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A COMPARITIVE ANALYSIS OF DIFFERENT ALGORITHM TO GENERATE OPTIMAL ROUTE FOR GARBAGE COLLECTION SYSTEM

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Abstract – *Garbage is a major part of pollution nowadays and effectively executing the collection of this garbage is a global issue. To provide better system, many researches have been carried out to manage the Garbage. Garbage Management System includes collecting and recycling the Garbage. Different algorithms are developed which efficiently collects the Garbage and even saves the fuel. Garbage Collection System uses algorithms such as Nearest Neighbor, Genetic algorithm, Ant colony and many more that provide better scheduling and shortest route generation for Garbage Collection Truck used in Garbage collection system. This paper provides a comparative analysis on different algorithms used for Garbage collection System such as Genetic Algorithm Ant Algorithm, Integrated Nearest Neighbor Algorithm and Genetic Algorithm, Floyd Warshall and, Dijikstra algorithm.*

***Key* Words: Ant Colony Algorithm, Garbage Management System (GMS), Garbage Collection Truck (GCT), Garbage Collection System, Genetic Algorithm, Nearest Neighbor Algorithm, Optimal route, Smart Dustbin.**

1. INTRODUCTION

In every city, there are government organizations that are engaged in collection of garbage. This organization work daily to keep our city and surrounding environment clean by managing the garage that is generated daily by visiting through Garbage Collection Truck (GCT). This GCT are scheduled daily according to areas but there is no proper management of truck scheduling, as there is absence of IoT in Garbage Collection System due to which there is wastage of fuel. However, there are situation when Garbage Collection Truck arrives the dustbins are overflowed or not fully filled or empty so if IoT comes in the consideration then there would be proper management in whole system [1].

In mega city, the garbage collection system is very complex, as there is a large area to cover which consist of lots of dustbin. A dynamic transit consists of large number of garbage from street to depot. The main problem is to generate optimal routes for truck for collecting garbage for each Garbage Collection Truck (GCT), with better utilization of available space of Garbage Collection Truck (GCT) and to decrease the wastage of fuel. This problem is being divided into two sub-solutions, first is providing smarter dustbin which consists of number of sensors connected over cloud and second one is generating optimal path for Garbage Collection Truck [2].

1.1 Smart Dustbin

A) Ultrasonic sensors are used to detect the status of dustbin that shows how much it is filled and its ultrasonic sensor vary in frequency according to the size of each dustbin.

B) Another sensor called load cell are used to give a signal when dustbin is cleaned and emptied, if ultrasonic sensor doesn't work properly.

C) The sensor then sends message or notification to server room through GSM. GPS sensors are used to locate the location of dustbin.

D) Microcontroller is being used to control power from being wasted[3].

1.2 Generating Path for Garbage Collection Truck

- The path is being generated according to the data received from each dustbin and priority to each dustbin is given according to status of dustbin.
- There are many different algorithm used for generating shortest path for GCT such as Nearest Neighbor Algorithm, Genetic algorithm, Ant Colony and many more.
- Shortest path which provide optimal route for GCT and stop the wastage of fuel and other resources.

This is some of the features of IoT that makes whole system very reliable and bring automaticity. Using IoT whole system is centrally managed and monitor, there is no requirement of monitoring particular sensors all sensors are being connected over internet and are being commanded centrally.

2. LITERATURE REVIEW

Various surveys have been conducted for Garbage collection system which uses different algorithms for generating optimal path for GCT.

2.1 GAAA (Genetic Algorithm Ant Algorithm)

- GAAA is a combination of both genetic and ant colony algorithm. As the survey says that Ant Colony Algorithm is very optimal but more time

consuming then other algorithms and similarly genetic algorithm is very fast in execution but can't predict that solution obtained from it is optimal. Optimal Solution is obtained when Genetic algorithm is used with Ant Colony Optimization.

- GAAA takes the advantage of genetic algorithm which provides stronger searching ability and faster convergence to generate initial pheromone for ant colony algorithm.

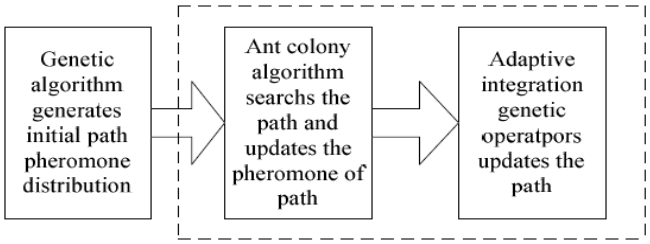

Fig.1- GAAA Process [4]

- As shown in figure 1, Using fitness function, Genetic algorithm is used to generate initial pheromones distribution for ant colony. The ant colony algorithm then searches the path and updates the pheromones using genetic operators like selection, crossover and mutation [4].
- This algorithm gives an optimal route than single genetic algorithm or single ant colony algorithm.
- GAAA can we used for Garbage Collection System for dynamic generation of route for the Garbage Collection Truck.
- The limitation of this algorithm is that, it is not dynamic and have wider path space which can be overcome by combing other algorithm like nearest neighbor or any else which give the better solution than alone GAAA.

2.2 Integrated NNA and GA

- NNA starts from depot point and finds the nearest point that the truck must visit and continues to find nearest point until the truck capacity exceeded then the original capacity.
- Therefore, the NNA provides initial pheromone to GA and generates the shortest path for all truck.
- Then the GA will generate initial pheromone and compare the pheromone that is generated by NNA and if required it updates using the fitness function.
- Further, selection operation compare the suitability of the initial chromosome to other chromosome and if the total length of all the route of that other chromosome is smaller than the route is updated to new chromosome [2].
- The Crossover operator is performed over selected pair of chromosomes, in which the genes are exchanged in order to form new chromosomes.
- Then, the mutation operators are used to generate and replace old random selected chromosomes from the population with new chromosomes.
- So when both algorithm comes together and provide the integrated solution it gives the most optimized solution, then working over single GA or Single NNA [2].
- The limitation over this algorithm is that it doesn't provide dynamic route generation and there is missing of traffic parameters.

2.3 Smart Garbage alert system using Adriano UNO

- In traditional system whenever garbage overload is found manually truck comes to clear the overloaded dustbin, but it is not a proper monitoring of system [5].
- It is necessary to periodically monitor the status of each dustbin and notify truck for collecting the garbage from the dustbin.
- Here RFID technology is used for e-monitoring and to overcome above problem.
- The system work as when truck comes near to RFID tag that is mounted to dustbin the RFID reader sends signal and tag responses to the signal [5].
- RFID reader reads data from tag. And data is arranged in specific format.
- Controller sends data to GPRS system.
- Modem sends SMS to server and authorized person.
- Server Updates database.
- Also ultrasonic sensor is being used to know the cleanness of surrounding area of the dustbin. The ultrasonic sensor transmits its waves and if any waves reflect then it identify that there is presence of some object [5].
- This is how the complete system works which provide smart dustbin with many functionality.
- The limitation of this system is that it does not provide the dynamic route for the Garbage Collection Truck.

2.4 ZigBee Network

- The IoT enabled waste management system using ZigBee and MQTT (Message Queue Telemetry Transport) protocol is used to determine filled status of dustbin [6].
- The data acquisition module placed within the dustbin which updates the sever via ZigBee ,etc
- MQTT is light weight protocol and it provide the communication link between coordinator and the server [6].
- Optimal path for collecting the filled container is determined using Haversine formula and travelling salesman algorithm.
- The information is initiated to the garbage collection unit through Telegram messaging application to minimize time and fuel cost[7].

Table -1: Comparative analysis of Algorithm

Protocol	Advantages	Disadvantages
Ant Colony	Better performance against global optimization technique Distributed computation avoids premature convergence	Slower convergence than other heuristic No centralized processor to guide AS toward good solution
Genetic Algorithm	More chance of getting optimal solution then other algorithm Suitable and time required is less for complex problem Better performance than other algorithm	Due to many parameter it involves much time consumption Combination of other algorithm are required to speed of execution time
Nearest Neighbor Algorithm	Faster than other algorithm	Less performance then other algorithm Doesn't provide optimal solutions
Integrated NNA & GA	Provide optimal solution then single NNA or GA Faster than single GA	Doesn't provide dynamicity.

3. Scope and Benefits of Smart Garbage Management System

- Today's Technology is transforming every aspect of life, the IoT is giving a drastic change in every field and providing better future. IoT has given the concept of Machine to Machine Communication (M2M) and many giant companies are implementing strategy to capitalize on IoT which will help to provide better future. IoT is developing platform in every field like home automation, transportation, garbage management system, building automation, etc [8].
- The IoT brought the drastic change in Garbage Management System and still improving the technology. In traditional work, the cleaning process was being carried out like daily visiting each dustbin and cleans it but there is no proper monitoring system to know the real time situation of all dustbins, due to which overflow of garbage or wastage of fuel happens [8].
- The current system developed using IoT contain many advantages then the traditional [8]. The current system contains the smart dustbin which sense the status of dustbin whether it is filled or empty using different sensor and upload over cloud and updating the status in sever.
- According to the status of all dustbin a route is generated for Garbage Collection Truck (GCT), the route that generated would be shortest as well due to which wastage of fuel is reduced. And the entire dustbin would be cleaned according to the route generated.
- This system makes fully automation and dynamism and provides a clean environment.
- Some benefits of this systems:

  - Overloading of dustbin can be stopped.

  - Centrally monitoring the status of all dustbins.

  - Providing the optimal path to Garbage Collection Truck (GCT).

  - Due to optimal route generation wastage of fuel can be reduced.

  - By providing smart dustbin which would detect the wetness level of garbage which would be easy for recycling or dumping.

  - Smart Dustbin senses the surrounding area of dustbin using ultrasonic sensor and detect the cleanness and if there is some garbage present then it cleans.

4. Issues and Challenges

- IoT faces many challenges like issues of governance, security, interoperability, privacy, regulations which provide power to million of sensor [8].
- Lack of support of the government organization to the researcher due to which there is no updating in system [8].
- There is no proper centrally monitoring system in garbage management. And absence of proper collection system for garbage due to which sometimes overflowing of garbage may occur and sometimes waste of fuel.
- Some research are being done in Garbage Collection System which provide better management of garbage like scheduling garbage collection truck for collecting the garbage according to live tracking of dustbin status.
- Different algorithms are being used for optimizing the route for garbage collection truck like genetic algorithm, ant colony, nearest neighbor and many more. All provide better solution but all have some limitations.
- The limitation of present model is that it doesn't provide dynamicity which includes parameters like traffic, providing optimal solution at each point and providing a narrow path space.
- So the challenge is that, it is required to develop the system which would cover such limitation to provide the complete system and work dynamically and provide better management and monitoring of complete system.
- The genetic algorithm or ant colony or nearest neighbor algorithm when some single it doest provide optimal solution so the hybrid algorithm must be developed which would include integration of this algorithm so it overcomes the limitation of each algorithm .
- The main challenge is that how to integrate this algorithm together so the time complexity would also be minimum. If the time complex increases then there would another limitation.
- But if we use nearest neighbor algorithm for collecting the data from each dustbin and dividing the path space into small area for each truck to visit then the wider path space get narrow in beginning only so the first limitation can be overcome.
- Then by using genetic algorithm we can generate initial pheromones and can dynamically update the route at each point by using crossover and mutation operator which would provide optimal solution.
- And the ant colony algorithm is used in later portion after generation of initial pheromone for updating the pheromone according to traffic parameter over a route.
- This how the complete system would be developed which give the optimal solution.

5. CONCLUSION

In this paper we propose a dynamic Garbage collection system which overcomes the limitation such as wider search space, dynamicity at every node considering the fluxions in status of dustbin and considering traffic parameter over the route, so the hybrid algorithm comes in criteria to overcome this limitation of present work and provide the optimal solution.

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