



# Automated Cucumber Harvesting

Request for Proposals: Pipe Rail Cart Subsystem

October 29, 2020

**Vineland Research and Innovation Centre** 



# Table of Contents

1. Project Background	1
1.1 Cucumber Harvesting Project	1
1.2 Pipe Rail Cart System	1
2. Project Scope	1
3. Project Requirements	2
4. Terms and Responsibilities	3
4.1 Consultant Responsibilities	3
4.2 Project Management	3
4.3 Deliverables	3
5. Selection Process	4
5.1 RFP Submittals	4
5.2 Selection Criteria	4

# 1. Project Background

#### **1.1 Cucumber Harvesting Project**

The Automation Group at Vineland Research and Innovation Centre is currently developing an automated cucumber harvesting machine for application in greenhouse environments. The system is comprised of a variety of imaging sensors, electronics, manipulator, and endeffector that traverse greenhouse environments for the purpose of fruit harvesting. During harvesting operations, the system is required to traverse on rails already installed on the ground between rows of plants. When not harvesting, the system is required to traverse along flat concrete flooring. This is the standard approach for most vegetable greenhouses, where manual push-carts and electric trolleys are designed to operate on flat concrete flooring as well as on rail systems. Heating pipes installed along the floor between rows of plants serve a dual purpose as rails for these carts and trolleys, and are often referred to as "pipe-rails".





Figure 1: Example of pipe-rail trolleys/carts in a vegetable greenhouse environment.

#### 1.2 Pipe Rail Cart System

The pipe rail cart subsystem is comprised of the overall conveyance system capable of traversing both flat concrete flooring and pipe rails as well as all the requisite support materials and mounting points for onboard equipment (sensors, manipulator, electronics, etc.), control electronics, communications, computing, power supply, etc. The cart interfaces with the overall control systems to provide the automated machine with the ability to govern the cart via software.

# 2. Project Scope

The overall scope of this project to provide the entirety of the cart system including all requisite electronics, mechanical systems, and software to allow the cart to move autonomously through a greenhouse space based on software instructions provided by the overall control system. The technical scope of the project includes (but not limited to):

- Design, manufacturing, and assembly of all requisite components for the autonomous pipe rail cart:
  - Governing Software
  - Communication Interface for System Controller
  - Electromechanical systems
  - Mechanical Systems
  - Mechanical mounting points for system components:
    - Electronics
    - Sensors
    - Manipulator
    - Cabling
    - Other Items
  - Safety requirements and required certifications
- Any additional items or tasks not mentioned.

Note that the technical scope of the work is intended to be flexible. At the very minimum, the required deliverable is a pipe-rail cart that may be controlled (forward/reverse speed) manually using standard control interfaces (buttons, dials, etc.) as well as controlled via computer connection (over WiFi, Ethernet, etc.). Additional capabilities such as dead-reckoning localization via sensors (wheel encoders, tracking cameras, etc.), a more complete simultaneous localization and mapping capability, autonomous traversing with obstacle avoidance, and so on, may be negotiated based on time and budget constraints.

# **3. Project Requirements**

These requirements provide some initial insight but may be subject to change and may also be negotiable through the tendering process.

3.1 Cart shall possess the ability to traverse both pipe rail and standard flooring.

3.2 Pipe rail cart shall have internal governing software to safely operate and navigate within a greenhouse setting

3.3 Pipe rail cart shall have suitable ingress protection for operation within a greenhouse environment.

3.4 Cart shall be able to fit within cucumber rows.

3.5 Cart dimensions to not exceed the operating envelope as defined by Vineland supplied layout of operating environment

3.6 Cart to have granular speed control.

3.7 Cart shall provide communication interface to overall system controller, providing the controller with pertinent real-time parameters of operation (i.e. speed, position).



3.8 Cart software and libraries shall be developed for integration into ROS (i.e., drivers for use in a Linux environment and/or a complete ROS package solution).

3.9 Cart shall be battery operated.

3.10 Cart shall provide power to auxiliary systems (sensors, manipulator, etc.).

3.1 Pipe rail cart shall provide mounting points and hardware for all requisite systems and components in a configuration provided by Vineland:

# 4. Terms and Responsibilities

#### 4.1 Consultant Responsibilities

The selected consultant will be responsible for ensuring that the delivered system complies with all laws and regulations that govern the operation of the cart in the selected environment.

The consultant will be responsible for procuring any requisite certifications for use of the system in the selected environment.

At the conclusion of the project the consultant shall transfer all rights to all designs, including but not limited to:

- Mechanical CAD
- Source code
- Electronic and electrical schematics
- Safety requirements and required certifications

#### **4.2 Project Management**

The consultant shall provide Vineland Research with the following schedule of management responsibilities and duties:

- Monthly update reports inclusive of project status, timeline, budget, and risk.
- Bi-weekly update meetings and follow up meeting minutes

#### 4.3 Deliverables

Note that these deliverables may be subject to change based on the agreed upon design requirements.

- Fully functional pipe rail cart that meets the agreed upon requirements and specifications.
- Mechanical systems and mounting points for auxiliary components as listed in the requirements and defined in Vineland supplied drawings.
- System software and libraries to allow for control of the system by way of onboard Ubuntu computer running ROS.
- Soft copies of all design files as defined in 4.1 Consultant Responsibilities.
- Assembly and operation manuals.

• Design reports.

### **5. Selection Process**

#### **5.1 RFP Submittals**

Bidders must supply at minimum the following information and documentation to be eligible for the selection process:

- Project work structure breakdown
- Project timeline and milestones
- Proposed project personnel
- Project budget (effort, prototype equipment, consumables)
- Conceptual Design:
  - Mechanical
  - Software
  - Control
  - Electrical
- Examples of similar past projects

Please submit a proposal that includes various levels of complexity and capability as described in the scope (section 2) and indicating cost and timeline for each:

- Basic pipe-rail cart with manual and computer control of forward/reverse speed on pipes, power supply, communications, etc.
- Additional dead-reckoning localization capability.
- Additional full simultaneous localization and mapping capability.
- Additional autonomous guidance, navigation and control capability.
- Additional autonomous obstacle avoidance capability.
- Any other additional features that may be desirable.

Requests for information may be submitted via e-mail to <u>kyle.crawford@vinelandresearch.com</u> with the subject heading *RFI: Pipe Rail Cart*.

#### **5.2 Selection Criteria**

Vineland will judge applicants based on the above submittal requirements with emphasis placed on a proven track record in delivering successful projects of a similar nature.

#### **5.2 RFP Process**

Stage	Stage Name	Date	Note
1	Launch RFP	November 20, 2020.	
2	RFI Deadline	December 4, 2020.	
3	RFI Response Deadline	December 11, 2020.	
4	RFP Submittal Deadline	January 4, 2021	
5	Selection Deadline	January 15, 2021.	
6	Signing of Contract	January 22, 2021.	
7	Project Kickoff	February 1, 2021.	

Vineland Research and Innovation Centre 4890 Victoria Avenue North, Box 4000 Vineland Station, ON LOR 2E0

tel: 905.562.0320

vinelandresearch.com

vinelandresearch.com







