Project Proposal - Automated Guided Vehicle (AGV) Item+Message Carrier

ELEC3848 – Integrated Project Proposal (F5-C)

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Introduction

Our proposed function for the Autonomous Guided Vehicle (AGV), on top of the pre-existing required functions such as car assembly, car alignment and data transfer, will seek to implement an Item and/or Message Carrier System. That is, an autonomous robot delivery system.

Application

An autonomous delivery robot system has a variety of real-life, practical applications across diverse industries, a notable example would be inside that of a workshop. In this context, a user can seamlessly designate a specific item for automatic retrieval, whilst simultaneously avoiding obstacles, then upon user request, the robot retrieves the specified item, showcasing its capability to navigate through environments with precision.

In instances where the item's size necessitates manual placement, the end user, such as an inventory clerk, may load the item into a compartment after reading a message of the required item.

Simple Schematic

The following simple, rough sketch encapsulates the essence of our idea (likely subject to revision):

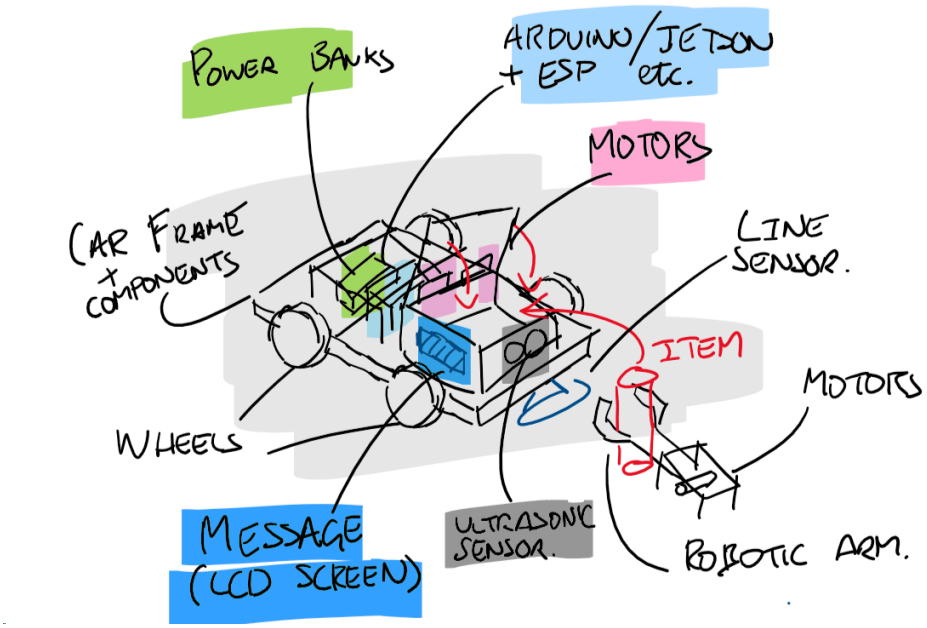

Figure 1: Simple schematic of the AGV Message+Item Carrier

It is a rough sketch that encapsulates the essence of the AGV's design, showing the integration of the different modules and components needed for its operation.

In the center of it, the AGV can be seen as a compact, multi-component vehicle. It features a set of wheels for mobility, suggesting a robust mobility platform capable of traversing different environments within a workshop.

At the core of the vehicle's control system, there is the NVIDIA Jetson Nano microcontroller which acts as the brain of the AGV, processing inputs from various sensors and managing the operations of motors.

Surrounding the microcontroller block are the other labeled components:

Power Banks: Provide power to all electronic and motorized components.

Motors: Represented on two sides of the vehicle, indicating propulsion and steering mechanisms, allowing the AGV to move and turn, and another one that will ensure operation of the Item Compartment Mechanism.

Line Sensor: A sensor placed at the front, which will be used for line following on the workshop floor, aiding in navigation.

Ultrasonic Sensor: These sensors are used for obstacle detection, helping the AGV avoid collisions as part of the Navigation and Obstacle Avoidance (NOA) System, as well as Item detection for a proper automated operation of the Item Compartment Lid Mechanism.

Robotic Arm: A mechanical appendage used for picking up and placing items, pivotal to the AGV's functionality as an item carrier.

Item Compartment: A space or compartment marked out as a place to store the items that the AGV is meant to carry, demonstrating the previously mentioned item compartment mechanism.

Message (LCD Screen): This screen could display messages or statuses of the AGV, such as the inventory or nature of the item being transported.

The AGV incorporates the aforementioned NOA System for navigation and obstacle avoidance, CCI System for communication and control interface, and an automatic pick-up system for handling items without manual intervention. This integration showcases the AGV's multidisciplinary design, combining mechanical, electronic, and software components to correctly perform its duties.

Modules

1. Navigation and Obstacle Avoidance (NOA) System (Aaron)

A NOA system for a robotic platform typically consists of several primary components and functionalities to enable the robot to move through its environment while avoiding obstacles as

aforementioned. The following elements are typically employed (excluding components already included in required function):

Obstacle detection sensors (ultrasonic sensors, infrared sensors, etc.) to detect obstacles in the robot's path.

Navigation algorithm to determine the optimal path, common approaches include Dijkstra's Algorithm or A* algorithm, or any other algorithms required (subject to investigation).

Mapping system, mapping algorithms and tools to create and update a map of the robot's environment, to aid in navigation and obstacle avoidance by providing a reference for the robot's location/obstacles.

Collision Avoidance Mechanism, to adjust the robot's trajectory or stop it altogether when an obstacle is detected, preventing collision.

2. Communication and Control Interface (CCI) System (Peter)

A CCI system for a robotic platform typically comprises various key components and functionalities to facilitate communication and control as previously mentioned. The following elements are commonly utilized (excluding components already inherent to the required function):

Interface protocols and modules for communication between the robot and external devices or systems.

Control algorithms to regulate the robot's actions and responses based on received commands or feedback.

Feedback mechanisms for providing real-time information to operators or external systems regarding the robot's status and performance.

Error handling mechanisms to address communication disruptions or system malfunctions effectively, ensuring robust operation.

3. Vehicle setup + Item Compartment Mechanism (Jorge)

This module aims to enhance the AGV's functionality by enabling it to not only navigate and communicate effectively but also to interact physically with the items it is designated to transport. This involves mechanical, electronic, and software components to ensure efficient and reliable operation.

Vehicle Setup: The vehicle setup includes the design and configuration of the AGV's physical structure and its propulsion system such as **motor selection** to provide the necessary speed and torque, considering the expected load, implementing a reliable **power supply** designing a **chassis** that supports all the AGV components, including navigation sensors, communication modules, and the item compartment, ensuring stability and durability.

Item Compartment Mechanism: The item compartment mechanism is crucial for the AGV's role as a delivery system. This module must be designed to accommodate items of various sizes securely and facilitate easy loading and unloading. Key considerations include:

Modular Compartments: Implementing adjustable or modular compartments to handle items of different dimensions, enhancing the AGV's versatility.
Automated Doors: Using sensors to control compartment doors, enabling automatic opening and closing for loading and unloading items.
Secure Fastening: Incorporating mechanisms to secure items during transport, preventing damage or displacement.

4. Automatic pick-up system (Jacky)

This system aims to enable automatic loading and transportation of small goods at destined positions. When the AGV arrives at the loading zone, the sensor reads how long the AGV stays and interprets whether to load the goods or not. Robotic arm driven by servos will load the goods onto AGV once “load” signal is given. Key elements employed:
Robotic Arm: Driven by an arm servo and a gripper servo. Performs transportation of goods by gripping and moving the arm in vertical-circular motion for 180°.
Automated System: Using sensor to check whether AGV stays for loading or just passes by. Load signal is sent if AGV stays at loading position for 3 seconds.

Weekly Milestone Plan

Subject to revision. Week 1 starts from 11/03/24 (Monday).

- **Week 1:** Design and procurement of self-proposed function, assembly of required function.
- **Week 2:** Continued assembly of required function + required function submission (Due 21st March) and programming.

- **Week 3-4:** Dedicated to NOA system, CCI, and item system, etc.
- **Week 4-7:** Continued development, testing and any necessary adjustments.
- **Week 7:** Final demonstration (April 25th)

Budget List

1. Extra Servo Motors (~HKD 20 x 2): HKD 40
2. Extra IR Distance/Ultrasonic Sensors (~HKD 40 x 2): HKD 80
3. Assorted Mechanical Components + Prototyping Materials: HKD 100
4. (To be confirmed) Extra ESP8266: HKD 40

Total: HKD 260