locations of the target holes need to be mapped using either a Lidar or a stereo camera. This task also requires a generation of docking and undocking manoeuvres, which might require a hydrodynamic model of the vehicle.
    - T6 – UAV picking the ball and bringing to a helipad: The PCS consists of a UAV that can perform a pick-and-deliver operation. It would require a grasping mechanism mounted on the UAV and detect a ball using a camera. Like T2, if the UAV is launched from the GMS site, battery charging and limited space can be resolved. This task is relatively independent of USV so that it can be implemented and tested on the ground.

- Stage 4 will focus on the system integration and testing
    - A modular and distributed computing approach will be taken to develop fully autonomous USV and UAV systems. Each PCS will be designed separately and in parallel before the system integration stage. The tested modules will be integrated through the internal network. ROS (robot operating system) framework naturally supports the distributed computation and will be used throughout the design stages.

- Testing Plan

- o Laboratory testing – each task module will be developed and tested on each embedded computer (e.g. Atom or NUC embedded computers) in the laboratory environment. Mock-up testing systems will be utilised as much as possible to simulate the environment. For example, the gates, path-following beacons, wildlife (using a simplified visual target, for instance), and docking system can be tested in a laboratory environment together with a mobile robot (such as Turtlebot3). This approach will significantly reduce the requirements of the field experiments and related logistics.
- o Field testing –Stages 1 and 2 require access to water to test the remote and autopilot control of the vehicle, which is critical to implement further mission-specific autonomy. We are considering the UTS Rowing Club arena, which can be used to launch/recover the WAM-V platform for testing in water. Mock-up floating obstacles can be deployed to test obstacle avoidance and path-following.
- o Field experiment for Stage 4 – Once the mission systems are implemented, extensive field experiments will be required to test the whole system and prepare for the competition.
- o Simulation – A ROS-based simulator will also be considered, which can significantly reduce the field testing.

- Fail-safe operation
  - o A heartbeat signal (e.g. at 1Hz) from the GCC to GMS will be implemented to monitor the active status of the GCC. An emergency stop button at the GMS (software) and a physical stop button at the vehicle would be implemented to stop the vehicle and hand over the control to the remote controller if it was in an autonomous mode operation.

- Project management plan
  - o Team Recruitment – Considering the scope and student-led nature of the project, strong leadership and management will be required for the project's success. The UTS team will consist of students, supporting academics and sponsors. The student team members will be recruited through the advertisement, but the majority of members will be recruited through the designed-oriented undergraduate and master project coursework:
    - ▪ MMD (mechanical and mechatronic design) course: This is a designed-oriented group project for 4th and 5th-year students in the Faculty of Engineering and Information Technology, UTS. The RobotX project can offer multiple projects over multiple semesters. We expect to retain some passionate students for the leadership roles towards the competition in 2022.
    - ▪ Robotics Master Studios: This is our new master program in mechatronics engineering focusing on design and project-based learning.
  - o Sponsorship – The supporting academics have active research engagement with the sponsoring partners (DST and Thales). Throughout the project, the applicant and supporting academics will seek support (financial and/or technical) from the partners and the faculty.
  - o Estimated costs – The estimated total cost is $68K with $46K (in-kinds) and $21K (cash). The cash component will be solicited from the UTS faculty and sponsoring partners throughout the development stages. Please refer to Appendix A – Estimated Budget for more details.
  - o Schedule for design, building and testing – A Gantt Chart is attached in Appendix B. The plan is based on each development stage discussed previously. Stage 3 is

mission-specific and would require the completion of Stages 1 and 2. However, to minimise the delay, Stage 3 will start in parallel to Stages 1 and 2 and be first verified using ground-based testing. For instance, a ground mobile robot and a UAV will be utilised as much as possible to test each mission task. In Stage 4, the PCSs will be mounted on the WAM-V platform and integrated towards the completion.

2. Team Qualification

The list of supporting team members is shown below. The academic members are all affiliated with the Faculty of Engineering and Information Technology, UTS. The supporting team has extensive experience in project management both for research and industry. The lead supporting team member A/Prof Kim has managed 4 ARC Discovery Projects and contributed to 3 large-scale international industry projects with BAE Systems, MoD UK, and Singapore. Dr Carmichael has been involved in several large-scale industry projects, including Sydney Harbour Bridge (SHB) grit-blasting robot and SPIR (submersible pier inspection/cleaning robot). Dr Carmichael is also the course convenor of the MMD (mechanical and mechatronic) course at the engineering, which will recruit passionate engineering students to this project. A/Prof Vidal-Calleja has led a team for the 2020 MBZIRC competition held in Dubai, UAE. The team has developed an autonomous mobile robot with a manipulator completing tasks, for instance, extinguishing a fire. A/Prof Bishop has successfully managed several research projects with DST Underwater/Naval Group providing support to the team. Dr Al-widyan is currently the director of FEIT's undergraduate innovation, leading student projects such as FSAE (Electric Car and Autonomous Car) and UTS Rocketry teams. She will support the UTS RobotX Team in management and organisation of the team. Prof Kodagoda is currently the acting director of the Robotics Institute and will provide advisory support to the team. The supporting team demonstrates strong experiences and capabilities in managing projects required for RobotX competition.

Supporting Academic Members				
	Name	Affiliation	Role	Experince
1	A/Prof Jonghyuk Kim	Robotics Institute, FEIT, UTS	Supporting Academic	4 ARC Discovery Project.
2	Dr Marc Carmicael	Robotics Institute, FEIT, UTS	Supporting Academic	XX Industry Project. MMD convenor
3	A/Prof Teresa Vidal-Calluja	Robotics Institute, FEIT, UTS	Supporting Academic	MBZIRC 2020 competition
4	A/Prof Adrian Bishop	Biomedical Engineering/CSIRO, FEIT, UTS	Supporting Academic	2 Naval research projects
5	Dr Fatma Al-widyan	FEIT, UTS	Supporting Academic	FEIT Student projects (FSAE-Electric, FSAE-Autonomous, Rocketry Team)
6	Prof Sarath Kodagoda	Robotics Institute, FEIT, UTS	Advisor	Acting RI Director

3. Facilities

UTS Robotics Institute is equipped with several facilities which can be used for the RobotX development and experiment, as listed below. The water tank is a pretty unique facility in academic institutes, significantly reducing the effort in testing and field trials. In addition to the field experiments, the team will utilise the indoor robot systems as much as possible. This approach will be essential in developing Stages 3 payload systems. Rather than waiting to complete the Stage 2 system, each payload system will be developed and tested indoors using a mobile platform to simulate the autonomous vehicle. For example, a UAV system can be tested using a Turtlebot3 robot to simulate Tasks 2, 3 and 6 on the ground. With minimal changes, the system will be tested on the WAM-V platform in Stage 4.

	Facility	Description
1	Water-tank facility	A indoor water tank facility with 6mx4mx2m dimensions. A gantry system is used to launch and recover vehicle or test equipment. Visual markers are installed for any localisation verification.
2	Sensors and embedded computers	Various sensors are available in the Robotics Institute. The actual availability will depend on the RI research projects and need some negotiation. The sensors inlucde a laser scanner, velodyne VLP-16, (hyperspectral or infrared camera), and embedded computers.
3	3D Printers	UTS provides Prototyping space to engineering project students, including 3D printers and a laser cutter.
4	UTS rowing club	UTS rowing club located in Harberfield, Sydney will be considered for the field experiment of the vehiccle in water.

4. Sponsorships and Partnerships

A list of sponsors and partners is shown below and the letters of support are attached in Appendix. The FEIT (faculty of engineering and IT) will financially support the UTS team and competition participation. The support will include both cash and in-kind contributions, although the exact amount requires a formal approval from the faculty which will take beyond this application due date. The Robotics Institute will provide in-kind support by leasing sensors and embedded controllers. Thales Australia has also agreed to support the UTS team both financially and technically. Due to the limited preparation time of this proposal, a detailed level of support needs further discussion and approval from the Thales management executives. Although provisional to formal approvals (and thus the exact amount cannot be stated here), these sponsorships can provide enough cash support of $21K as requested from the project.

Sponsoring Partners				
	Contact Personnel	Details	Contact Phone	Email
1	Sara Mesgari Hagh	Faculty of Engineering and IT, UTS	02) 9514 9098	Sara.MesgariHagh@uts.edu.au
2	Herni Winarta	Robotics Institute, UTS	02) 9514 2588	Herni.Winarta@uts.edu.au
3	Daniel Dent	Thales Australia Limited	02) 9848 3500	NA

5. Management Approach

A list of team recruitment and organisation plans is shown in the below table. As previously discussed in Section 1, we will recruit the student team members through our project-based coursework, MMD (mechanical and mechatronics design) course, which is offered every semester (or session) at the FEIT. Around 150 engineering students form a small group (4-6 students) and participate in various projects in the course. The UTS team will recruit students through the advertisement of the projects at MMD from Spring Session 2021. We also anticipate retaining some of the passionate students for the RobotX leadership roles after the semester finishes, which will ensure students' continuity. Another source of recruitment will be through the Robotics Master Studio program and advertising the project to general engineering students through the FEIT's student project activity. Their contributions will be either individual or a small group-type project.

Team Recruitment Plan				
	Courses	Team	Session	Target number of Students
1	MMD projects	Team 1 for Stage 1 development	Spring Session 2021	4-6 students
		Team 2 for Stage 2 development	Spring Session 2021	4-6 students
		Team 3 for Stage 3 development	Spring Session 2021	4-6 students
		Team 4 for Stage 4A development	Autumn Session 2022	4-6 students
		Team 5 for Stage 4B development	Autumn Session 2022	4-6 students
		Team 6 for Competition	Spring Session 2022	4-6 students
2	Robotics Master Studios	Individual or a small group		4-6 per semester
3	FEIT Engineering Students	Individual		4-6 students

6. Estimated cost

Please refer to the estimated budget table attached in Appendix A, which budgeted items including sensors, actuators, computers, experiments, and competition logistics. Total expected costs are $68K with $46K of in-kinds and $21K of cash. The cash expenses will be sourced from the sponsorship and partnerships.

7. Summary

Given that a WAM-V platform is available, the UTS RobotX Team will construct a fully autonomous surface vehicle that can perform the tasks required in the RobotX 2022 competition. UTS Team will have strong support from the faculty and the government/industry partners to enable such a system. UTS Robotics Institute will also support the team, which has extensive expertise and experiences in developing autonomous systems. UTS engineering also offers project-based design coursework, such as MMD and Robotics Studios, which naturally fit the RobotX project. A fully autonomous WAM-V system supported by a UAV will be developed and demonstrated in the competition through the multiple stages of development and the parallel/modular development approaches.

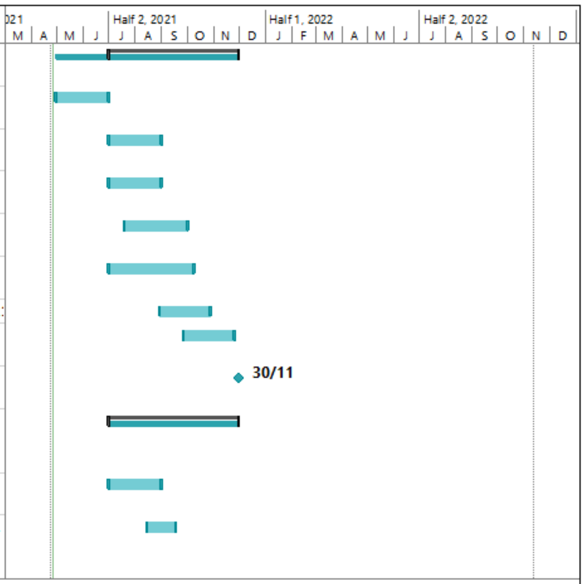
Appendix A. Estimated Budget

RobotX 2022 Competition Budget

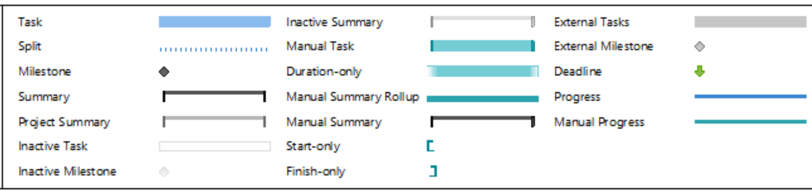
Category	Item	Price (AUD)	Qty	Total	In-kinds	Cash	Comments
Sensors	Laser Hokyuo 30M	5000	1	5000	5000		
	ZED2 camera	1000	1	1000		1000	
	PX4 with GPS and accessory	200	1	200		200	
	Velodyne VLP-16	12000	1	12000	12000		
	Hyperspectral camera (Bay Spec, OCI)	25000	1	25000	25000		assumed in-kind
Power	Battery (Car 12V)	300	1	300		300	
Embedded computer	NXT for GCC	1000	1	1000		1000	
	NUC i7	800	2	1600	1600		
	Atom board (3.5")	500	2	1000	1000		
UAV	With a gimbaled camera	800	1	800		800	
	Gripper design	300	1	300		300	
	Battery	300	2	600		600	
Actuators	Thrusters (T200)	240	4	960		960	
	ESC motor controller	40	4	160		160	
GCS	Laptop	1500	1	1500	1500		
	Handset controller (Spectrum DX6)	500	1	500	500		
	Radio-modem (Xbee Digi)	250	1	250		250	
Field experiments	Travel (UTS - Rowing Club)	100	10	1000		1000	
Competition	Accommodation (Penrith Regatta)	500	7	3500		3500	
	Travel (TUS - Penrith)	300	1	300		300	
	Per diem for meals	200	7	1400		1400	
Consumables	Mechanical parts	5000	1	5000		5000	
	Electronics parts	5000	1	5000		5000	
Total				68370	46600	21770	

Appendix B. Gantt Chart

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Stage 1 Development - Remote control**	**109 days**	**Thu 1/07/21**	**Tue 30/11/21**
2		Acquisition of WAM-V platform	44 days	**Fri 30/04/21**	**Wed 30/06/21**
3		PX4 low-level controller setup	44 days	**Thu 1/07/21**	**Tue 31/08/21**
4		Actuators purchase/installation	44 days	**Thu 1/07/21**	**Tue 31/08/21**
5		Handset controller interface	55 days	**Mon 19/07/21**	**Fri 1/10/21**
6		Ground Monitoring System	72 days	**Thu 1/07/21**	**Fri 8/10/21**
7		Heartbeat mechanism	44 days	**Mon 30/08/2**	**Thu 28/10/2**
8		Emergency stop mechanism	44 days	**Mon 27/09/21**	**Thu 25/11/21**
9		M1. Remote-mode control of the vehicle	0 days	Tue 30/11/21	Tue 30/11/21
10		**Stage 2 Development - Autopilot with collision avoidance**	**109 days**	**Thu 1/07/21**	**Tue 30/11/21**
11		Integration of PX4 autopilot with	44 days?	**Thu 1/07/21**	**Tue 31/08/21**
12		Tuning the autopilot parameters for waypoint guidance	26 days	**Sun 15/08/21**	**Fri 17/09/21**



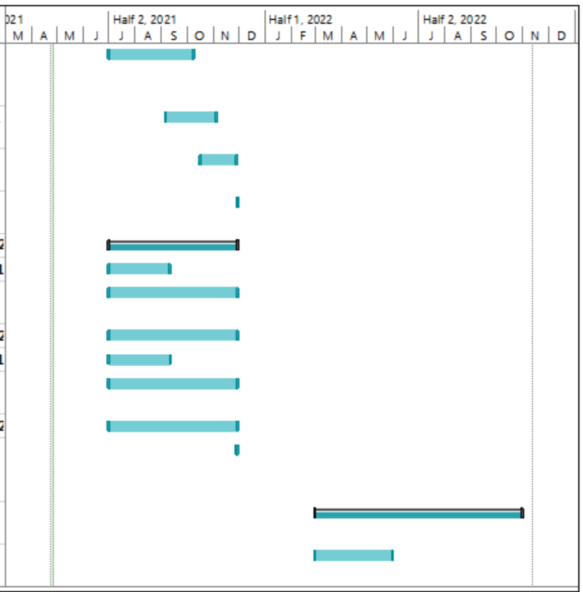
Project: Schedule
Date: Mon 26/04/21



Page 1

RobotX Competition 2022 - The UTS Team

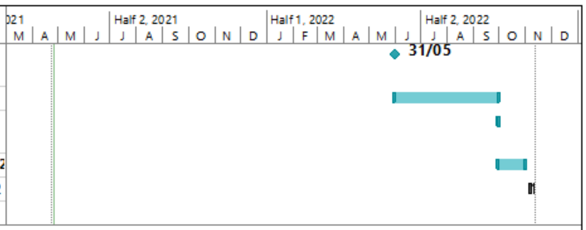
ID	Task Mode	Task Name	Duration	Start	Finish
13		GCC (guidance control computer) with a lidar sensor	72 days	**Thu 1/07/21**	**Sat 9/10/21**
14		Waypoint guidance with obstacles	44 days?	**Mon 6/09/21**	**Thu 4/11/21**
15		General trajectory generation for	31 days	**Sun 17/10/21**	**Mon 29/11/21**
16		M2. Demonstrations in water	1 day	Tue 30/11/21	**Tue 30/11/21**
17		**Stage 3 Development**	**108 days**	**Thu 1/07/21**	**Mon 29/11/2**
18		T1 Sonar detection	52 days	**Thu 1/07/21**	**Sat 11/09/21**
19		T2 Path following with UAV	108 days?	**Thu 1/07/21**	**Mon 29/11/21**
20		T3 Wildlife detection	108 days?	**Thu 1/07/21**	**Mon 29/11/2**
21		T4 RGB pattern detect	53 days	**Thu 1/07/21**	**Sat 11/09/21**
22		T5 Docking and ball projection	108 days?	**Thu 1/07/21**	**Mon 29/11/21**
23		T6 UAV pick and place	108 days?	**Thu 1/07/21**	**Mon 29/11/2**
24		M3. All payload control systems (PCS) demonstrated on	1 day	**Mon 29/11/21**	**Mon 29/11/21**
25		**Stage 4 Integration and Testing**	**175 days**	**Tue 1/03/22**	**Mon 31/10/22**
26		Testing each PCS on WAM-V	66 days	**Tue 1/03/22**	Tue 31/05/22



Project: Schedule
Date: Mon 26/04/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

ID	Task Mode	Task Name	Duration	Start	Finish
27		M4.1 Demonstration of each PCS on	0 days	Tue 31/05/22	Tue 31/05/22
28		All PCSs tests on WAM	89 days	Tue 31/05/22	Fri 30/09/22
29		M4.2 Demonstration of all PCSs on WAM-V	1 day	Fri 30/09/22	Fri 30/09/22
30		M4.3 Competition Tes	22 days	Fri 30/09/22	**Mon 31/10/2**
31		**RobotX 2022 Competitio**	**5 days**	**Mon 7/11/22**	**Fri 11/11/22**
32		Competition			



Project: Schedule
Date: Mon 26/04/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

Appendix C. Letters of Support

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Professor Michael Blumenstein
Associate Dean (Research strategy & Management)
Faculty of Engineering and IT
15 Broadway, Ultimo NSW 2007
T: +61 2 9514 4650
Michael.Blumenstein@uts.edu.au

PO Box 123
Broadway
NSW 2007 Australia
www.uts.edu.au

UTS CRICOS PROVIDER CODE 00099F

30 April 2021

Letter of Support of UTS RobotX Team

Dear RoboNation,

This letter supports the UTS RobotX Team's application (led by A/Prof Jonghyuk Kim) to acquire a robotic vessel platform called WAM-V. Also, it confirms that the Faculty of Engineering and Information Technology (FEIT) at UTS is pleased to support the UTS Team for the 2022 Maritime RobotX Challenge, which will be held at the Sydney International Regatta Centre, Penrith in New South Wales, Australia.

We believe the student's participation in such international activity is well aligned to the UTS's 2027 strategy to enhance students' learning experience and foster research collaboration with industry and defence. Thus, the faculty will support the UTS Team financially and technically by providing access to the infrastructure robotics laboratory equipped with a water-tank facility and the state-of-the-art Protospace, a rapid prototyping facility equipped with 3D printers and laser cutters.

Yours sincerely

Professor Michael Blumenstein
Associate Dean (Research strategy & Management)
Faculty of Engineering and Information Technology

Faculty of Engineering and Information Technology

PO Box 123
Broadway NSW 2007
Australia

University of Technology, Sydney

Professor Sarath Kodagoda
Director (Acting), UTS Robotics Institute
President, Australian Robotics and Automation Association (ARAA)
Ambassador, NSW Smart sensing Network (NSSN)
Ph. +61 2 9514 7629
E-mail: Sarath.Kodagoda@uts.edu.au

03 May 2021

To whom it may concern,

Letter of support of UTS RobotX team

Dear Jonghyuk Kim,

This letter supports the UTS RobotX Team's application to acquire a robotic vessel platform, WAM-V. Also, it confirms that the UTS Robotics Institute is pleased to support the UTS Team for the 2022 Maritime RobotX Challenge, which will be held at the Sydney International Regatta Centre, Penrith in New South Wales, Australia.

The student's participation in such international activity is well aligned with the UTS's 2027 strategy to enhance students' learning experience and foster research collaborations with industry and defense. Thus, UTS Robotics Institute will support the UTS Team in terms of providing access to labs, equipment, some sensors and the water tank.

Yours Sincerely,

Professor Sarath Kodagoda,
Director (Acting), UTS Robotics Institute

THALES

274 Victoria Road
Rydalmere, NSW 2116
Australia
Tel.: +61 (0)2 9848 3500
Fax: +61 (0)2 9848 3888
www.thalesgroup.com.au

UNCLASSIFIED

Ref: 563

Date: 30/04/2021

UTS
15 Broadway
Ultimo NSW 2007
Australia

Dear Jonghyuk Kim,

RE: SUPPORT FOR THE ROBOT X 2022 CHALLENGE

Please consider this a notification of Thales support for UTS for the Robot X WAMV challenge currently set for 2022. Thales recognises due to its existing relationships with several Universities in Autonomy, it will not be sponsoring any University exclusively.

Thales is considering the provision of sponsorship and in-kind support for the competition, amounts to be agreed between Thales and the University through the sponsorships process, compliant with the sponsorship rules of Thales, the University and the RobotX competition.

Kind Regards,

Dent, Daniel
Thales UWS R&D Projects Manager
Thales Australia Limited