Automated Material Cart

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Abstract

A line-following material cart has previously been in-use, within the health care industry, to deliver patient medicine, receive vitals, remove waste, and many other functionalities, without posing the risk of contracting diseases for medical personnel. It is becoming apparent that robotics will soon play a key role in aiding medical professionals with their everyday tasks, especially during this time of staffing shortages in healthcare workers. By providing hospitals with an autonomous robot to deliver meal trays to patients, medical personnel can respond to their patients with the necessary amount of care, while the robot delivers their food. In turn, the reduction of human traffic in-and-out of these patients' rooms will mitigate the spread of contagions within the medical facility as the more time spent in the vicinity of an infected person increases the risk of exposure [1].

Background

The healthcare industry has evolved significantly due to the Covid-19 pandemic. Protecting medical personnel from the potential risks of exposure, while ensuring patient care, has become a pressing concern. Due in part to the staffing shortage in health-care workers during this time, a revolutionary line-following material cart has been introduced to the healthcare setting. This autonomous cart handles tasks like medicine delivery, collection of vitals, and waste disposal, minimizing the need for human interaction while significantly reducing the risk of infections for medical staff. Building on the success of the line-following material cart, robotics in healthcare has been a field full of promise[2]. A key area of impact is the delivery of food trays to patients. By deploying an autonomous robot built to safe and efficiently deliver food trays, medical personnel can focus on other aspects of patient care. This ensures medical workers can give all patients the time and attention they need. Simultaneously, this robot can reduce staff exposure to infected patients. Curbing contagion spread and enhancing overall healthcare safety, satisfaction, and well-being.

Design

The finalized robot will have five tray compartments on conveyor belts that will push food trays onto the lift to then be raised to the height of the patient's table.

1. LiDAR sensor to detect objects and map its surrounding area for navigation.
2. Mecanum wheels and speed controllers for precise harmonic movement.
3. 12V motors and high torque gearboxes for movement under heavy loads.
4. IR sensors for efficient navigation to and from patient's rooms.
5. Ultrasonic sensors for obstacle avoidance.
6. NVIDIA Jetson Nano for system control programs using Python and ROS.
7. RoborRio2.0 for drive system control using C.
8. Motorized winch to lift meal trays to patient's bedside tables.

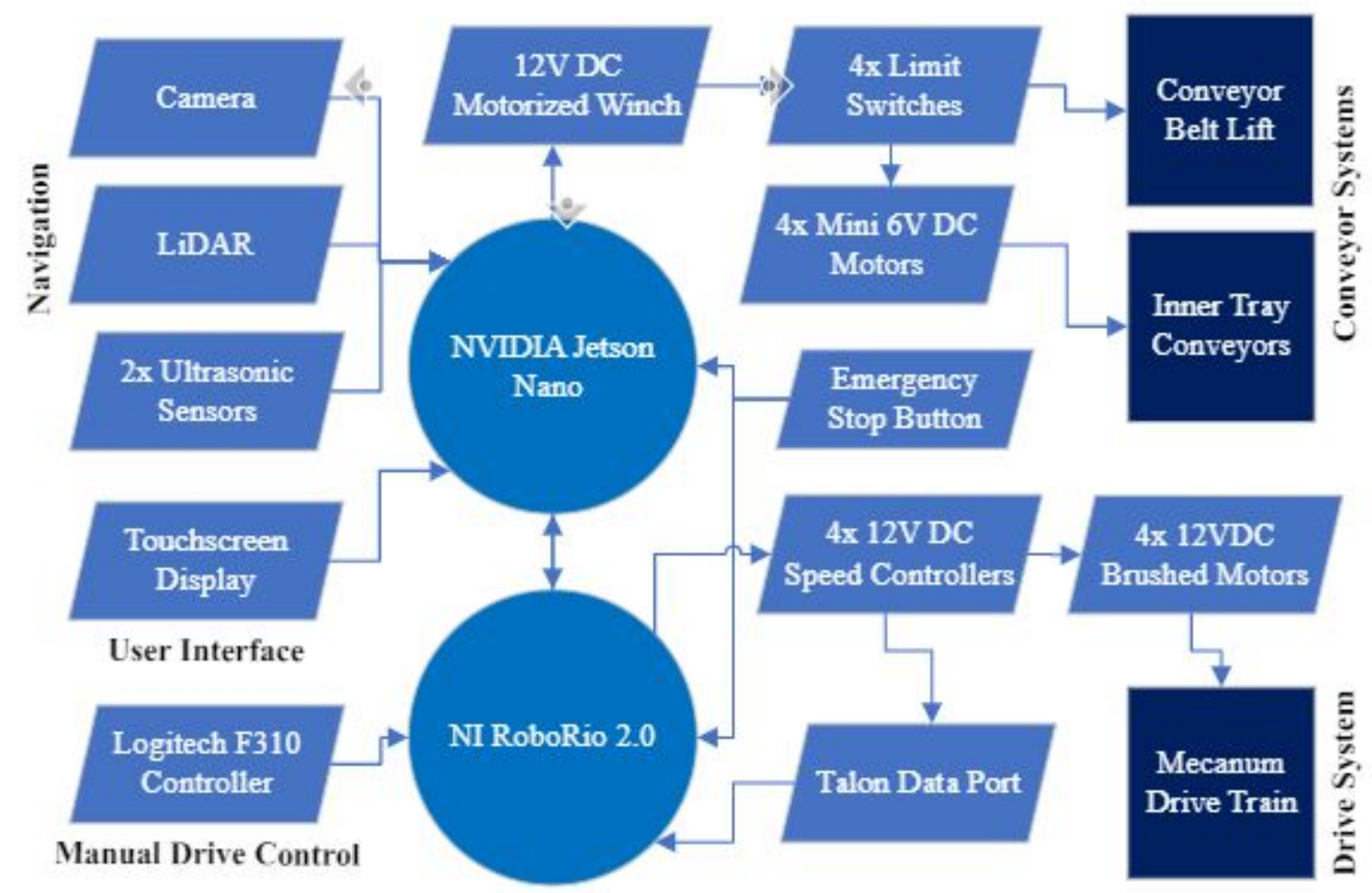

Figure 2: System-Level Diagram

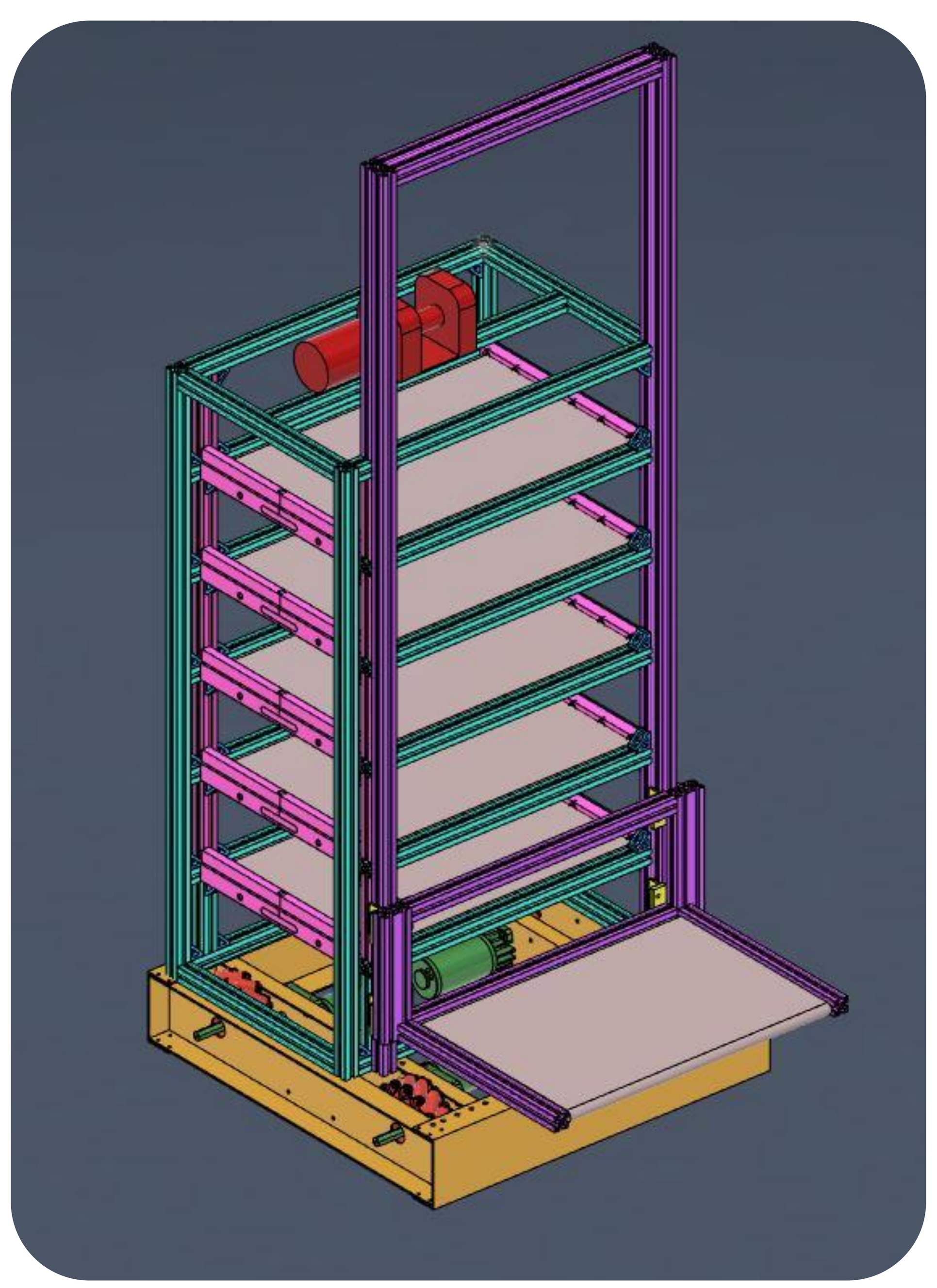

Figure 1: CAD Model

Data and Analysis

- The LiDAR sensor can detect walls, which it then maps within a 2D plane. The generated plane allows for effortless navigation through transitions in environments, like entering the hallways of a medical facility, while avoiding any potential obstacles.
- While this sensor is proficient at mapping its surroundings, it still has some difficulties with overlapping previous maps. If the LiDAR sensor is affected by a non-negligible vibration or if the orientation of its initial position changes, the data will become inaccurate.

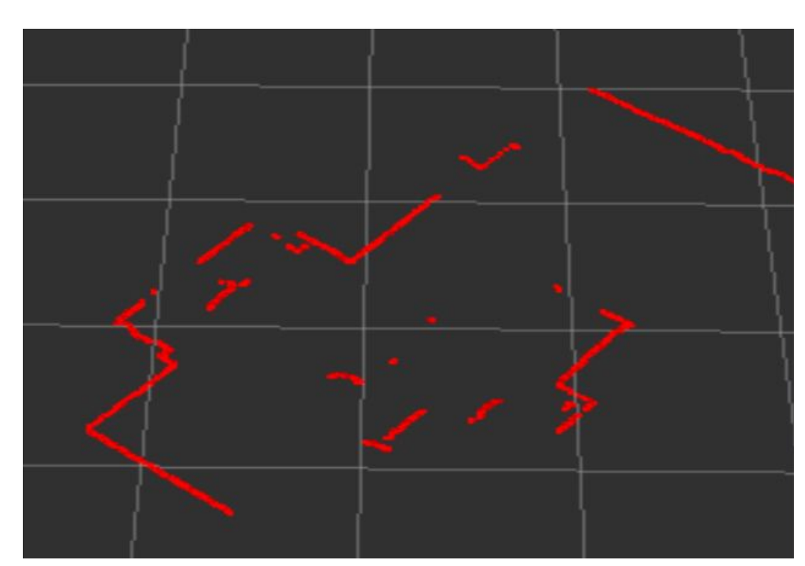

Figure 4: LiDAR wall map

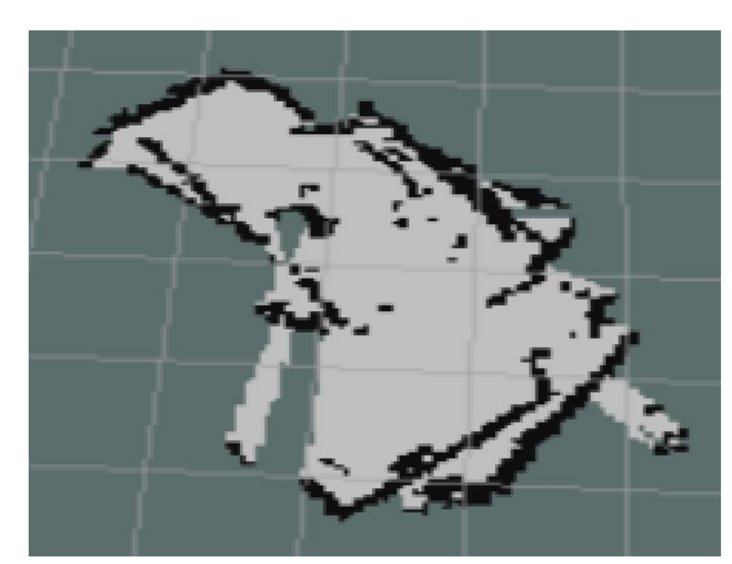

Figure 3: LiDAR generated map

Future Steps

- Fully autonomous navigation using LiDAR
- Line-following for direct navigation to the bedside table once room is entered.
- Increase number of conveyors for more patient trays.
- A garage-door based system to protect the food trays from carrying airborne illnesses
- Walls to protect the food trays from being exposed to airborne contaminants
- Design a system for the robot to scan a QR code to identify which tray is being offloaded to that room.
- Utilize LiDAR for fully autonomous movement.
- Implement ultrasonic sensors and limit switches into the speed controller data ports for advanced control.

Conclusions

The meal delivery robot represents a significant advancement in healthcare with autonomous robotics. The line-following material cart, equipped with IR sensors for navigation and ultrasonic sensors for obstacle avoidance, effectively addresses crucial challenges faced by medical professionals, particularly during the Covid-19 pandemic. The integration of the Nvidia Jetson Nano Developer Kit and mecanum wheels ensures efficient control and smooth motion, prioritizing safety and efficiency. Despite entailing higher costs, the innovative design substantially enhances patient care and reduces the risk of contagion spread in hospitals. This project exemplifies the transformative potential of robotics in healthcare, paving the way for future innovations that support medical professionals and enhance patient well-being.

Acknowledgements

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References

[1] Romero V., Stone W. D., Ford J. D., 2020, "COVID-19 Indoor Exposure Levels: An Analysis of Foot Traffic Scenarios Within an Academic Building," *Transportation Research Interdisciplinary Perspectives.*

[2] Kanade, Prakash & David, Fortune & Kanade, Sunay. (2021). Design and Implementation of Automated Cart for COVID-19 Patients Treatment. European Journal of Information Technologies and Computer Science. 1. 1-5. 10.24018/compute.2021.1.4.13.