A Review Paper on E-commerce Delivery Robot

Mr. P. Ravikiran[01], K. Venumadhav[02], B. Saiprasad[03], T. Venkatesh[04].

01- Assistant professor, 02,03,04-UG students, Department of Mechanical Engineering, Guru Nanak Institute of Technology, Hyderabad.

ABSRACT- The E-commerce delivery robot is meant to be a substitute for a goods delivery person. The delivery robot is capable of navigating through a cluttered space environment from a home location to a destination point while avoiding obstacles in the process. It uses an ultrasonic sensor to detect if anything has been placed inside the bin and only once when something is placed inside, the robot starts moving from a position to another.

Bluetooth beacons are used to represent the start, end and mid-point which will be used by the robot to differentiate the specified locations. Bluetooth beacons will act as a terminal for the robot to detect. The autonomous robot will move on an undesignated path i.e. an unmarked route unlike the archaic robots only capable of moving inside a marked black lane. The robot will be trained and multiple simulations are run on it with the help of the DonkeyCar library so it can successfully avoid obstacles and relay the path with efficacy, making the delivery fast and efficient. A Pi camera is used which will help rectify the unmarked desired path over which the robot has to move.

1. INTRODUCTION

Robotics" is the term practically defined as the design and utilization of robot systems for industry . Robots are usually preferred to use for performing hazardous, complicated as well as highly monotonous, and unpleasant jobs . These areinstalled in many workstations where ever heavy loads and hectic operations has to be perform such as material handling, different part assembly.

Autonomous delivery system, not yet intelligent enough to deliver goods across cities, but able to deliver small objects from one place to another in small boundaries. The use of DonkeyCar represents the robot, open source platform, which will be powered by the Raspberry Pi and Pi Camera to create an autonomous vehicle. The delivery robot is trained meticulously with support of Open CV and TensorFlow, which are a part of DonkeyCar library to allow run simulations and can be used to teach or create autopilots or models. Thus, allowing the car to manipulate itself by the judgment bestowed upon it through rigorous training.

In India, most deliveries are performed by human beings. The main idea of the self-driving system is to have a robot which can transport physical objects from one place to the other. The objective of the robotics field is to create intelligent machines that can assist humans in a variety of ways. The model uses artificial intelligence technology to navigate the waypoint and reach the destination successfully. This technology has the capability of a computer-controlled robot to do the tasks commonly associated with intelligent humans. Artificial intelligence is the simulation of human intelligence processes by machines, especially digital computer systems. Stuart Russell and Peter Norvig defined Artificial Intelligence which differentiates computer systems on the basis of rationality and thinking vs acting. The human approach defines the functionality of the systems that think like humans and the systems that act like humans.

1.1 Types of Delivery Robots

Delivery robots can be used in different settings such as food delivery, package delivery, hospital delivery, and room service.

1. **Food delivery robot**

Deployments of food delivery robots were in a small scale prior to the COVID-19 pandemic. continued on, demands for food deliveries had increased significantly. This caused the demands for food delivery robots in college campuses to surge as well Starship and other companies such as Kiwibot deployed hundreds of food delivery robots to several college campuses and some city streets in the United States and United Kingdom. Food delivery service companies also added delivery robots to their platform.

2. **Grocery delivery robot**

The first African American-owned autonomous grocery store in the world.The new store processes transactions using computer vision equipment in tandem with artificial intelligence-based voice and gesture technology. Nourish + Bloom offers delivery service using robotic vehicles supplied by Daxbot.

3. **Package delivery robot**

In January 2019, Amazon launched an experimental service to deliver small packages to their Amazon Prime customers using delivery robots called Amazon Scout.

4. **Hospital delivery**

Delivery robots can perform several tasks in hospital settings to reduce operational costs. The first set of tasks are for food, medical specimens, and medicine deliveries. With multiple sensors, the delivery robots can navigate the interior layout of the hospitals.

5. **Room service**

A room service robot named Relay was introduced by a robotics startup company, Savioke. When hotel staff received an order from a guest, the staff would put items inside Relay and the robot would deliver items to the guest room.

2. LITERATURE SURVEY

[1] Devang Dave: The autonomous delivery robot is meant to be a substitute for a goods delivery person. The delivery robot is capable of navigating through a cluttered space environment from a home location to a destination point while avoiding obstacles in the process. It uses an ultrasonic sensor to detect if anything has been placed inside the bin and only once when something is placed inside, the robot starts moving from a position to another. Bluetooth beacons are used to represent the start, end and mid-point which will be used by the robot to differentiate the specified locations. Bluetooth beacons will act as a terminal for the robot to detect. The autonomous robot will move on an undesignated path i.e. an unmarked route unlike the archaic robots only capable of moving inside a marked black lane. The robot will be trained and multiple simulations are run on it with the help of the DonkeyCar library so it can successfully avoid obstacles and relay the path with efficacy, making the delivery fast and efficient. A Pi camera is used which will help rectify the unmarked desired path over which the robot has to move.

[2] Mamatha KR: Humans are responsible for the majority of deliveries in India. When compared to other delivery systems, robotic systems offer more advantages because they are a large transportation medium capable of transporting huge items across long distances. Automation, such as driverless robots, is a result of technological growth. This proposed model depicts an automatic robot system that travels from point A to point B without the need for human

involvement. The sensors are used to identify obstacles. If there are any obstructions in the path, the robot will stop and restart its travel once the obstacle has been cleared. The basic premise of a self-driving system is to have a robot that can transport physical objects from one area to another. A self-contained delivery robot is a robot that makes deliveries. The self-driving robots uses artificial intelligence technology and stops at the destination after following the correct path. The robot is used for safe delivery of the packets.

[3] Miguel Figliozzi: E-Commerce and package deliveries are growing at a fast pace and several start-ups have already began pilot studies to deliver packages and groceries to consumers utilizing Autonomous Delivery Robots (ADRs). Two research questions guide this research effort: (a) What are the existing capabilities of ADRs? and (b) What are the energy and emissions reductions that ADRs can bring about? A model to understand potential ADR energy and emissions reductions is presented and several scenarios are analyzed. Results, insights, and potential implications are discussed. The results show that ADRs have the potential to significantly reduce energy consumption and CO2 emissions in urban areas

[4] ELIN JANEBACK: HUGO is an autonomous, last mile delivery robot concept currently under development by Gothenburg based tech agency Berge. The aim of this thesis was to design a top module for HUGO, making the robot fit into the context of collaborative consumption. A literature study about collaborative consumption, last mile delivery, and robot interaction was conducted to deepen the understanding of these subjects and to find requirements that the context of collaborative consumption pose on HUGO. Also, potential HUGO users were repeatedly involved throughout the project to establish user needs and requirements posed on the robot in order to make it visually appealing and user friendly. To gather user insights, a questionnaire was sent out, interviews were held and focus groups were implemented. User needs and criteria were identified regarding the design and function of the robot as well as the delivery service connected to it. A brief attempt at integrating a delivery robot into current Swedish collaborative consumption services was made by creating user journeys showing step by step how the service could work. Some concerns emerged regarding the integration of autonomous delivery robots in the public space, however, the user study indicated that users are generally positive to autonomous delivery drones, proving HUGO's potential as delivery method. The user study further indicated that for an autonomous delivery robot to be accepted in the public space, it is essential that its purpose and primary function are obvious. The project resulted in HUGO C - a product proposal for a delivery robot suitable for collaborative consumption. This concept is unique in that it is modular and can transport between one and four parcels at a time as well as adapt its compartment sizes to the user needs.

[5] Victor Emeli: Poor medication adherence and dehydration are well-documented challenges for older adults living independently that lead to reduced quality of life. Robotic delivery of pills and water in the home could potentially improve medication adherence and hydration for older adults by providing timely, reliable, and convenient delivery. In this technical report, we present a prototype multi-robot system that can autonomously deliver pills and water to a person in a realistic home environment. The system consists of a mobile robot with a tray, a stationary dispensing robot, and a smartphone carried by the user. Within this paper, we discuss the opportunity to improve quality of life, describe our robotic system, and convey results from an experimental evaluation of the system's delivery performance.

[6] Anjali. M: In today's era most of the people prefer dinner in the restaurant. The use of robots as waiters in restaurants is an increasing trend in the service industry. The Waiter-robot is an exceptional autonomous robot which has the ability to follow a designated path by measuring the distance and reach its intended destination. It reducing effort, time, error, etc and increasing quality, capacity and efficiency in the delivering the food. This robotic application using a Raspberry-pi based kit mounted with ultrasonic sensors for mapping and localization of destination table.

[7] Ziyu Wang: A robot cart to deliver food on airplane autonomously is developed. In this report, the features of the robot cart are briefly introduced first. Then, the design of whole system is explained including circuit connection and programming algorithms. After that, the mechanical components are listed which are cart frame, wheel track, scissor screw and food box lifting structure. Following this, the electrical components are introduced including microcontroller board, manipulator, stepper motors. After these, there will be experiments to test the whole system and results will be recorded and discussed.

[8] Andrea De Capitani Da Vimercate: Autonomous Robots are an innovative technology deployed with the objective of alleviating the existing pressure on last mile delivery. In the study, the technology is studied under the logistic operations perspective in the context of Food Delivery industry. Operational and economic performance are studied though a simulation study highlighting the fundamental influential factors affecting the results and underlining the future required changes for a more widespread deployment of the technology.

[9] Jue Ni: Our project is about an autonomous delivery robot in coffee shop. As a delivery robot, it is able to navigate to the destination as well as avoid obstacles that are blocking its way. We successfully finished the main functionalities of the delivery robot and it is working in the following procedure. As it gets loaded and initiated, the robot turns around to find the direction of destination. Then it navigates to the destination and reacts to obstacles properly. Though there are some flaws in the design of navigation, the robot is able to work as expected in most cases.

[10] Dylan Jennings: Road autonomous mobile robots have attracted the attention of delivery companies and policy makers for their potential to reduce costs and increase urban freight efficiency. Established delivery companies and new startups are investing in technologies that reduce delivery times and/or increase delivery drivers' productivity. In this context, the adoption of Road Automatic (or Autonomous) Delivery Robots (RADRs) has a growing appeal. Several RADRs are currently being tested in the United States. The key novel contributions of this research are: (a) an analysis of the characteristics and regulation of RADRs in the US and (b) a study of the relative travel, time, and cost efficiencies that RADRs can bring about when compared to traditional van deliveries. The results show that RADRs can provide substantial cost savings in many scenarios but in all cases, at the expense of substantially higher vehicle miles per customer served. Unlike sidewalk autonomous delivery robots (SADRs), it is possible the RADRs will contribute significantly to additional vehicle miles per customer served.

[11] Tolga Karakurt: Autonomous robots are employed in numerous areas. In this thesis, it is proposed to design and build a self-controlled wheeled vehicle to deliver food. As there are many applications of an autonomous agent for indoor and outdoor environments, this study is conducted on indoor settings whereas all the requirements and design processes are achieved for both operational boundaries. The fundamental approach is to design and implement a Wheeled Mobile Robot (WMR), and to test skid-steering performance on proposed trajectories using a System Engineering approach. From this point of view, system requirements in mechanical, electrical, and software are evaluated, and overall system is divided into subblocks which are motor processor, image processor, and central processor. One of main concerns is indoor and outdoor positioning. While outdoor tasks are widely solved in terms of the Global Positioning System (GPS) technology, indoor navigation appears with challenges. Hence, it is aimed to acquire a deeper understanding in mobile robot indoor localization through Deep Neural Networks (DNN) and learning algorithms.

[12] Valeska Engesser :The implementation of autonomous delivery solutions in last-mile logistics operations is considered promising. Autonomous delivery solutions can help in tackling urban challenges related to last-mile logistics operations. Urbanization creates higher mobility and transportation demand, which contributes to increased congestion levels, traffic, air pollution, and accident rates. Moreover, mega-trends, such as e-commerce, demand that logistics

companies react to increased customer expectations in terms of delivery time and service. Concerning service, electrified autonomous delivery solutions have the potential to operate 24/7 and can help to overcome driver shortages. This paper conducts a systematic literature review. Based on the literature set, a snowballing procedure was applied. Complementary gray literature was included. This work discusses different autonomous delivery solutions such as Autonomous Delivery Robots (ADRs), Unmanned Aerial Vehicles (UAVs), two- or multi-tiered systems, and the concept of passenger and freight integration. The work presents advantages and disadvantages, enabling the comparison of solutions. Furthermore, a research agenda is provided, from which practical-managerial and theoretical implications can be derived. The research agenda can help researchers, manufacturers, businesses, and governmental institutions to prepare for the arrival and subsequent implementation of autonomous delivery services. Various implications related to energy demand, legislation, implementation strategy, training, and risk and safety are presented. The outcome of this work calls for collaboration among various stakeholders, encourages mutual learning, and hints at the importance of national and international development projects.

[13] C. Liang: In e-commerce fulfillment warehouses, manual item picking is a labor-intensive and tedious task. Therefore, automation of item picking can improve efficiency and save cost for e-commerce businesses. This paper presents an automated robot picking solution that meets the requirements of automating the picking of items from shelves. The hardware of the proposed system comprises a lightweight robot manipulator, a low-cost commercially available 3D camera system and a custom-built robotic gripper. The software of the proposed system is modular comprising the task planning module, item identification and registration modules, grasp planning module and the motion planning modules. Simulations are carried to illustrate full cycles of the automated picking of items. Experiments were conducted using a prototype of the proposed system. The test results show the system is capable of picking several regularly-shaped and irregularly-shaped items from the bins of the shelf. Such preliminary observations prove the system to be flexible and versatile. It has the potential to be used in real e-commerce fulfillment warehouses.

[14] Swagat Kumar: In this paper, we provide details of a robotic system that can automate the task of picking and stowing objects from and to a rack in an e-commerce fulfillment warehouse. The system primarily comprises of four main modules: (1) Perception module responsible for recognizing query objects and localizing them in the 3-dimensional robot workspace; (2) Planning module generates necessary paths that the robot end- effector has to take for reaching the objects in the rack or in the tote; (3) Calibration module that defines the physical workspace for the robot visible through the on-board vision system; and (4) Gripping and suction system for picking and stowing different kinds of objects. The perception module uses a faster region-based Convolutional Neural Network (R-CNN) to recognize objects. We designed a novel two finger gripper that incorporates pneumatic valve based suction effect to enhance its ability to pick different kinds of objects. The system was developed by IITK-TCS team for participation in the Amazon Picking Challenge 2016 event. The team secured a fifth place in the stowing task in the event. The purpose of this article is to share our experiences with students and practicing engineers and enable them to build similar systems. The overall efficacy of the system is demonstrated through several simulation as well as real-world experiments with actual robots.

[15] Nils Boysen: E-commerce retailers face the challenge to assemble large numbers of time-critical picking orders each consisting of just a few order lines with low order quantities. Traditional picker-to-parts warehouses are often ill-suited for these prerequisites, so that automated warehousing systems (e.g., automated picking workstations, robots, and AGV-assisted order picking systems) are applied and organizational adaptions (e.g., mixed-shelves storage, dynamic order processing, and batching, zoning and sorting systems) are made in this branch of industry. This paper is dedicated to these warehousing systems especially suited for e-commerce retailers. We discuss suited systems, survey the relevant literature, and define future research needs.

[16] Heleen Buldeo Rai: Automation represents the next big buzz in transport and promises many advantages beneficial for society, including a more efficient use of space, energy, time, as well as reduced costs. An impressive range of autonomous vehicles is introduced, covering applications for personal and goods transport. In particular in response to the global pandemic linked to COVID-19, autonomous vehicles were proposed and celebrated as safe and reliable home delivery solutions of the future. In the midst of visionary trend reports, eye-catching press releases and promising research simulations, the actual applicability of autonomous vehicles in an e-commerce context remains difficult to assess. This lack of clarity holds for delivery automation in ordinary situations as well as in exceptional circumstances, such as those presented by a severe health crisis. To understand the state of practice and future potential of autonomous vehicles for e-commerce delivery in cities, we carried out desk and field research on the topic. This article structures the different types of autonomous e-commerce delivery vehicles and scenarios and discusses their state of practice and potential in ordinary as well as in exceptional circumstances. The study focusses on France, against a comprehensive international backdrop.

[17] Peng: There are three defects for providing human-labor customer services in e-commerce operations: high costs of human labors, staff turnover, and lack of service quality assurance. Breakthroughs made in artificial intelligence, natural language processing and related fields make it possible to replace human labors with online artificial intelligent robots to provide the e-commerce customer service, which indicates the online robots are the future of e-commerce customer services. However, most of the current robots are designed to reply with knowledge matching the key words in question sentences from the database, rarely involving in research on customer intentions that are key factors influencing user experience and online sales. In this research, an intention recognizing model was proposed to obtain intentions of e-commerce consumers by computing the strengths of candidate intention nodes in the intention graph, which was used to describe relations between different goods that could be the intentional targets of e-commerce consumers. The proposed robot was constructed based on the intention recognizing model to identify intentions of consumers and use the located knowledge combined with the AIML based sentence composition template to produce the response sentences for consumers. At last, the proposed robot was evaluated using F3 and ROUGE metrics by comparing with a keyword matching robot. And the evaluation results proved the validity of the proposed robot.

[18] Ying:E-commerce is booming with the development of new business model and will be continuously boosted in the several decades. With large number of enterprises carrying out E-commerce, logistics driven under the background has been largely influenced. This paper presents the state-of-the-art E-commerce logistics in supply chain management from a view of practice perspective. Worldwide implementations and corresponding models together with supporting techniques are reviewed in this paper. Typical E-commerce logistics companies from North America, Europe, and Asia Pacific are comprehensively reviewed so as to get the lessons and insights from these practices. Opportunities and future perspectives are summarized from the practical implementations so that interested companies like E-commerce and logistics companies are able to get some guidance when they are contemplating the business.

[19] Rhiat: The problem addressed is taken from warehousing and distribution. It concerns the order preparation in e-commerce. An order is a set of lines. Each line describes the ordered product (box) with its corresponding quantity. The problem consists of packing boxes subject to orientation, fragility, stackability, weight and volume constraints of various sizes into available containers (trays, cartons) in a way which optimizes the total number of containers to integrate in a number of delivery trips in e-commerce. The article addresses the problem where the packing is performed by a mobile robot. The aim of the work carried out in the context of the project which is a plat-form of the is to conduct, among other experiments[2] a set of experiments where the packing activity is performed by a mobile robot in order to pick up items from shelves and then pack items in boxes. To keep the problem simple, we assume that positions of items to pick up and to place them in the box are known; they are computed by efficient bin packing optimization algorithms (2D, 3D) of

Optim Suite of KLS OPTIM in production since many years. There are many ways of using bin packing algorithms. The first possible use is the online packing of items based on a fixed order defined by the host system. This approach has several drawbacks, among them the inefficient handling of stability constraint and sub-use of available box volumes. The second approach is to allow packing algorithms to compute optimal or sub-optimal solutions whilst respecting all constraints; this approach is used in production. One drawback of this approach is such solutions are not always feasible by a mobile robot. The aim of our work is that the mobile robot must be able to take into account optimization constraints in order to place objects on the pallets. The objective is to find a trade off between optimality and feasibility. The work is to conduct a set of real-life experiments and simulations by mobile robots to identify failure cases like falling, unsteady, damaged items due to robot arm forces, instability or space. The aim is to learn from these simulations, introduction of machine learning, and to derive a set of rules to integrate in the bin packing optimization algorithms as strategies to build robust packing solution for autonomous mobile robots.

[20] Zou: Distribution centers of E-commerce companies have been under pressure as a result of the development of the Internet and E-commerce technologies. Therefore, the improvement of order picking efficiency and the reduction of logistics cost rely on the optimization of order picking in distribution centers. In this paper, a picker-robot collaboration order picking system has been proposed. The human pickers are assigned to different zones, while the automated guided vehicles (AGVs) pick the orders from different zones. To optimize the collaboration scheme, the mathematical model together with a two-stage heuristic algorithm is proposed to solve the problems, including order batching, AGV routing and zone scheduling. The case study results have shown the effectiveness and the computation efficiency of the proposed two-stage heuristic algorithm.

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