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ROBOTIZED SERVING OF AUTOMATED WAREHOUSE – QUEUED MESSAGE HANDLER (QMH) SOFTWARE ARCHITECTURE

Training Module Developer version

www.trinityrobotics.eu

The TRINITY project has received funding from the European Union's Horizon 2020 research and innovation programme under the GA 825196

Introduction

- Fully functional, scaled-down, table-top model of an automated warehouse served by an omnidirectional mobile robot.
- Used as an attraction in exhibitions.
- The goal is to demonstrate the capabilities of mobile robots in intralogistics.

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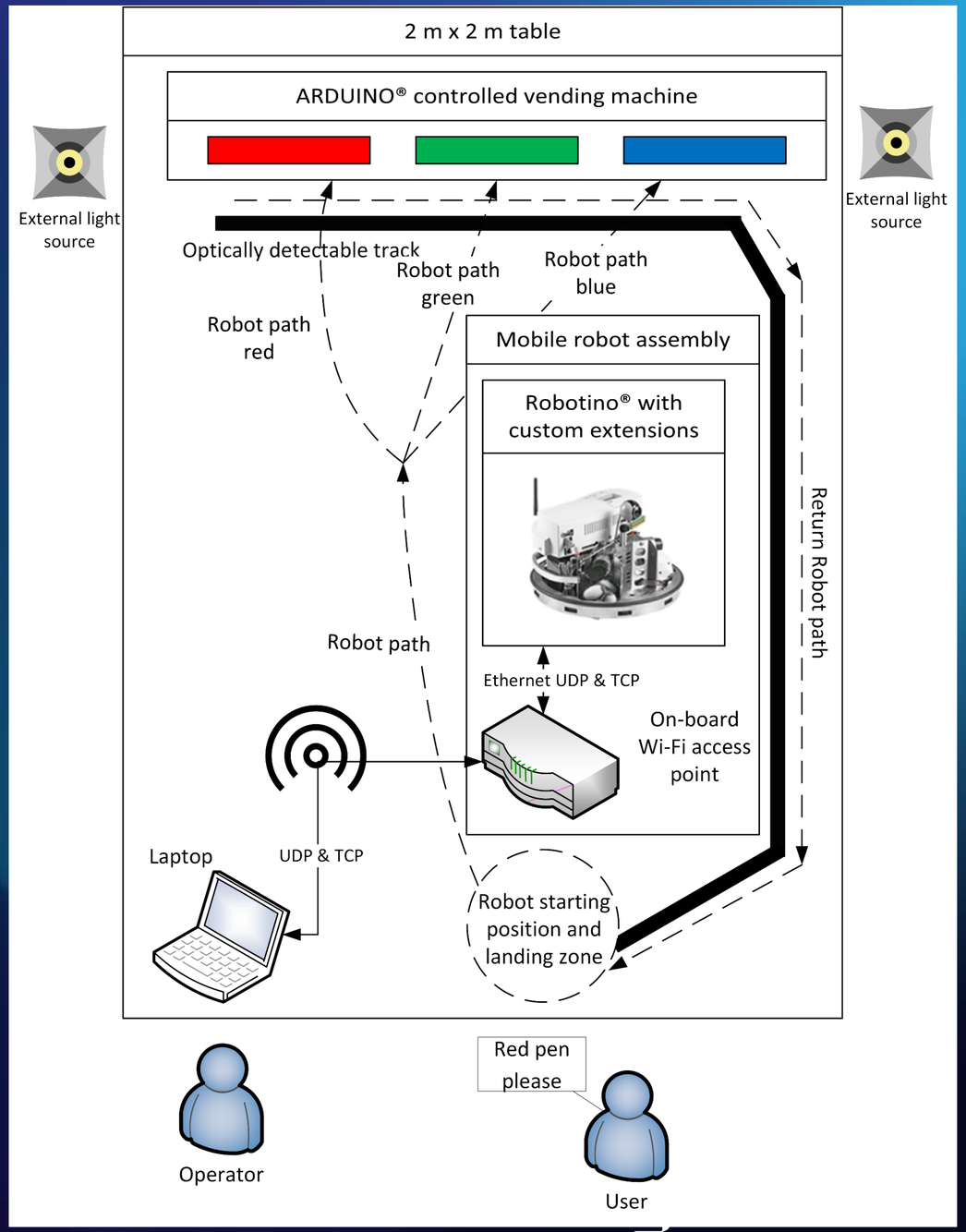
System design

- Based on an omnidirectional mobile robot equipped with three omni-wheels.
  - Kiwi drivetrain
- The automated warehouse is modeled by a pen vending machine operated by a microcontroller.
- The vending machine has 3 slots for holding 3 differently colored pens
- Serving one pen at a time.



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Hardware infrastructure

- FESTO Robotino®
- Uniquely designed parts
  - Workpiece tray,
    - Bent sheet metal part accommodating the workpiece during the wending process.
  - ARDUINO® controlled vending machine,
  - Proximity switch holder,
    - Bent sheet metal part holding in place a factory standard optical proximity switch accessory to detect the proximity of the wending machine during the final approach.
  - Optically detectable path
    - Painted or glued tape.
- Commercially available parts
  - 4 m^2 wooden flooring,
  - Two standard light sources on a tripod,
  - Laptop with Microsoft Windows® operating system.

Image Source: https://www.festo-didactic.co.uk/gb-en/learning-systems/education-and-research-robots-robotino/the-highlights.htm?fbid=Z2luZW4uNTUwLjE3LjE4Ljg1OC40NzUy

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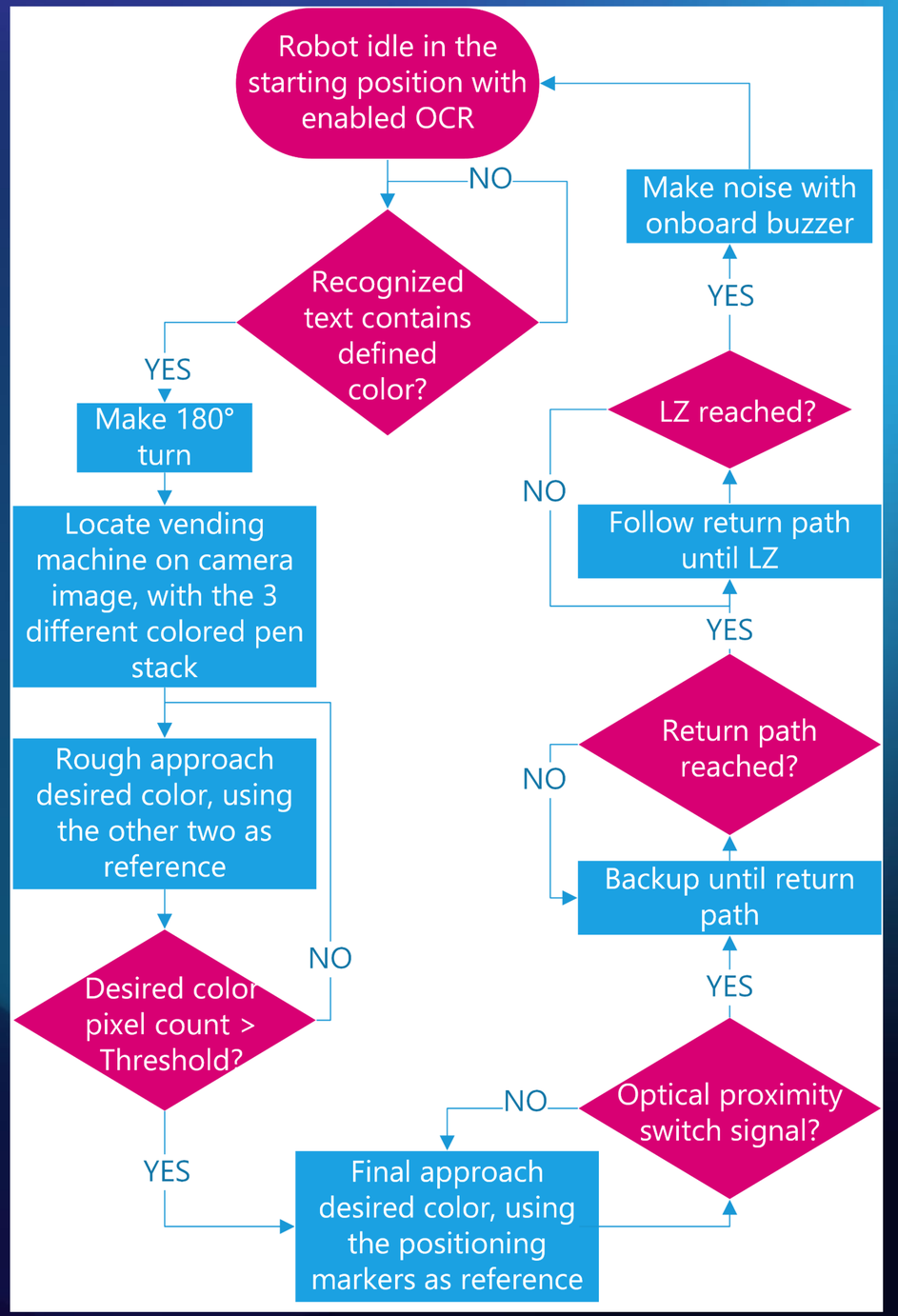
Software infrastructure

- The complete robot control software is made with National Instruments LabVIEW™ graphical programming language



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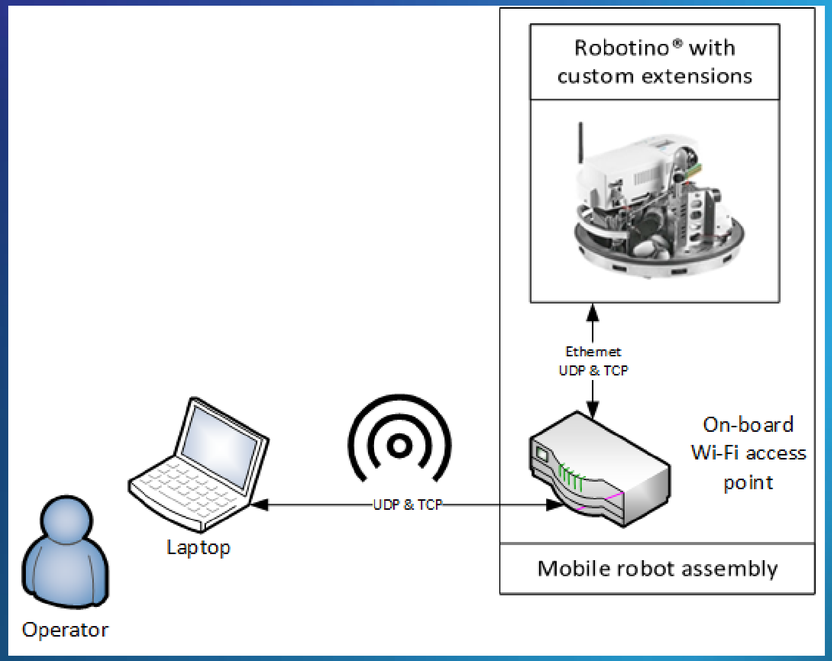
Cyber-security

- Closed system with no need for access to the internet.



Vulnerabilities	Mitigation
Control laptop security: if the laptop is online for any reason	Completely prevent control laptop internet access
Wireless encryption	Already has WEP, will be changed to WPA
Wireless router security key issue	MAC address filtering on the wireless network. AP only accepts allowed MAC addresses
Interference caused to wireless communication	
DHCP service	Disabling the DHCP server, only fix IP addresses will be allowed
The qDSA protocol is open source and publicly available	
No encryption implemented in the qDSA protocol	
The mobile robot enables a secondary connection in spectator mode and sends the camera image and feedback messages to the spectator	

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Module description

- Organises the whole software in separate tasks
- Executes them in parallel at different execution rates
- Based on the Queued Message Handler Template
- Customised for the Use Case demonstration

Queued Message Handler Template documentation available at http://www.ni.com/tutorial/53391/en/

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Module description

- Made with National Instruments LabVIEW™ graphical programming language
- The QMH template facilitates multiple sections of code running in parallel and sending data between them.
- Each section of code represents a task, such as acquiring data and is designed similarly to a state machine

Queued Message Handler Template documentation available at http://www.ni.com/tutorial/53391/en/

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Module description

- The QMH template is a version of the Producer/Consumer design pattern, where the user interface (producer) produces messages and the tasks (consumers) consume them

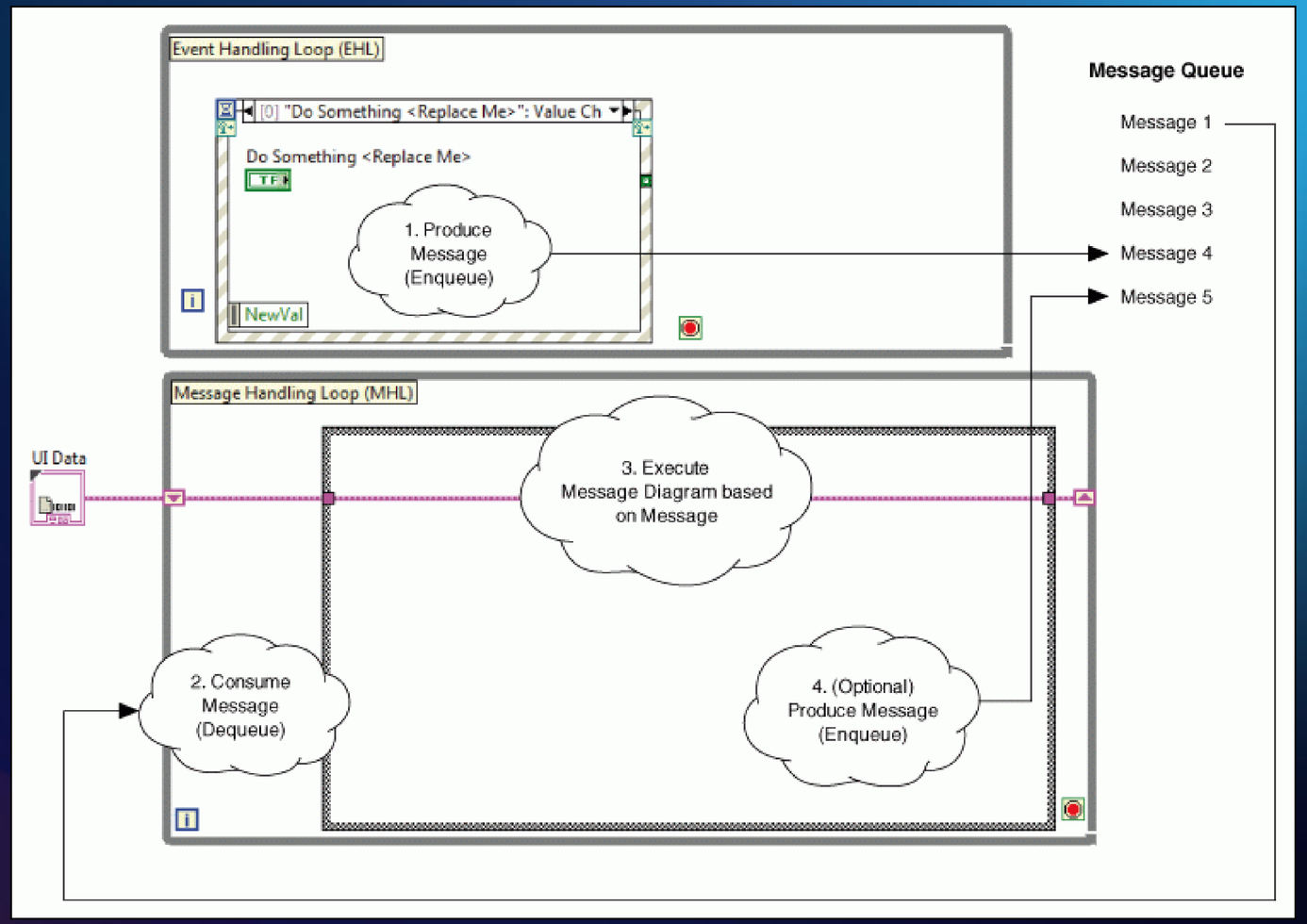

Image source: http://www.ni.com/tutorial/53391/en/

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Module description

- Can be used with any computer that complies with the LabVIEW™ system requirements
- No further inputs or outputs are required for the operation of this module.
- This module is the interface between the end-user and other parts of the robot control software.
- An end-user can operate the robot control software through a user interface.

System Requirements for LabVIEW Development Systems and Modules: http://www.ni.com/product-documentation/53740/en/#toc1

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Thank you!

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