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Autonomous Drone Delivery System: A Survey

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ABSTRACT - *The use of drone for delivery is the updated and modernized method of delivery system. The aim of this paper is to simplify the delivering process using this unmanned aerial vehicle by delivering file to multiple customers at a specified locality, hence Improving the efficiency of delivery and reduce human efforts. The one time password [OTP] is used for security enhancement. The prerequisites of this paper includes electronic speed control [ESC] to control the speed of motor, global positioning system [GPS] model to control the longitudes, latitudes and elevation points of the drone.*

Keywords: Drone, Electronic speed control, One time password, Global positioning system, Unmanned aerial vehicle.

1. INTRODUCTION

Robotics is the way of the future. Drone is one of the major part of robotics. The drones are formally known as unmanned aerial vehicles. They are the flying robot that can be remotely controlled or can fly automatically. Drones are used in a wide range of civilian roles like firefighting, traffic monitoring etc and business roles like photography, videography and even delivery services.

Companies like Amazon are starting service called Amazon Prime Air. This service is designed to safely deliver the package to the required destination within 30 minutes using drones. The improved automation in such companies results enhancement in customer service by providing rapid package delivery. UPS, Google and other European companies are experimenting with delivery drones. Drone delivery is becoming omnipresent as drone technology progresses.

Thus, the aim of this project is to design an aerial unmanned vehicles capable of payload delivery. This objective is achieved by designing a quadcopter with 6 degree of freedom and a basket attached to it. Drone delivery services facilitates rapid delivery, and also increase the efficiency and safety of transportation system. It also reduces the human effort of home delivery.

2. LITERATURE REVIEW

Christopher Burke, Mary Magilligan and Hung Nguyen[1] describes the improvisation in drone delivery system by installing the basket, that helps to carry the required package. This upgradation helps in improving the accuracy of delivering the package at the drop off location.

Most of the companies are working for automating the delivery system using drone, this is achieved by constructing the quadcopter with 6 degree of freedom, having basket attached to it. The drone can carry the payload of 1kg, this payload can be discharged quickly and reliably. This drone has the range of 3km and cost less than INR 17.8k

As the drone reaches the required destination, it takes the pitch, roll and yaw movement to discharge the package from the basket. This facilitates the smoother deliver of packages and results in the improvised system of drone delivery.

Fig 1: fully assembled quadcopter with payload basket.

Dongbin Kim1 and Paul Y[2] presented a drone concept design for high throughput system. A 6 degree of freedom parallel manipulator and parallel sensor gripper are fixed together to a robocraft.

The parallel manipulator has 8 revolute spherical mechanism the inverse kinematics property is used to identify the goal angle

P1*=Pi Tp

In this lab automation drone design of freedom parallel manipulator and sensorized gripper is developed by the two testing environments.

The work referenced in [3], focuses on heavy traffic in road transportation ,within the cities, the companies are not able to deliver its products. Since, we are using vertical dimension above road, the drone will solve ths problem.

UAV drone is a remote controlled vehicle. It is pre programmed to fly to its destination. When the adress is given as input as to it. The drone works at high speed and carry the load upto 2 kg.

This model produces 3 motions about X,Y,Z (pitch, yaw, rool). The quadcopters consits of 4 rotors. It receiver, flight controller, battery, 4 rotors, etc,.

Design calculation:

- Determine weight of the drone. Double the weight to get the minimum thrust.
- Add 20% of the total to ensure , it works efficiently.
- Divide the total thrust by number of rotors.
- It gives the thrust that can be carried by each rotor. Then, a power greater than that thrust must be provided in order to fly.

The drone is designed to carry weight upto 500grams. By using high resolution camera we can monitor the crowd and can also be used for security purpose.

Reference [4] talks about delivering critical medical suppliesis dangirous and immposible because of poor system. Zipline's avoide such problems by using drones.

The drones are used to carry medical supplies to remote areas. These drones are called zips, it carries blood packets to required hospital within the range of the given area.

At the time of emergency, doctors use whatsapp messenger to request medical products, which is packed in the drone and forced into the air. Using GPS navigation the drone reaches the required destination, typically within an hour of intrest. The zip drones, flies back to home and it ready to fly again after battery charging

Used to provide medical supplies to remote and dangerous area. Reduces travelling time, faster deliver of product.

Zipline drone goal is to provide blood distribution services. The drones are able to provide service to entire countries and it is established in other countres as well.

Reference talks [5] about Unmanned system, they are becoming popular in many fields like military, health care, mapping, advertising etc. This system will deliver small size and light weight and it will be cheaper and faster means of transport, the drone should be reliable enough to consider them as a option. Today most of the companies use the concept as shown below

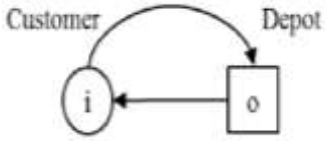

Fig 2: One depot, one customer and one drone.

Drone moves to the customer 'i' and completes the demand, but coming back to depot it will not carry any payload.

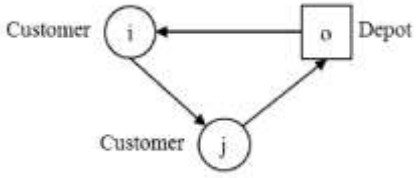

Fig 3: One depot, two customers and one drone.

Here also only one depot but two customers 'I' and 'j', at first the drone moves to customer 'I' and then goes to customer 'j' after that back to depot. This results in more amount of parcels are delivered to customers safely.

Suttinee Sawadsitang, Dusit Niyato, Puay [6] proposed the concept of siew Tan Drones. They are used in package delivery, because of its efficiency and cost consideration. The paper deals with supplier cooperation in delivery system using drone. It considers package, supplier and cost management. Several drones can be used under one supplier, which reduces the cost and improve the efficiency.

The poles of drones are used to provide variety of services. Package assignment: out of the pool of drone to deliver a particular package to a defines destination. Supplier cooperation: if there are more number of drones in a system, the cooperation between them is assigned by the supplier. Cost management: usage of drone must not increase the overall cost of the service, it must be fair and effective.

The "supplier cooperation in drone delivery" paper helps to manage the cooperation between the drones. In future, the disadvantages such as decrease in efficiency, uncertainties will be considered.

Reference [7] focuses on parcel services that tend to have their own drone fleet services. This paper tends to eradicate all those in urban areas for a mile of delivery.

The major issue is logistics support with an intention to deliver required materials in an urban areas. The drone delivery operator should handle the fleet in term of Logistics Support system and that found to be the greatest myth. The drone delivery system specifically wanted the drone operator to modify the Logistics Support system.This was adopted in terms of the inspection rate and the activity constraints.

As a result Post-Production analysis came into proposal where to drive the analysis requirement in function of the activity to describe the suitable maintenance scope and identify the possible system changes. Here the major goal is to manage the activity that might be changed by same system alteration and then calculate the Logistics Support requirement consistently. Therefore, a CVRPTW was introduced to handle a fleet's missions and considers the energy consumption.

Niklas Peinecke, Alexander Kuenz DLR [8] presented about the air space. The air space is growing day by day and the urban airspaces are getting huge demand. Hence the conflicts are increasing. To resolve this type of conflict the some methods were implemented which were in small scale.

The conflicts recognized in the scenarios were solved using one of three methods: Standard Time Shift, Recursive Time Shift and Vertical Resolution.Hence this paper produces a solution to this conflict in more drones occupying the same area.

Here there's a simulation process which is given in the paper which is a major solution. Here the urban airspace is firstly fed with the number of times the drones visit the area and the demand for it. Then it's being updated with the maps containing the locations, the drone needs to deliver and the schedule is updated too. Then haphazardly the location is selected from the map and delivery is done.

It then checks with the schedule which is planned in previous order, this helps in solving the conflicts without any delay.Then it results in to what amount the solutions can solve conflicts in urban areas.

But there were some aspects which were not considered while evolution like Concurring delivery networks,Safely landing and starting the drones,Real-time conflict solution,Avoiding ground obstacles,Conflicts with other airspace users and scenario problems like helicopter emergency.

The paper [9] discusses deeply about Recent advancements in logistics, that have been made primarily based on the usage of drones. Existing approaches involve the usage of trucks in getting the drones to costumer location and then launching the drones to deliver the package to the target customer. This approach hinders the possible capability of drones. Now if a drone is programmed to learn from every instance that it encounters, then this drone can use its intelligence to travel to a wider area and deliver packages not just to one customer but to many of the nearby customers too, without getting trucks involved in every scenario. This enables trucks to also get involved in the distribution of packages to locations where ever the drones do not deliver and also to pick up drones after their delivery along the route and not at the particular place where they were initially left.

This paper proposes the above mentioned idea and certain methodologies to implement this idea for efficient operations of the logistic companies. Amazon's Prime Air project is one such example of the usage of drones in the delivery system. But the concept of using drones in Amazon's Prime Air project is not efficient. The updated concept which is suggested in this paper is called the Arc-based truck-drone distribution concept. This concept gives rise to a novel optimization problem called travelling salesman problem with drone (TSP-D). The problem generalizes the vehicle routing problem, which is already NP-hard(non-deterministic polynomial time hardness), resulting in a harder problem. This hardness is the motivating factor for the development of the intelligence in the drones to solve the problem approximately.

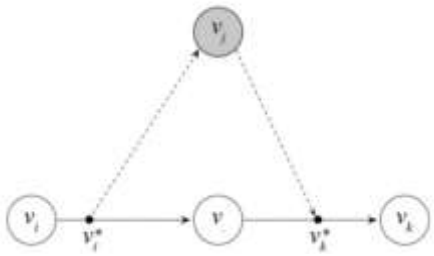

Fig 4: Arc-based truck–drone operation composed by a new launch node (vi∗), a drone node (vj), a new rendezvous node (vk ∗), any possible truck node (v.) between node vi∗ and vk∗.

Although the approach is efficient, there are a few challenges to consider and work up on. If the speed of the drone is more than that of the truck then the synchronous work between the two would get disturbed and the drone might have to wait, resulting in the inefficient usage of time. Capacity of drones to carry heavy loads should be increased. Battery power of drones should be improvised. Hoping that these challenges will be resolved in the near future, the proposed approach will be even more efficient.

Savan Vyas, Chanda Rajurkar, K. Venkatasubramanian[10] proposed a comparative study of online shopping, that brought the requirement for the delivery man. The swift increase in the usage of online shopping and ordering has increased the requirements of man power in various ways. So the drone based technology was introduced to meet this requirements. But drone delivery system has few limitations i.e., the drone just discharges the order package to the location without the knowledge of whether the customer is present or not. This problem can be solved by interfacing GPS and GSM to this unmanned aerial vehicle, the GPS helps in changing of the location as per customer's request and the GSM is used for security that is when the drone reaches the destination, if the customer do not input the pass code on the keypad provided, the drone will not discharge the package, in this case the customer will receive an SMS about the failure to deliver the package.

The paper[11] shows a novel detached way masterminding figuring for the quadcopter based transport system. For any quadcopter like structure, time of execution to be restricted as it impacts the system execution. This proposed estimation is a mix of testing based Bidirectional RRT count and advanced Artificial potential field (APF) computation, with the objective that the past is made increasingly objective arranged. Count rely upon the data on the earth from sensors, to structure a path beneficially with diminished execution time. Advanced APF limits the request space to a smaller fragment of the earth in this way lessening the

execution time. Endorsement of the estimation is done with the help of ROS TUM test framework AR Drone in closeness of hindrances. A relative position and tallness controller are used to follow the manner in which is organized using proposed count.

Vivek Yadav and Anand Narasimhamurthy[12] address the issue of setting up a development plan for wanders randomly in an Unmanned Aerial Vehicle transport framework. The issue specification incorporates a lot of requesting (every sales contains a quick overview of things with whole) to be given to clients whose districts are known, in addition specified are zones of scattering centers and machines. The truth of the matter is to control the ideal open entryway for finishing a great deal of requesting developments. The issue has a problem of Vehicle Routing, notwithstanding, the all-inclusive number of objectives and dynamic nature of the issue are the specific highlights right now. As most sorts of the issue are NP-hard we utilize a heuristics-based methodology since such a way of thinking would be powerfully reasonable to loosen up enormous scale occasions of the issue that may be experienced by a business development association. The proposed heuristics are stood apart from respect with game-plan and calculation overhead.

Marius Kloetzer, Adrian Burlacu, Gabriel Enescu, Simona Caraiman, Cristian Mahulea[13] proposed a comparative study of optimal indoor goods delivery using drones. During the most recent couple of years, the field of miniaturized scale ethereal vehicles has experienced a critical concentration among the mechanical autonomy inquire about network. Self-governing moving for indoor situations is exceptionally testing on one hand due to space topology that can incorporate distinctive storerooms, and then again because of requirement for ideal arranging that spares ramble battery and assignment achievement time. Right now study a kind of vehicle directing issue applied to an indoor distribution center. Specifically, a few products ought to be moved from capacity regions to conveyance zones by restricted vitality rambles with limited capacities with respect to shipping products. The introduction incorporates an arranging arrangement dependent on numerical programming and presents supporting reenactments and ongoing examinations. Record Terms—quadcopters, indoor arranging, merchandise conveyance, scientific programming

Roman Ibrahimov1, Evgeny Tsykunov1, Vladimir Shirokun1, Andrey Somov2, and Dzmitry Tsetserukou[14], describes about drone object picking and delivery using drone by a Wearable Tactile Display. During the most recent couple of years, the field of small scale flying vehicles (rambles) has experienced a noteworthy concentration among the apply autonomy explore network. Independent moving for indoor conditions is exceptionally testing on one hand due to space topology that can incorporate diverse storerooms, and then again because of requirement for ideal arranging that spares ramble battery and undertaking achievement time. Right now study a kind of vehicle directing issue applied to an indoor distribution center. Specifically, a few products ought to be shipped from capacity regions to conveyance zones by constrained vitality rambles with limited capacities with regards to moving products. The introduction incorporates an arranging arrangement dependent on scientific programming and presents supporting recreations and continuous investigations. Record Terms—quadcopters, indoor arranging, merchandise conveyance, scientific programming.

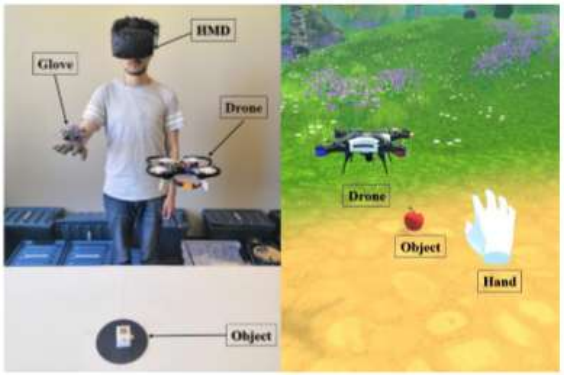

Fig 5: A human operator operates the quadcopter to pick the remote object.

The authors in their paper referenced [15] discuss about the life ring delivery drone system. Most of the people in united states visits beach frequently, the rip current from the waves in the beach may cause life risk to the visitors. Rip current is the narrow, fast moving stream of water that occurs near beaches with breaking waves.

The drones are used to deliver the life ring at the time of rescue. 80% of the beach rescue is due to the rip current. The lifeguards must reach the victims within 120 second, to achieve this octocopter with 1000mm wheelbase and the battery capacity of 20000mAh is used. It can lift the total weight of 10.2 kg.

As the pilot hears the call on radio, the command is passed to lift off and fly the drone to the destination. The drone releases the life ring when the victim grabs this flotation device. This type of drone delivery system results in the increase in successful probability of rescue from 92% to 99% and the reduction of time to reach the victim by 39% .

Fig 6: A model of the LDDS drone concept.

3. CONCLUSION

From the above paper, the things to be noted is that the efficient drone delivery system can be achieved by the better battery positioning along with the incorporated GPS system for accurate location identification. Lithium Polymer batteries are used for its high voltage per cell and high energy density. The solar cells can be incorporated onto the frame, so that the drone travels to a greater distance. Use of OTP to ensure that the documents are received by the required person. The quadcopters having four propellers is suitable for package delivery, this makes the delivery system cost efficient.

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