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Robotics for pallet and drum storage inspection

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ABSTRACT

All over the world, stores of waste are kept in steel drums that are densely packed into storage facilities, often preventing the thorough inspection of the storage infrastructure, contents of the drums, or critical containment measures like seals. The paper presented here aims to explore the use of robotic systems that can provide a comprehensive coverage of such hazardous environments, keeping human inspectors out of harm's way and enabling visibility into locations people could not previously reach without physical intervention. The Data61 innovation network of Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) has begun development into two such robotic systems; one to transverse the top of the drums, and the other, a low profile system capable of inter-layer inspection by moving through pallets. This paper will present the initial prototypes developed as part of an ongoing body of work and explore the successful engineering design approaches which have enabled rapid technology development and deployment within a waste storage facility.

BACKGROUND

The technologies presented in this paper were specifically designed to enable access and visibility to an environment with thousands of steel drums stacked on pallets and densely packed into an internal facility (FIG 1). The aim of building these technologies was to gather information about the state and stability of the infrastructure and map the environment in 3-dimensions. By building a 3-dimensional map with location-tagged information (photos, video, spatial information, gamma radiation readings and dose rates) thorough planning and risk mitigation can be implemented to enable the safe relocation and processing of the drums. Two platforms were proposed and built as a multi-pronged approach to penetrate and better understand this environment. Whilst future iterations will see these platforms developed as autonomous robots, they currently act as tele-operated sensing platforms designed specifically for such environments.

In this project we develop two systems but talk about them generally as simular components are used and leveraged in both.

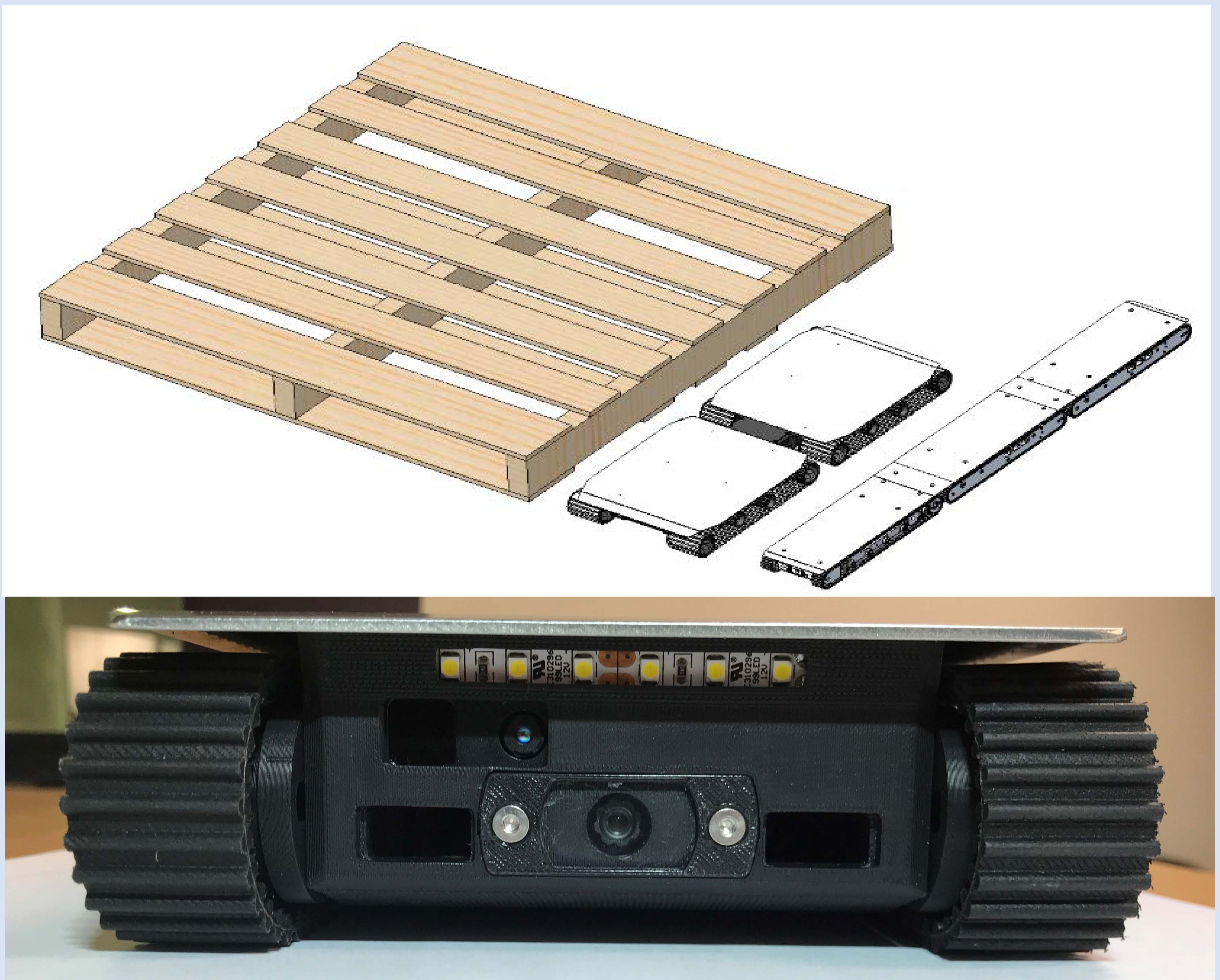

FIG 2. a) Size comparison of in pallet system (Standard pallet, v1.0, v2.0.)
b) front view of v2.0 (1200mm x 150mm x 55mm)

FIG 1. a) Waste storage facility, b) Top of drums in storage facility

METHODS

LOCOMOTION

The systems have to be able to traverse through the environment. For the in pallet robot it must be small and skinny and be able to move between pallet to pallet which means a potential gap and alignment. The above drum robot must be able to drive without adding excess stress onto the drums.

FAST FAIL

Fail fast is a systems design principle which encourages rapid prototyping and frequent testing to identify flawed processes or designs. We utilised this methodology to develop our robots which has proven invaluable for the unknown environment that it will be in.

PREVIOUS EXPERIENCE

Utilizing components that we have used previously is critical to the success of this project and allows us to focus on the other challenging aspects.

ROBOTIS OPERATING SOFTWARE (ROS)

ROS is an open source software that connects you to drivers and software that has been used by the whole community. This means you can quickly add new sensors to evaluate and replay and record the information for further processing.

OUTCOME

The key outcome which encapsulates the work presented in this paper is the capability to rapidly design and build deployable robotic platforms for a complex environment (FIG 2). The design methodology in combination with in-house expertise, rapid prototyping techniques and standardised software, enabled the development of a practical, field deployable robot in less than one month. In under 6 months, two platforms have been developed and are being prepared for a second field test, where the focus will shift from mechanical design validation to sensor system testing. Continued development will see these systems capable of driving in and around drum storage facilities to map and monitor the state of the infrastructure and waste contents. As we continue the project the systems will provide further insights and will be a tool that can be used in many similar facilities around the world.

CONCLUSION

- Example of rapid prototyping design and build of deployable robots for customized robots for nuclear store applications
- System has enabled information about the state of the store that has not been looked for decades.
- CSIRO Robotics and Autonomous Systems Group has technologies that can be deployed as components to the system.
  - 3D Real-Time Lidar SLAM – position and 3D point cloud
  - Customised robotics for real-world applications
- We are continuing the work here and currently have a team deploying the system.