

# **Solid waste management using optimal path planning and autonomous bins.**

- **Motivation –**

- Waste management has become one of the important task for the proper functioning of cities. As many of the cities are becoming smart cities in doing this one of the main things that can distinguish a smart city is how efficiently and intelligently it manages its waste. And there is a more than ever need to shift from the conventional methods of waste management, as they cannot handle the modern problems of rapid population growth, Environment pollution, high fuel consumptions and low efficiency and work towards modern and intelligent solutions for this problem, Artificial Intelligence can be a solution in managing the waste in intelligent and efficient way. One of the main problems municipalities faces is the logistics cost and inefficiency regarding waste collection. Nearly 70% of the total amount spend by municipalities is on logistics. In this article we propose a modern, intelligent and efficient way that according to assumptions can significantly lower down the logistics cost and is sustainable. The path planning for the pick-up van has a limitation that it can optimize the path to a limit. Also, there are some other factors that affect the logistics time, cost and efficiency and cannot be solved by optimization alone. In this article we are going to propose an advanced Artificial Intelligence based solution that can help us in reducing the logistics cost, time spent, Environment pollution (reduce carbon footprint), improve ease of living and provide a good service to citizens, it is the intelligent and smart solution for the smart cities.

- **Research gap –**

- The research going on right now focuses on path optimization using historical data or using sensory data.

- Article by researchers of Chongqing university suggest path optimization considering low fuel consumption, low gas emissions using info from smart bins with sensory data.
- Another article supported by national research foundation of Korea suggests using historical data to predict the waste generation from particular grids. And then use optimization algorithms to calculate the minimum path.
- All this is very helpful in reducing fuel consumption for transport of waste but has certain limits. We can do more reduction in costs using autonomous dustbins for collection operated on clean energy fuels. This autonomous dustbin can access places inaccessible by pickup trucks which has been a major problem in waste collection for unorganized area with dense population.
- **Problem Definition:** The problem we are facing is that only optimizing path has a limitation like the large pickup van cannot move conveniently inside a compacted street also picking up waste from each bin is time consuming and fuel consuming. And some time we find that we have spent our time and fuel for picking up an empty bin

The possible reasons that the conventional method cannot completely solve the efficient waste management problems of modern era are -

- Laziness/ low work ethics of sanitary personnel.
- Lack of information among the household about the status of their nearby waste bin.
- Lack of awareness among the control authority about the real time status of bins.
- Limitation of labor power.

- **Contributions:** The contribution to these problems will result in sustainable, environment friendly, improve the ease-of-living of customers, well organized and highly efficient system that has the solution to the modern days waste management problems. The detailed solution for these problems are explained here -

- Collection of waste from local house hold (keeping shortest path and less time) and covering maximum area. For this we are developing an intelligent dustbin that can operate autonomously and collect waste from

each household under its area with optimal path. To make the collection process more efficient, improve ease-of-living and more organized.

- We connect the household with the bins and update household about the waste status of bins.
- We update bins with household waste collection requirement to make optimized path for collection.
- We update bin with the volume of waste each house producing to get well equipped with storage requirement (like call nearby bin if required).
- To tackle labor limitations and human error.
  - Our system is based on artificial intelligence designed to finish our given work. As we know robots can do much more work/labor with good efficiency than a human.
- Intelligent bins are cost effective and needs less maintenance, we need an initial cost for developing the bins than it can serve for lifetime.
- Path optimization and garbage collection in modern efficient way. After collecting the waste from every household, the dustbin will move to the nearest pickup point where the pickup van is waiting and put all the waste into pickup van and come to their initial position.
- The collection of waste from household will be efficient, environmentally friendly (we use solar power for the operation of bins), needs less effort and improves ease-of-living.
- We develop an algorithm that plans the optimized path for dustbins and pickup vans.

- **Objective:**

- To develop Algorithms:
  - To optimize the path to particular node or multiple nodes. (Node: may be location of household or pickup truck).
  - Autonomous movement of our Bin.
- Making the process of waste collection autonomous.

## Methodology:

- We design our project considering the scenario of Chandigarh.
- **Assumptions –**
  - We are assuming that we have a real-time connectivity with dustbins-households-Control authority. By having a real-time connectivity. We can-
    - Monitor and check the status of level of waste in the dustbins.
    - Gather information from households whether they want to get their waste collected.
  - Our Bins are well equipped with the necessary sensors.
- **Project work:**
  - We develop-
    - The algorithm that can analyze data given by households and make an optimized path for the bin for the collection of waste using **Dijkstra's algorithm**.
    - The algorithm that can optimize path for pick-up trucks to landfill sites, using **Dijkstra's algorithm**.
    - The algorithm that is used for the autonomous movements of the dustbins.
      - Our algorithm determines pre-defined path and halting locations and our bin follow the algorithm for the collections of waste.

## Possible results:

- Transport and collection of waste with significant reduction in costs, efforts and improving ease-of-living.
- Optimizing collection with autonomous bins.
- Making the collection of waste autonomous.

## Role of each team member –

- **Ritik, Shubham** – Work on designing and developing algorithms to make bins autonomous in its tasks.
- **Pushpendra, Shubham and Ritik** – Work on developing algorithm for optimization of the paths for bins and pick-up vans.

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