Two pick and place collaborative robots

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AIMS AND OBJECTIVES

Aim:
Two collaborative robots that are intended to operate in an environment where humans coexist. These robots should be able to perform a pick and place task. These robots will avoid obstacles and move autonomously. Both robots will be masters.

Primary objectives:

•Research existing pick and place robots, collaborative robots, and their applications.
•Research algorithms that are used for path mapping with the aim to reduce power consumption.
•Research into network technologies that are suitable for wireless communication for collaborative robots using Raspberry pi.
•Identify system and user requirements.
•Design and 3D print the robot's chassis and components.
•Design and build the required circuitry for motors and sensors.
•Use test navigation in order to allow the robot to know where it is.

Secondary objectives:

•Use Robust Control Systems to help increase speeds of operation and reduce need for calibration to reduce cost of floor grid.
•Further develop path analysis tools and algorithms to reduce power and/or increase speed of operation.

METHODS AND MATERIALS

- Using Raspberry Pi Zero W as the main board for each robot. It has a WiFi module which will be used to control the wireless communication between both autonomous robots.
- L298N chip will be the motor controller used to control two 12V DC motors for each robots. It is a dual H-bridge to control both motor's direction and speed at the same time.
- Using UltraSonic sensors at the front of the robot which converts energy into ultrasound waves and measure the distance between the obstacle and the robot. It can be then displayed on a computer screen to track the robot.
- Using three servo motors that will be attached to the arm in order to control the arm movement in different dimensions, pick objects from one place to another.
- Figure 3 showing the design of the robot that was made using AutoCad to enable 3D printing for the arm and laser cut printing for the chassis.
- Battery holder to hold four AAA batteries and supply power to the robots
- Python IDE to program the raspberry pi (motors and sensors) and to write the A-Start Algorithm.
- Distance I-R sensors that will be implemented on the arm, those sensors will locate objects in specific zones which will trigger a mechanism to low the hand, search for the object, and hold it.

PROJECT WORK PLAN

	Year 2019				Year 2020			
	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
Research								
Hardware								
Software								
Testing								
Report								

References:

- **[1] J. Romeo. (2016). "Is Your Warehouse Robot Ready?" Available:** https://www.bath.ac.uk/publications/library-guides-to-citing-referencing/attachments/ieee-style-guide.pdf
- **[2] International Federation Of Robotics. (March 2018). "Robots and the workplace of the future" Available:** https://ifr.org/downloads/papers/IFR_Robots_and_the_Workplace_of_the_Future_Positioning_Paper.pdf

INTRODUCTION

There are many different warehouses that depend on collaborative robots to reduce the amount of interaction humans have with the products. This has transformed the warehousing business by bringing speed, accuracy, and signals to expedite order fulfillment through gathering, picking, packing, transporting, and sometimes shipping good and products. [ref1]

The robotics field is developing and increasing daily, new technologies are being introduced of more advanced engineering in the collaborative robots' field which will help cost reduction benefits.

Companies with big warehouses such as Amazon now have more than 100.000 warehouse robots that are used everyday in their warehouses around the world.

As companies continue to face competition in rapid turnaround time and perfect accuracy, collaborative robots need to be capable, flexible, and less expensive which has some challenges which will be discussed. [ref2[

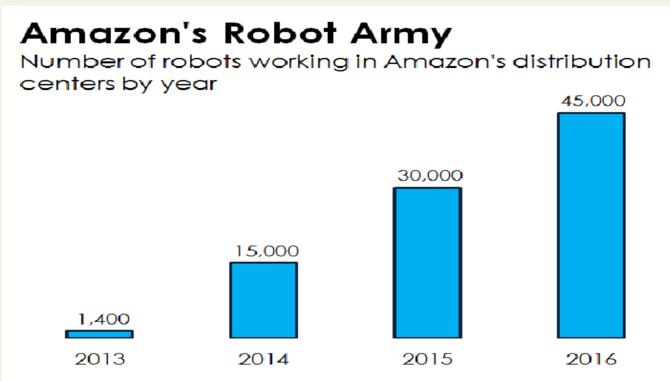

Figure 1: Robots working in Amazon's warehouses between 2013 and 2016

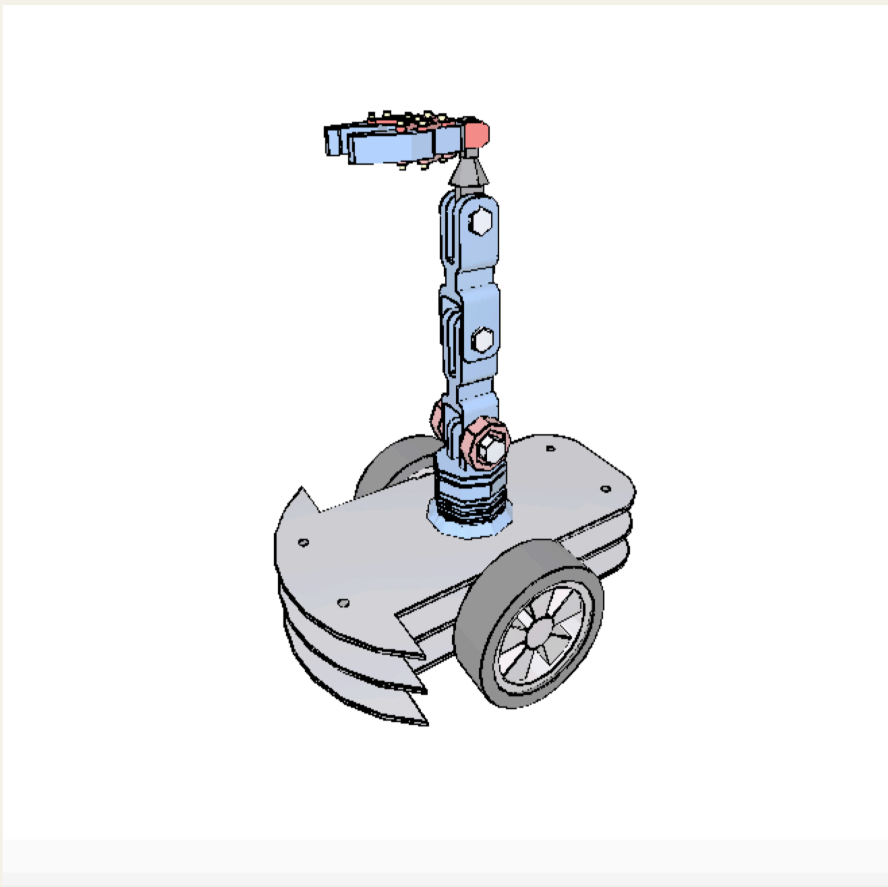

Fig 4: 3D design of the robot designed using AutoCad

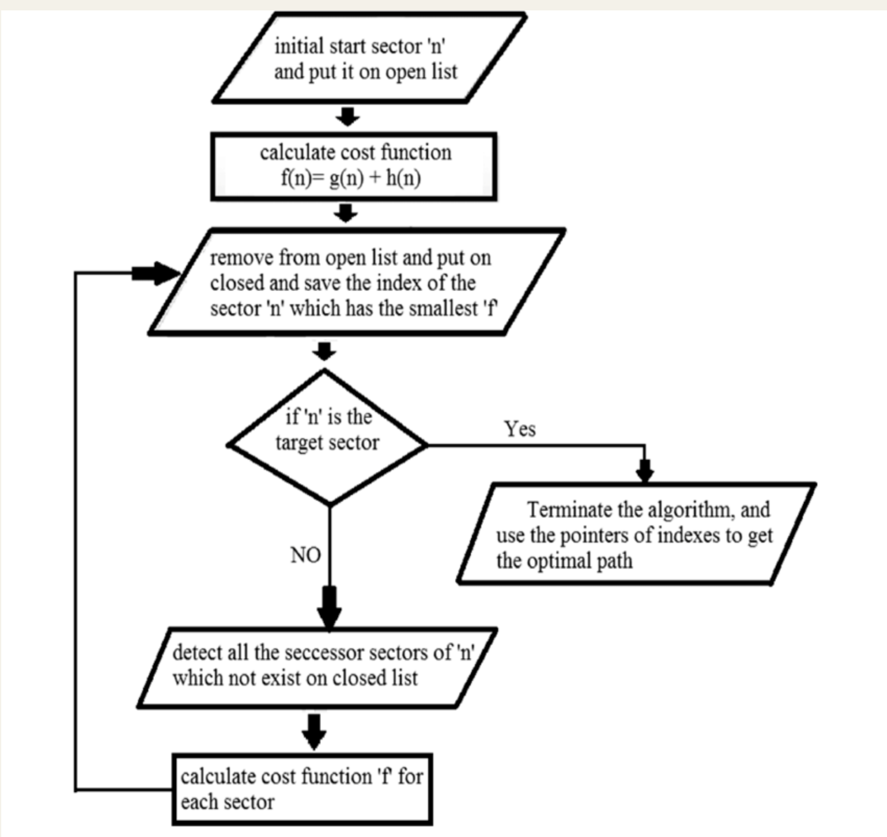

Fig 5: Code Flowchart for A Star path finding algorithm

ALGORITHMS AND TESTING

- The main objective of the algorithm is to find the fastest and shortest path between a start and an end point.
- Many algorithms were researched such as Breadth First Search, Dijkstra, and A-Star algorithm.
- The best algorithm choice is A-star algorithm due to its completeness, optimality, and efficiency.
- The testing grid in figure 2 below was created using "React" (Web Testing Page) that was built using JavaScript and HTML. The gird, starting, and ending points were created.
- The tested algorithm is Dijkstra's algorithm which is the father of pathfinding algorithms. It was coded using JavaScript. Green box represents starting point, black boxed represent obstacles, and red box represents ending point (Goal).

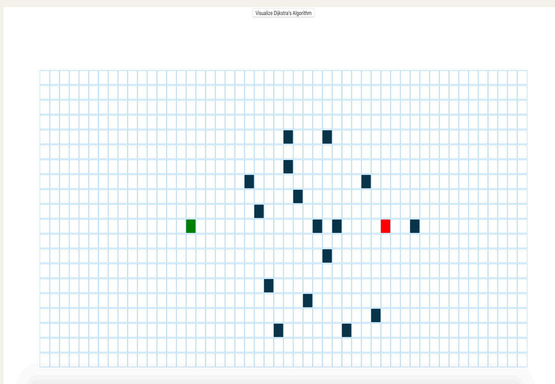

Fig 2: Start & End Point with Obstacles.

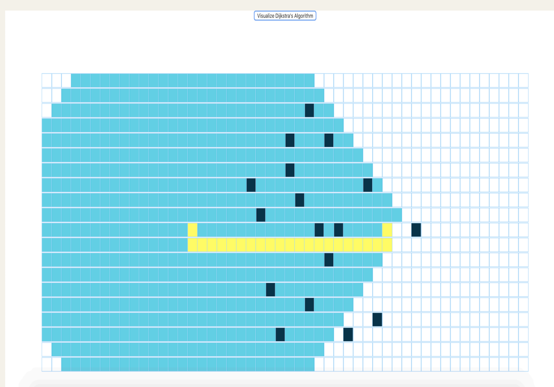

Fig 3: Result after running the algorithm.

ETHICS, HEALTH, AND SAFETY

- The ethical part regarding the pick and place collaborative robots is that they should be able to work in warehouses, which will result in the robots taking over human jobs, such as packaging, delivering, counting. According to Amazon, they installed two collaborative machines at dozens warehouses, removing at least 24 roles per machine. It resulted in 20% of the warehouses employees in the U.S to lose their jobs [ref 3]
- The safety part in this project is that those machines can be built in different sizes and power, those robots will be working in a human existing environment; therefore, safety of the robots around humans is important when it comes to moving objects, electric power, and speed / power of moving around the environment.
- Finally, the awareness environmental cost including disposable parts, batteries, and life cycle. As those robots should operate for hours in order to deliver all the work on time and with no delays which will cause problems with the customers.

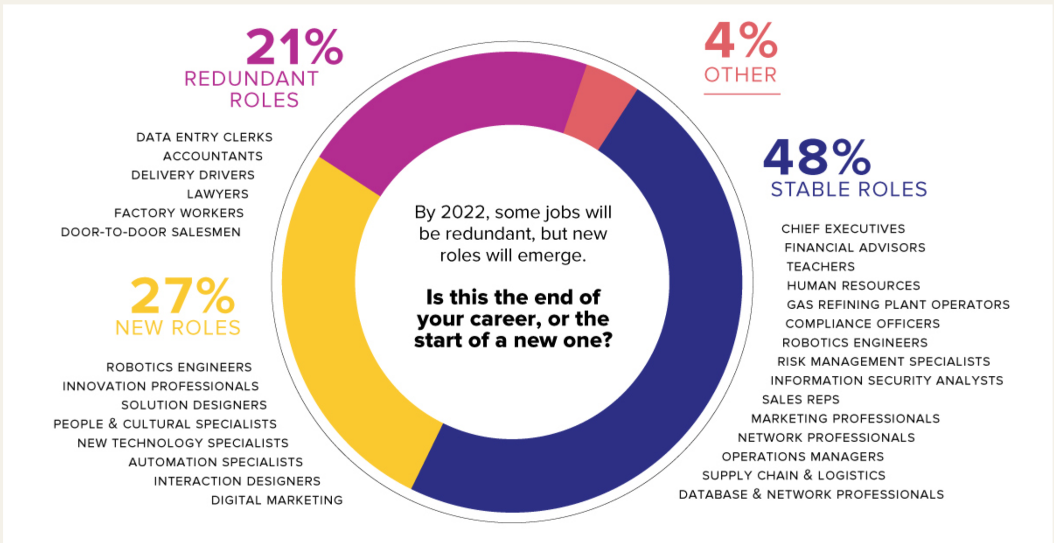

Fig 6: Robots effects on employees depending on roles.

CONCLUSION

After extensive testing of the algorithm on the grid that was created on the "React App", the Dijkstra algorithm was finally fully developed using JavaScript and was working perfectly in the simulation, it tested all the nodes in the grid then took the fastest path to the ending point which proves the function of the algorithm. The next step is to implement the A-Start algorithm using Python as it will be uploaded on the Raspberry PI to function the robot.

Regarding the hardware, Fitzing Software was used to simulate the circuit for both, the motors and the sensors. I have reached the correct connections for the circuit and are ready to implement all the connections physically.

Finally, the design in figure 4 was made using AutoCad. The arm will be printed in 3D printing and the chassis will be printed using Laser-Cut. The DC motors will be located on the base chassis along with the UltraSonic sensors. The Servo Motors will be implemented on the arm to control the arm movement along with distance IR sensors to find the objects and pick them.