Development of A Robotic System for Large Diameter Sewers

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PROJECT DESCRIPTION:

Motivation & Objectives

The Deep Tunnel Sewerage System (DTSS) is designed to meet Singapore's needs for used-water treatment, reclamation and disposal. As a preventive measure, regular inspection of the tunnel's corrosion-protection lining is required. This project focuses on the design of the mobile robot, the on-board sensing system and the umbilical system. The robot has to cope with conditions such as flowing water and sediment. The prototype will be test bedded within a large diameter trunk sewer.

Methodology

Robotic Platform and Communication Architecture

The robotic platform comprises of the base plate, wheel frames, hub-motor wheels, an inspection array, drawbar and two water-resistant enclosures. The enclosures are equipped with the necessary cable glands for easy and fast connection or disconnection. An Ethernet based communication system is used with a single Ethernet cable spanning the robot and control station. This reduces the size of the communication tether, allowing easier deployment. The Robotic Operating System (ROS) at the control station serves as the middleware software stack to support communication via the RQT user interface framework. The software framework at the control station is shown in the figure below.

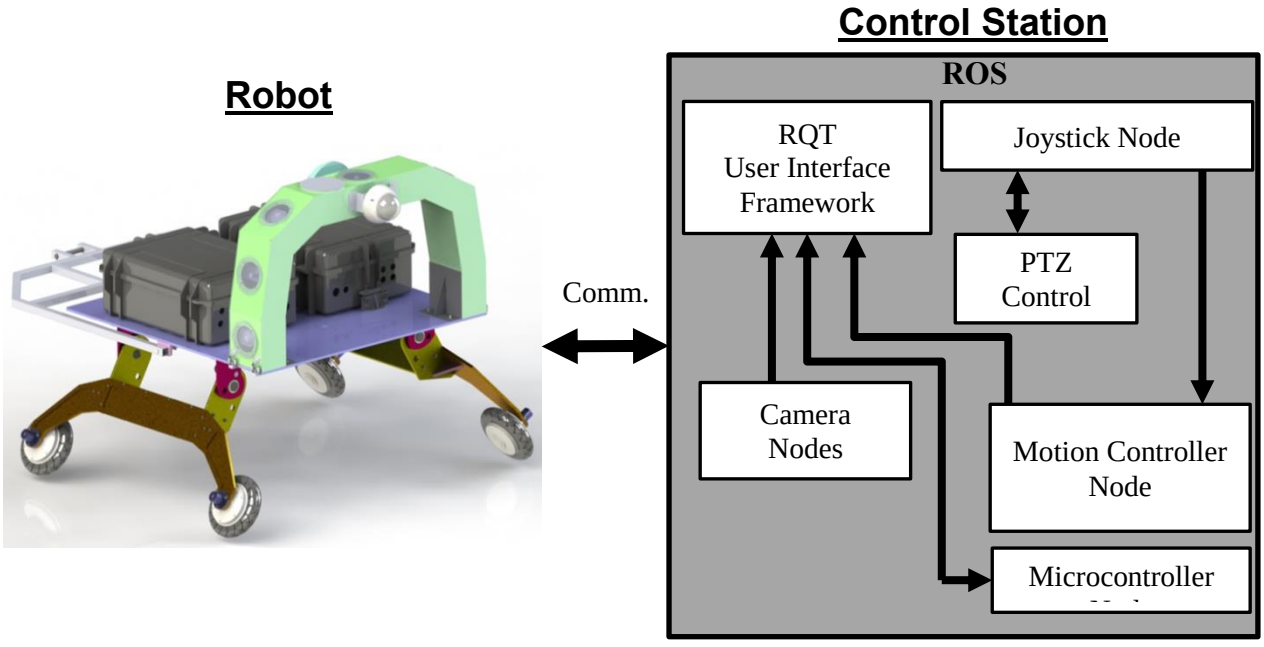

Figure 1: Communication Architecture of the Robotic Platform

Hoisting and Inspection System

The robotic tunnel inspection system consists of a number of hardware modules:

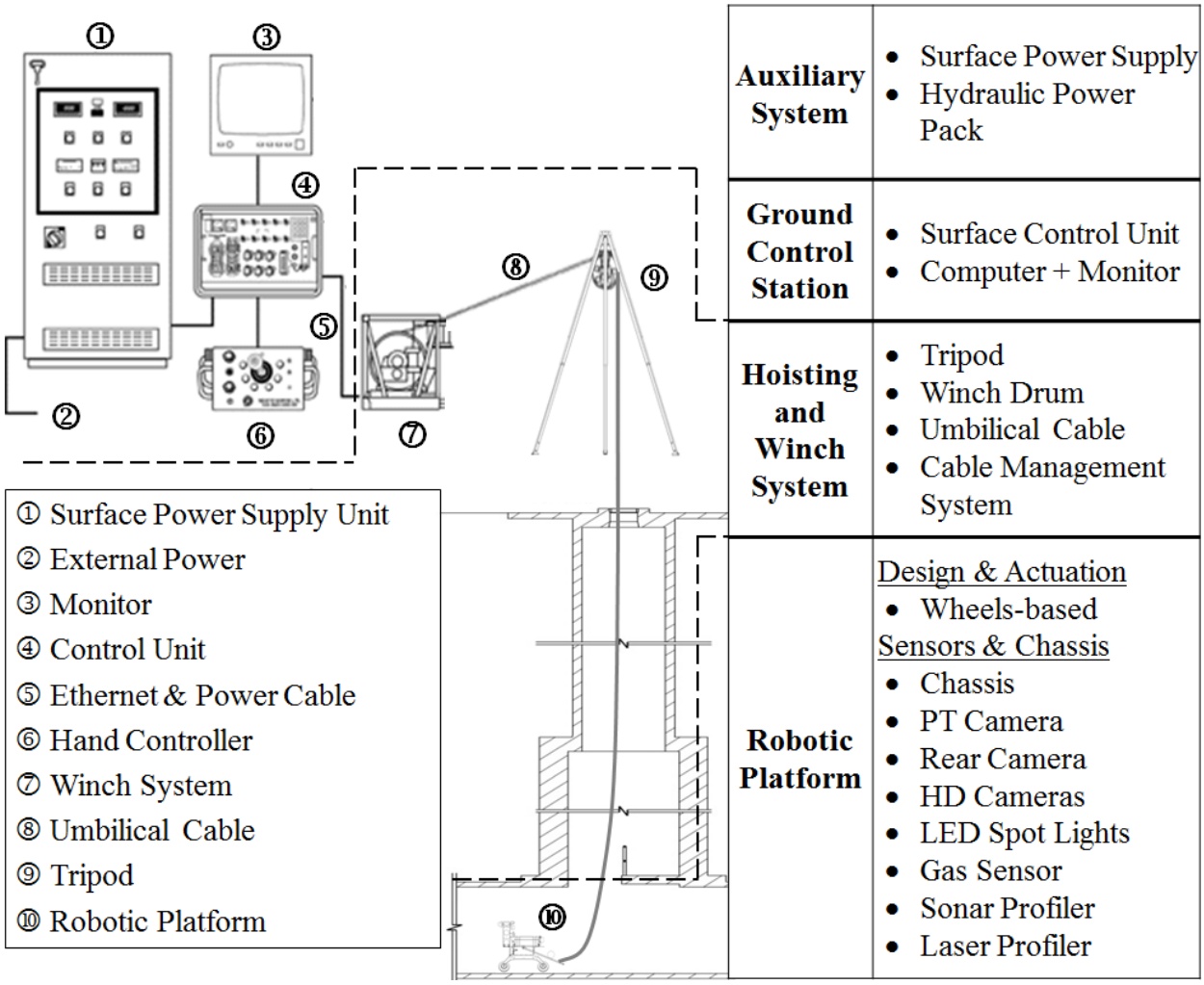

Figure 2: Hoisting and Inspection System

1) **The auxiliary system**. This module provides electrical power to the winch and the robotic platform.
2) **The ground control station.** This module houses the displays showing data from the robot's on-board cameras and sensors, as well as control devices for robot-operation.
3) **The hoisting and winch system.** This system performs operations for lowering and lifting the robot via the vertical access shaft. A length encoder is installed on the cable management system to determine the robot's distance downrange.
4) **The robotic platform.** The robot has its own actuators and houses various sensors needed for inspecting the sewer tunnel. Cameras on board capture the images of the tunnel. A laser profiler scans the tunnel surface while gas detectors sample the air for concentration of dangerous gases. The diagram in the next page shows the current prototype.

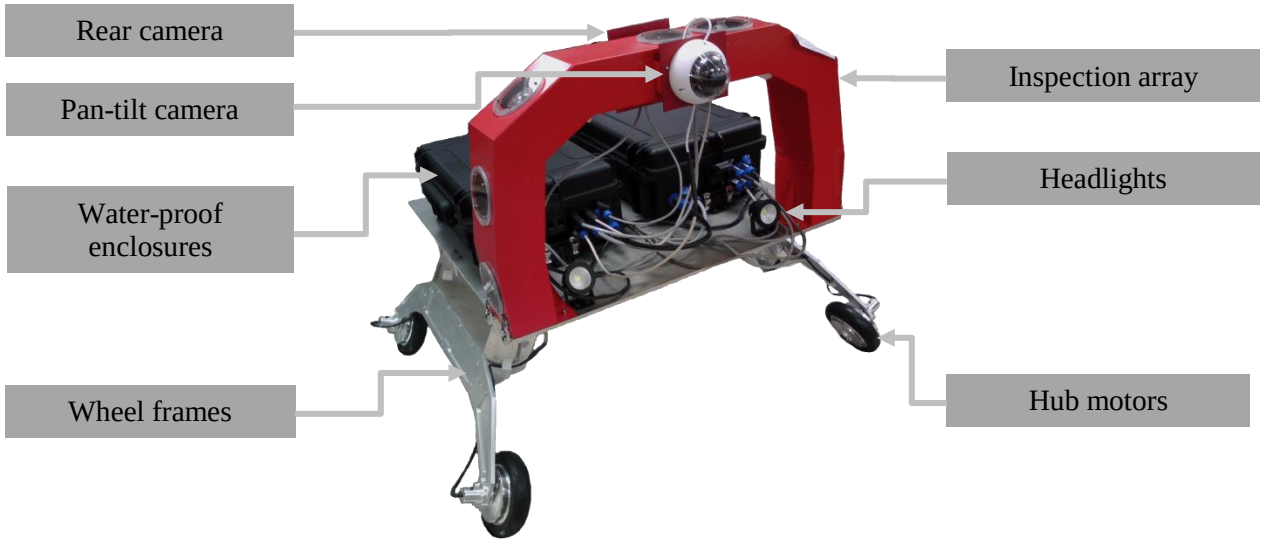

Figure 3: Prototype of Robotic Platform

Results / Progress

A prototype of the mobile platform as well as the control software and user interface have been developed for test bedding within the large diameter trunk sewer.

GRANT:

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