STUDY OF UNMANNED AERIAL VEHICLES IN LOGISTIC PROCESSES

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ABSTRACT

As an automatic and efficient delivery approach, the unmanned aerial vehicle (UAV) has received much attention in the field of electronic commerce and urban logistics for its natural ability to avoid traffic congestion. In order to respond to the challenges of modern society, the organization of logistic processes requires synergistic optimization effects of physical processes and application of innovative technologies. The emphasis is based on continuous optimization of the processes with the aim of faster, more quality and more cost-effective services to the end user. In this paper possibility and potential of UAV (Unmanned aerial vehicle) application in logistics processes will be explained. Processes as stock inventory in warehouses and others can be improved with application of UAV.

INTRODUCTION

Unmanned Aerial Vehicles (UAVs) are aircraft that do not need a human pilot on board. In general, these vehicles are either controlled by an embedded computer or by a pilot operating a remote control. Drones, remote controlled helicopters, and unmanned gliders are examples of UAVs. Gliders differ from the other types due to the lack of on-board propulsion (e.g., an electric or combustion engine). Modern UAVs were first developed in the 1920s to support military operations in which the presence of human pilots was either impossible or too dangerous (Beard & McLain, 2012; Keane & Carr, 2013).

However, UAVs have recently become very popular for logistics and surveillance applications (Tsourdos et al., 2010).

UAVs have a wide range of applications and models. They are categorized into three categories, which are safety control, scientific research, and commercial applications. Inbusiness, companies such as Amazon and Facebook have been grabbing the headlines and the public's imagination with multimillion-dollar research into UAVs for same-day deliveries and to expand the internet to remote parts of the world. While these are a long way from commercial reality, other industries are finding numerous uses for UAVs technology – uses that could bring wider benefits to the environment and society, as well as greater efficiencies. Commercial UAVs are used in field of agriculture, construction, transportation, traffic management, inspection, public safety and lots of other civil-government uses. Except transportation, use of UAV can be applicate in different phases of supply chain, and this paper will refer to the use of UAV in various logistic processes.

LITERATURE REVIEW

Maza et al. (2011) described a multi-UAV distributed decisional architecture developed in the framework of the AWARE Project together with a set of tests with real UAVs and Wireless Sensor Networks (WSNs) to validate this approach in disaster management and civil security applications. Their paper present the different components of the AWARE platform and the scenario in which the multi-UAV missions were carried out. The missions described in their paper included surveillance with multiple UAVs, sensor deployment and fire threat confirmation. In order to avoid redundancies, instead of describing the operation of the full architecture for every mission, only non-overlapping aspects are highlighted in each one. Key issues in multi-UAV systems such as distributed task allocation, conflict resolution and plan refining were solved in the execution of the missions.

Mohammed et al.(2014) examined the applications of unmanned aerial vehicles (UAVs) in smart cities, their opportunities and their challenges in their paper. They wrote about various UAV applications in cities which include monitoring traffic flow to measuring and detecting floods and natural disasters by using wireless sensors. They also explain challenges and issues of UAV usage such as safety, privacy and ethical uses. Findings revealed that integrating UAVs with smart cities will create a sustainable business environment and a peaceful place of living. And that UAV systems and smart cities can significantly impact and benefit any country when used effectively and efficiently.

Floreano and Wood (2015) explained the important socio-economic impacts of small UAVs such as fixed-wing UAVs with a long flight time which could provide bird's-eye-view images and a communication network for rescuers on the ground, rotorcrafts with hovering capabilities which could inspect structures for cracks and leaks; UAVs for transport od medical supplies from nearby hospitals, swarms of dispensable UAVs with flapping wings which could enter buildings to search for chemical hazards and multi-modal caged robots with purpose to fly and roll into complex structures to safely search for signs of life. They show the advantages of small drones and the future possibilities for their implementation in various fields.

Skorput,P et al (2016) explored " The use of Unmanned Aerial Vehicles for forest fire monitoring". Through research it was shown how UAVs can contribute to reducing probability of errors made by tactics on the ground and in air, reaction time, accuracy in decision making and load of people and equipment in peak days.

Patra and Sengupta (2017) studied mechanism to deploy and rearrange the positions of the UAVs considering the irregular user densities and requirements. Their mechanism consists of an initial deployment scheme for the UAVs and the UDPR algorithm to enable the UAVs to move according to the heavy demands of the users. UDPR algorithm calls either of the two approaches, the primitive Juxta positioning or the proposed Hot Center Positioning, as a method for calculating the distance that the UAVs must travel to serve the users in high density sub regions. The former approach, as is rudimentary, expects the UAVs to attain a position closest possible to the UAV in need of assistance. Whereas, the latter approach meticulously calculates the effective position which can be attained by traveling the minimum distance so that the requesting UAV can be effectively assisted and at the same time least amount of energy will be consumed in traveling the distance. They simulate their approaches using C++ language. The simulation results shown that the proposed Hot Center Positioning approach the primitive Juxta positioning approach by covering more area (serving more number of users) and at the same time keeping more number of UAVs active.

APPLICATION OF UNMANNED AERIAL VEHICLES IN LOGISTIC PROCESSES

Unmanned Aerial Vehicles (UAVs) have received attention in the last decade because of their low cost, small size, and programmable features. Drone delivery is one of the most promising applications to deliver packages efficiently. At the end of 2016 Amazon developed Prime Air - a delivery system designed to get packages to customers in 30 minutes or less using unmanned aerial vehicles. To qualify for 30-minute UAV delivery, the order must be less than five pounds (2.26kg) and small enough to fit in the cargo box that the UAV will carry. The recipient must also be within a 10-mile radius of a participating Amazon fulfilment centre.

When Amazon first unveiled its UAV, dubbed the Prime Air Drone, it showed off an octocopter with eight rotors. It weighed 25kg and could carry up to 2.26kg at speeds of 80kph. However, the latest UAVs designed by Amazon are smaller with no fixed wings. They actually appeared very different from the original drones, which were more massive with fixed wings. In 2017 Amazon has received a patent for a shipping label that includes a built-in parachute, to enable the delivery of packages by UAVs or other aerial vehicles. They still didn't put it in use but this move announces the expansion of UAV use for commercial purposes.

Kim and Matson (2017) in their study shown a proposal to solve problems with drone’s limited capacity and battery life by collaborating a drone delivery system with existing public transportation. Their study allocated the tasks to the UAVs and buses in the context of the multi-agent delivery system. Also, this authors found a path for each package by solving the vehicle routing problem (VRP) to find the cost-optimized path given the heterogeneous multi-agent system and minimize the number of UAVs needed for deliver. The experimental results in paper showed that the routing algorithm will reduce the total mileage and the number of UAVs given the same set of orders.

Beul et al. (2017) concluded micro aerial vehicles (MAVs), such as multirotors, which are envisioned for autonomous inventory-taking in large warehouses. Fully autonomous operation of MAVs in such complex 3D environments requires real-time state estimation, obstacle detection, mapping, and navigation planning. To this end, we employ a cognitive MAV equipped with multiple sensors including a dual 3D laser scanner, three stereo camera pairs, an IMU, an RFID reader, and a powerful on board computer running the ROS middleware. Tasks with hard real-time requirements such as attitude control and state estimation are processed on a Pixhawk Autopilot, which communicates with the main computer via the MAVLink protocol. The authors described integrated system for autonomous MAV-based inventory in warehouses and detailed the involved components and evaluated their system with the real autonomous MAV in a realistic scenario.

Harik et al. (2016) in their paper present a novel warehouse inventory scheme towards the automation of the warehouse inventory task.. The main purpose of work is to make the inventory process completely autonomous. They used UAV to replace the manual inventory of the available stock.They put an Unmanned Ground Vehicle (UGV) and an Unmanned Aerial Vehicle (UAV) to work cooperatively. The UGV is used as the carrying platform, and considered as a ground reference for the indoor flight of the UAV. While the UAV is used as the mobile scanner which flies vertically to scan Barcodes using the onboard frontal scanner. The UGV navigates among rows of racks carrying the UAV. At each rack to be scanned, the UGV stops, and the UAV takes off to fly vertically scanning goods in that rack. Once the UAV at the top, the UGV moves to the next rack, and since the UAV takes the UGV as the ground reference, it will follow it autonomously, which results in placing the UAV at the top of the second rack, and scanning goods from top to bottom starts. The process is repeated until the row of racks is fully scanned. The UAV then lands on the UGV, and recharge its batteries while the UGV moves to the next row of racks. They present in their paper the proposed architecture and the first experimental results of the proposed scheme.

Bae et al.(2016) proposed new approach to investigate open storage yard using unmanned aerial vehicle and RFID. It reduces cost of inventory checking and mismatch of real world and cyber world. They also implemented a prototype system to show the feasibility. RFID enables identification from a distance, and unlike earlier barcode technology[8]. Many companies adopt RFID technology to monitor flow of factory and manage the inventory.

It is composed of three major components. The first is a RFID reader that detects RFID tags of products distributed outdoor inventory yard. It stores the detected tag id, location, time, and product count. The second is a drone that navigates whole outdoor yard manually or automatically. The last is server program for inventory checking that compares database values and real product data. They used C# as programming language and the .net framework was also used for the program. They developed a data collection program to detect and save tag information. After the flight, the gathered tag data is transferred to the inventory checking server and is compared with the inventory data stored in database. The server program is developed using java and MySQL server. It lists all product of inventory database and compares each states defined in above. Abnormal states like location error, missing product or unregistered were highlighted in inventory checking system. The investigator proposed new approach for inventory checking in open stock yard using UAV and RFID technology. They concluded it will decrease the mismatch between information stored in inventory system and real world data, also reduce labour cost of investigating stock and equipment cost for the system.

UAVs are also useful farther up the construction supply chain, in mining and aggregates. Working out how much material is sitting in a stockpile in a mine or quarry usually involves taking a few dozen measurements with manual surveying equipment and then calculating the volume. UAV can measure the volume of dozens of stockpiles in a single flight, taking thousands of measurements that are converted into an accurate point cloud within an hour. As well as being far quicker and more accurate, it is also much safer. Falling off stockpiles is one of the industry's biggest occupational hazards. Using UAVs to survey quarries and building sites also means that human surveyors do not need to venture close to dangerous sheer drops.

CONCLUSION

The use of UAV primarily results in optimization of logistic processes, with the aim of reducing inventory costs, significantly shortening the process, reducing use of human resources, and so on. It can be concluded that the use of UAV, apart from optimization effects, also has an effect on increasing worker safety, increase the quality of work done, reducing errors and else. Today, the UAV application in logistic processes such as delivery and warehouse operations has just begun, which means that in the future we can expect a broad application and implementation of expert systems in supply chain m operations.

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