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Autonomous Drone Postal Service Delivery System

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Abstract: Drones are used in wide ranges of the field like entrainment, surveillance, logistics delivery, etc. In this paper, a drone delivery system that will help to deliver the services of Indian postal to the customer is proposed. This paper explores the different types of Algorithms which can be used for finding the path in Autonomous Drone Delivery System along with topics like increasing battery life and to create a secure path for delivery of the package. This paper explores the different types of algorithms and methods used in the drone delivery system to deliver the services. An innovative framework has been generated to implement the drone delivery system to deliver the services for Indian postal to the customer with a fast and efficient manner. This will help to decrease the time of delivery, cost-effective, traceable and secure.
Keywords: Drone, Delivery System, Autonomous Drone, Postal Service

I. INTRODUCTION

A Drone is a type of machine that can fly, and can be guarded by a remote system or can autonomously fly with the help of software that works in coordination with GPS, flight controller and different types of sensors. Usually, it is referred to as an unmanned aerial vehicle. Drones initially were used in the defense sector, for the works like gathering the information about the remote area, weapons supply etc. Currently, Drones are used for various purposes in addition to military purposes like oil pipeline monitoring, vital organ delivery, humanitarian aid and disaster relief, conservation, disease control, infrastructure development.

In manufacturing industries, one of the biggest challenges is to deliver the products on time to increase the profit. The customers are geographically far off places from the manufacturer's location to deliver the product. Poor delivery services are severe as you sell a low-quality product. Poor delivery services lead to customer dissatisfaction. Hence, the firm may lose the customer. So delivery plays a major role in manufacturing industries. Major challenges in the current delivery system are traffic congestion, parking problems, long transportation time. Hence to minimize this delivery problem, we can use currently emerging drone technology. The major advantage of using a drone in transportation or delivery purposes as it reduces transportation time and also compared to the conventional method it has more efficiency. It also saves money from the firm since it requires less human interference.

II. LITERATURE REVIEW

In [1], the author is doing the survey report of UAVs in the near future. The theoretical simulation models of UAVs have been discussed here, along with a brief report of the different factorial design which is considered for the drone

Delivery e.g. Velocity of drone, flying altitude, etc. The effective drones can be used to both B2B purpose and end-user delivery purpose. Managing Battery power is one of the challenging tasks in delivery through drones.

In [2], how to assign and schedule battery for drone delivery purpose have been discussed. This also tells about how to reduce the aging of battery problems. They recognized the two slight major problems which are parameters to be considered during the assignment of Battery and battery charging routine are used to get a solution for the batteries aging problem. The experiment performed by them found a way to decrease the buying cost of battery 25% and mean waiting time by 50%. Along with this, they have also found that the mean duration between the charges also affects the life of the battery.

The advantages of drone delivery have been discussed in [3]. This includes highly efficient, eco-friendly, timely delivery over the conventional method. This paper has also proposed a design for drone delivery. It together consists of work assignment, operator's co-operation and also controls the cost.

By using this design, we can even reduce delivery costs along with workload. Here in [4], the authors have explained that logistics delivery will have a problem for the timely delivery of goods to the remote and hilly region compared to other regions. So the authors of the paper have explained for such problems drones are the best solution. Also, they have carried out many experiments where they have tested various factors of drone such as battery life, recharging speed, maximum payload, etc. They have come to the conclusion that when developing drone main focus should be for battery recharge time and payload weight. The path selection is much important for drone delivery system.

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In [5], the author has discussed the algorithm for drone delivery techniques. For any delivery system, the execution time should be reduced as much as possible. Their algorithm is made up of two potential algorithms namely the Bidirectional RRT Algorithm and improved artificial potential field (APF) algorithm. The sensor provides the data for the algorithm to decide the path and reduce execution time. The algorithm planned route is tracked with the help of a proportional positioner and altitude controller. This also reduces the path length. But the proposed algorithm increase processing time. We know that there is a great increase in the demand for door-to-door deliveries. The company is facing a large problem with this because of the traffic problem in cities.

In [6], So to avoid this problem the author has designed drone which has great flight efficiency, with decreased sound. They have also tested the drone with a payload of 250gm and a flight time of 6min.

The author, in [7], is telling that most of the earlier study where only considering the delivery using a drone, they have not considered the challenges with it. Hence, he has come up with the solution for this by implementing a Novel Hybrid Genetic Algorithm by which, the well-planned delivery system can be formed. By implementing the above-mentioned algorithm, the author says it is possible to implement multiple parcels in a single delivery to a different customer. The algorithm consists of 3 parts namely the population initialization, crossover, and education. The experimental results have shown it was better than the other algorithm with which it was compared. The prototype for an autonomous delivery system with the help of a quadcopter has been discussed in [8]. They have discussed two topics in this paper. One, the hardware materials were chosen to build the drone and the other is the design of an interface to accept orders and delivery of the product to be displayed. By this design, the author is telling that it has increased mainly the delivery speed which is very important for the timely delivery of life-saving drugs.

In [9], speaks about the usage of aircraft and drones for delivery purposes. Drone individually can't take a large number of packages but can land easily in the destination. On the other hand, aircraft can take a large number of packages but cannot land easily in the location. So the speaker is proposing the model in which, we aircraft take a large number of parcels and drones. Once the aircraft arrives at the location, it releases the drones which will contain the delivery items. The drone will deliver the item in the proper location and will come back to the aircraft. Usually, on the beach, lifeguard when sees the person drowning, must rescue him within the meantime of 102 seconds. But this is not easy for a lifeguard.

In such a situation, in [10] the author presents the idea of using octocopters in such a situation. An octocopter contains the life-saving ring, which is nearest to the victim's location will from the lifeguard's tower be used to launch the drown. Also, he speaks about hardware requirements for building the drone for the same purpose. By using such drones, we increase the rate of successful rescue from 92.3% to 99.4%. Novel Composition framework which is called Drone as a Service (DaaS) which can be used for drone delivery system is discussed in [11]. The service selection algorithm for a drone is 3D Rtree. The customer's requirement is met by the composition of Dijkstra-based and a heuristic-based drone algorithmic approach. The test performed by the author on this approach shows that it is an effective method. The paper [12] address the issue where most drones are facing in today's delivery. For an instance, for efficient delivery, we need accuracy in following things like battery lifetime, battery type, aerodynamics design, payload weight, the material the drone made off, energy consumption and other parameters. It not only depends on the above factors but also depends on the vehicle routing, like in-network where packet is assigned shortest path to reach the destination by routers, in same way drone are required proper model for finding out shortest path to its destination where less amount of energy is consumed and this is termed as vehicle routing. There is a huge requirement for a better vehicle routing system, as there is an insufficient model for deliveries. A single drone cannot have a number of trips to the destination, which results in the participation of more drones, which results in price increase and infeasible routes, also addresses this issue by two upcoming ones minimize the time of delivery subject to cost constraint and another time limit of delivery. To achieve this

[12] As come up with an energy consumption model which is derived mathematically and validated across the payload and battery weight that linearly varies with consumption model. An approximation method is known as a mixed- integer linear program. Simulated annealing (SA) heuristic is used to find suboptimal solutions for practical events in which a cost function is evaluated with parameters being an energy consumption model and drone reuse. SA plots an association and correlation between minimum cost and delivery time limit which is inversely exponential. A graph is plotted between minimum overall delivery time and budget which is inversely exponential. Therefore, outcome numerical results emphasized on the reuse and battery size optimization in drone delivery.

Author address a model that overcomes security threats that are caused by attackers, in [13]. For the secured line of communication and delivery without any interruption, zero-sum network interdiction game is prepared methodically between vendor, control system and an unauthorized person. In this game, the shortest path is chosen between vendor and customer location, but the attacker interrupts this optimal path to cause potential damages to drone delivery, increased delivery time.

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So to avoid these cyber-attacks [13] as addressed a point is determined using Nash equilibrium and behavior of vendor and attacker is captured and a concept is introduced in this game.

This concept out results

1) Subjective perception of attack success probabilities.

2) Comparison based on actual delivery time and expected delivery time/previous delivery time without interruption.

At last adoption of path selection strategies vulnerable to surpass of delivery time expected by the vendors due to attacks as shown in simulations.

In [14], introduces the network of stations for long-distance delivery, drones were first limited to military purpose as it became commercial, and the drone delivery became a means of transport in logistics. Delivery may involve delivering the small packages to remote areas or in time times highly flooded areas where it is accessible and to urban areas of traffic where drones play a major role in delivery the packages to customers. Drones can travel with high speed for a shorter range of distance powered by the batteries or fuel cells, however, there is a need for refueling or recharging at particular at the point. this point is termed as a recharging station for more flight time and longer coverage of distance. A network of stations has to be set up for recharging. A feasible path to a network of stations has to be designed. In air transport modes drones travel in continuous space. An object detection sensor should take care of obstacles in the path and avoid hitting them. We need a system that configures itself in the space for feasible paths to recharging stations. These are achieved by looking into the planar-space routing, range-restricted flow-refueling location, and maximal location coverage. Some of the methods like mixed-integer programming formulation and an efficient heuristic algorithm are used for result simulations. In [15], the autonomous remote controlled car work with the help of machine learning. In [16], the smart controlled traffic is evaluating the smooth running of the vehicle without any disturbances.

III. DISCUSSION

By referring to all the above papers, we can tell that drone technology can be used in many fields including transportation. Transportation or delivery purpose drones require long battery life and also aging of the battery should be minimized. For this, there is a solution like battery assignment and battery scheduling. Meantime between the Battery charging also decides the life of the battery. Cooperation with the other supplier can be decided by a framework called Supplier Cooperation in Drone delivery (CoDD). This is implemented by split and merge algorithm and Shapley value. Drones can be mainly used for the delivery of goods in the hilly and remote regions since the conventional method of transportation is too difficult for this. When the drone delivery concept is chosen, we must mainly consider the battery life of the drone along with the payload which drone can carry. For a drone delivery system, to decide the path we can use the Bidirectional RRT Algorithm and improved artificial potential field (APF) algorithm. The different sensors embedded in the drone feed the data for the mentioned algorithm. Multiple parcels in single delivery for the different customers are quite a challenging task in the drone. To implement this well-planned delivery system using drones we can make use of a Novel Hybrid Genetic Algorithm. To make a drone delivery system more efficient, we can make use of aircraft that carry the drone for the required location and drops the drone which contains the package. The drone deliveries the package safely and returns to the aircraft. If there are a number of drones in the aircraft, we can deliver a large number of the package at a single instance. Drone as a Service (DaaS) is a framework which can be used for Drone Delivery purpose. Vehicle routing problems that arise in a drone delivery system can be overcome using simulated annealing(SA) heuristic and mixed-integer programming for the formulation of results related to routing problems. There are security threats in the drone delivery system which arise on the optimal path selection and the solution is to track the behavior during delivery using Nash equilibrium and zero-sum network interdiction. These algorithms are useful in avoiding malicious attacks. For longer distance coverage and recharging the fuel cells or batteries, at recharging stations, we use planar-space routing, range-restricted flow-refueling location, and maximal location coverage. Some methods like mixed-integer programming formulation and an efficient heuristic algorithm are used in result simulations.

By studying all this paper, we are proposing an idea of implementing drone technology which can help the speed post facility of Indian postal service. Usually, in speed posts, only an important document or package will be sent. In the conventional method, the package arrives at the head post office of the receiver. Then it is sent to the local post office. As the package arrives at the local post office, the postman goes to deliver. He gives the post to the customer, once his identity is authenticated. If the actual receiver is not present, he will take back the package to the post office. The customer, then himself have to go to the post office and collect the package or document once his identity is verified. Here, we are proposing a drone delivery system that will be used for transportation of speed post from the head post office of the receiver to the customer's place directly. The officer from the head post office will send a message to the customer's mobile. The customer has to respond to the received message. Based on the response,

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the officer will decide whether or not to send the speed post. If the response is positive, the officer will place the package or document in the payload of the drone and lock the box and enters the customer's location and sends the drone to the same. If there is a negative response, the document will be kept in the head post office. There will be continuous monitoring of drones. When the drone reaches near the location of the customer, one more message will be sent,

Which will contain a passkey. The customer has to send the same passkey again to the officer. If the passkey is appropriate, the drone will be landed, or else it will be hovering in the same location. Once the drone is landed in the location, the customer has to apply the same passkey to the payload and open the box and remove the package. If the passkey is inappropriate or drone is not landed within a certain period of time, the drone will be called back for the head post office.

The main disadvantage of the existing system is, time efficiency is low and also if the customer is not present on the day which postman arrives, he will be not knowing the arrival of the package. By implementing a drone delivery system here, the efficiency of the delivery system can be increased since it can travel fast, and users can track their package. Also, we can save some amount of fuel required for the vehicles to deliver the package.

IV. CONCLUSION

In this paper, we have done a survey of drone technology being deployed in the different delivery systems. The efficient drones can be even used for life-saving purposes like delivering medicines for remote areas etc. We have studied different effective algorithm which can be used in drones for effective flying and some battery saving techniques which can increase the battery life. By all these, we can tell that delivery using drone technology will be the future of the delivery system and this field has a huge scope for future growth.

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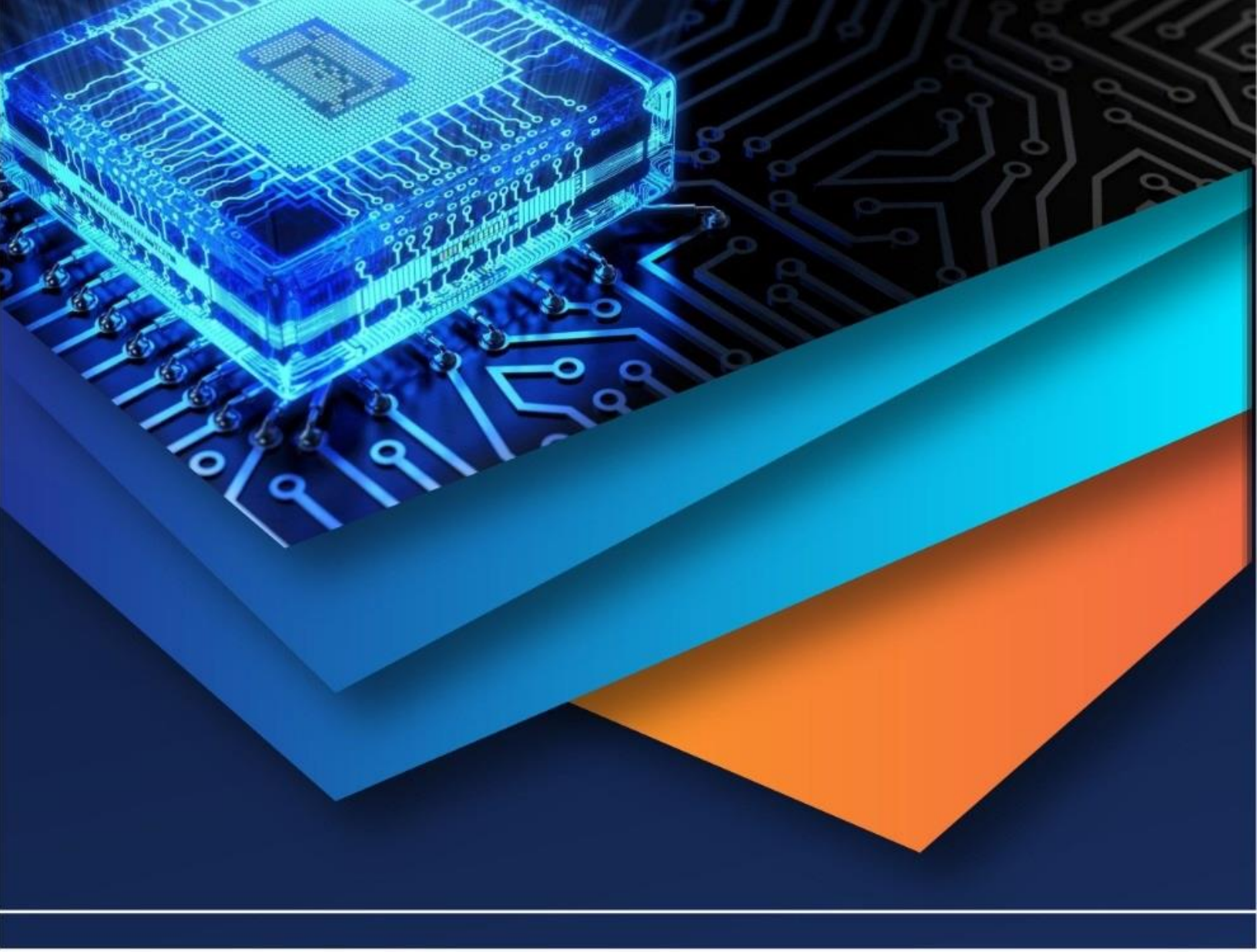

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