

# Deep learning based Identification of Solid Waste Management in Smart Cities through Garbage Separation and Monitoring

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**Abstract**— The solid waste management is the process of proper decomposition of waste materials within a period of time. This includes the collection of garbage's and then proceeded through certain measures for decomposition. There are various methods adopted in the garbage separation process. This includes the artificial intelligence techniques for the estimation and determination of the solid waste through automatic detection and separation of the garbage waste using control and sensing units. They are integrated with the internet of things to enable the two way communication system. This helps to visualize the functioning of the system adopting the digital platform. The proposed system is implemented through the smart dust bin held in every household that automatically senses the non-biodegradable and biodegradable waste materials. The classification of the waste materials are identified through the image processing techniques.

**Keywords**—Solid waste management, garbage, smart decomposition, artificial intelligence, deep learning, genetic algorithm

## I. INTRODUCTION

Due to the rapid increase in the global population, there is also increase in the waste products that are needed to be decomposed. It will become an alarming issue in the upcoming decades due to enormous rise in population and modernization. There are various forms of waste that are excreted daily such as domestic waste, industrial waste and medical waste products. The decomposition of the waste varies from one another due to the composition. Hence the decomposition must be done in order to obtain a cleaner ecosystem. The decomposition process must be done without causing any harm to living organisms through emitting toxic gases in the environment. The conventional decomposition methods involve manual collection and separation of the garbage. This leads to time consuming and the separation through manual process can use various harmful effects and infections. Thus to overcome the various imitations in the

existing system, the proposed system with automatic decomposition methods are implemented. These waste products are various kinds based upon the materials in which it is built and the category of the usage. Based upon the rise in the global population, the various measures must be taken for the garbage decomposition techniques [1]. The important factor includes the change and shifting of population from the rural areas into urban areas. The accretion of waste leads to rise in the various diseases and constrains in the environment. Due to the process of modernization and industrialization, the areas are occupied for residential and industrial purposes that causes rise in the accumulation of decomposes in the ecosystem [2]. The garbage collected in a home may be considered as minimal amount but if collected across the particular areas are larger are needed to be decomposed accordingly. The waste management is referred as the process of decomposition of the accumulation of unwanted materials of animals and human beings [3]. There are various forms of waste includes hospital waste, human waste and animal waste, radioactive waste materials and domestic waste.

They are much beneficial to decompose the garbage's through smarter ways. These waste must be adopted to collect at different regions with different kinds of materials in the system. In residential, the waste material are mostly biodegradable and hence complex system are not necessary [4]. If the garbage collected in the industrial sectors, the waste materials are highly infectious and decomposed through various chemical components. They are decomposed with proper care in order to avoid the consequences in the environment. The radioactive components are the highly dangerous compounds that helps in the decomposition process to become more complex. The decomposition of the radioactive components must be made with proper precision techniques without the emission of toxic components in the atmosphere [5]. The garbage waste management involves the recycling and disposal process.

This requires various activities that needed to be decomposed through proper manners. The decomposition are done through various techniques based upon the composition of the substances. These decomposition must be done carefully due to the various effects occur at the time of decomposition [6].

The municipality and corporation had formed various techniques for the decomposition of the garbage waste. These techniques and regulations must be keenly observed and practices to avoid various consequences in day to day life [7]. The emission of the toxic materials are due to the burning of plastics. Thus the plastics and its materials are decomposed through proper measures due to the emission of toxic gases that affects the surrounding atmosphere [8]

The emission of the components from the decomposed materials must be keenly monitored and observed. The decomposition of the biodegradable particles does not create harm effects on the other hand they are helpful in many ways [9]. The organic waste are served as fertilizers in the agricultural farm lands due to the enriched content with nutrients and various components in the organic matters. Large amount of garbage are dumping into the outskirts of smart cities that are tend to be decomposed periodically [10].

The decomposition process is a tedious process because it needs several manpower. The decomposition of the garbage cannot be done in a simpler way due to the availability of the materials inside the system. In rural areas, the garbage are decomposed quickly due to reduced population and the vase areas resource [11]. This is not a bigger challenge although decomposition of the garbage in the urban areas causes various complexity. The first stage involves the classification of the garbage such as degradable waste, bio-degradable waste and electronic waste management system [12]. Thus the increase in the population rise leads to the accumulation of the garbage waste. They are decomposed properly with certain measures. Improper decomposition techniques leads to the rise of various consequences in the environment. They cause various hazards to the living organisms [13].

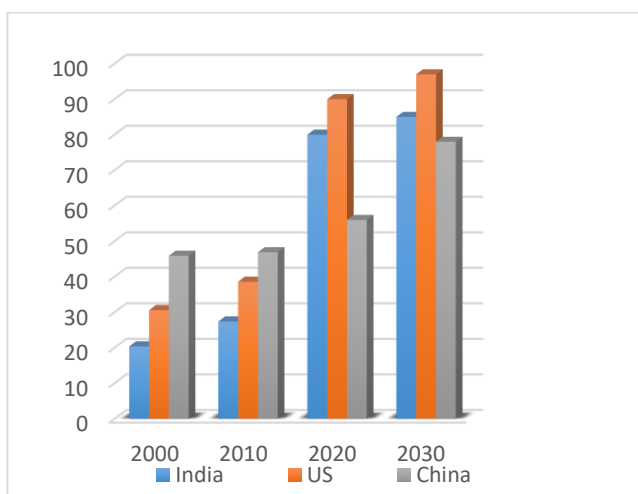


Fig 1: Generation of solid waste

The figure 1 represents the generation of solid waste from past and future decades. Thus the decomposition of the

garbage waste plays a prominent factor in the garbage management system. The garbage management system is a lengthier process which includes numerous stages in the selection and decomposition techniques [14]. This includes larger energy and time consumption parameters. The important stages involved in the garbage decomposition includes the collection of garbage, dumping in the larger areas, classification of various garbage's based upon the products and accompanied through the decomposition techniques. The overall functioning of the collection of the garbage's to the decomposition are done through the municipality [15]. The municipality makes the garbage decomposition through collecting the large amount of garbage through trucks and lorry and dumped in outskirts.

Thus larger amount of funds and energy are needed to perform the operations. Thus to overcome these kinds of consequences, the artificial intelligence techniques are implemented. This helps in the garbage monitoring system in diverse ways starting from collection of the garbage in smarter way with automation in the decomposition process. The artificial intelligence are largely evolved due to the automatic decision making techniques with automatic problem solving [16]. Thus the automations in the system are achieved through the use of artificial intelligence techniques with internet of things. The internet of things (IoT) helps in exchange of information from one end to another. They are the expanding network for storage and processing of information. They are accompanied with a communication network with sensors and microcontrollers. This make to provide a smarter environment through collaboration with the physical and virtual systems. This leads to providing an efficient methodology for the smart disposal system. The burning problem in the smart cities are the waste decomposition due to the non-availability of unused land in the outskirts. This is a serious issue to the municipality to take care of it. The smart decomposition system helps urban areas to obtain an efficient system for garbage. This helps to communicate between two centers such as the collection of various waste products to the garbage dumping area in the outskirts. It is implemented through the collection of information through real time implementation. This helps to analyze the leftover places where the garbage are needed to be collected. Thus the initial step in the collection and separation of the garbage are done through the Internet of things.

Here the deep learning are employed for the garbage decomposition process. These artificial intelligence helps to decompose the garbage in a smarter way through analyzing and collecting in an appropriate dust bin [17]. They are programmed with microcontrollers and sensing units. The overall functioning is done with the genetic algorithm to optimize the functioning of the system in a smarter way. Thus they are also termed as recycling process. The decomposition are done in smart way to reduce the cost and time through adopting computational algorithms. Thus the deep learning techniques helps in the solid waste management in the urban areas involving internet of things.

## II. PROPOSED SYSTEM

The conventional method of garbage collection and decomposition is a complex process that includes numerous complex techniques. The conventional method of garbage disposal can be eliminated through the aid of artificial intelligence and internet of things. This helps to automatically function and detect the garbage based upon the use of image processing techniques.

This includes the collection of garbage in the residential consumers through a smart bin system in which the bin is accompanied through microcontroller.

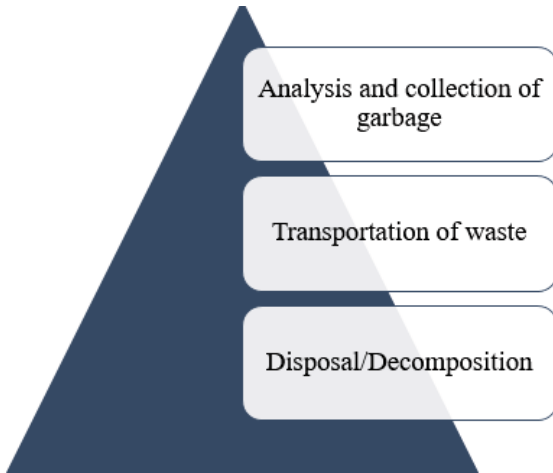


Fig 2: Solid waste management techniques

The figure 2 demonstrates the solid waste management techniques. There are three important stages that include the collection of solid waste through smart dust bins that automatically classify the garbage.

The second stage involves the transportation of the waste materials to the outskirts for the purpose of decomposition. This microcontroller helps to differentiate the degradable waste and non-biodegradable waste materials [18].

This helps in the easier decomposition of the garbage. The waste materials must be decomposed according to the kind of material composition. The proposed system involves the deep learning techniques for the decomposition of the garbage. This helps to occupy an area and dump the garbage to remain for a certain period of time to remain dried. They are dumped for a period of time and allow for the process of decomposition [19]. These decomposition processes vary for different materials. Based upon the decomposition techniques, the garbage tends to decompose and leads to completely vanishing the waste materials without causing any damages to the environment.

## III. INTEGRATION OF SMART DECOMPOSITION TECHNIQUES WITH ARTIFICIAL INTELLIGENCE

The detection of the garbage classification and identification and obtaining the smart solid waste management includes the process of artificial intelligence. This helps to function the machinery as similar to that of the human intelligence. They are trained and tested accordingly. The proposed system is implemented through deep learning techniques with genetic algorithm as an optimization technique [20].

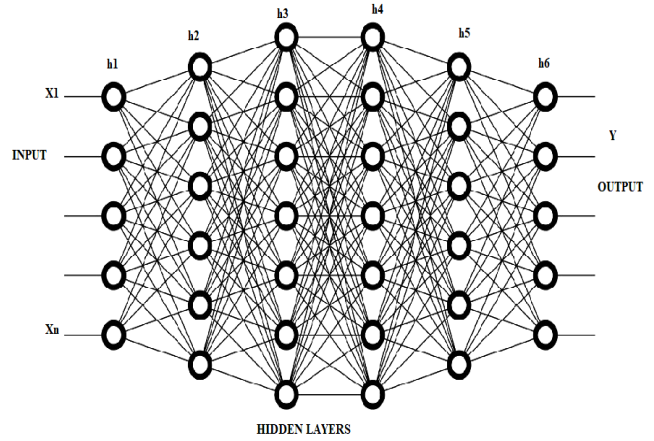


Fig 3: Deep learning

The figure 3 represents the deep learning techniques. This includes the input layer, hidden layer, and the output layers. The data are processed in the hidden layer to perform the yield with optimum solution. The identification and collection of garbage is done through the image processing techniques [21]. This helps to accurately predict the category of the garbage based upon the residential and industrial waste.

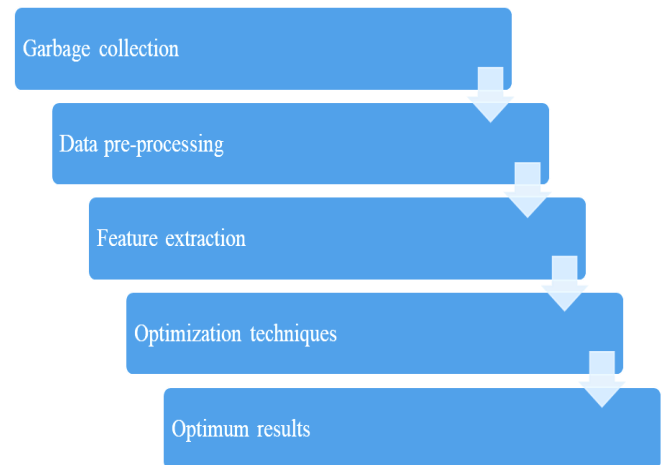


Fig 4: Image processing techniques

The figure 4 demonstrates the image processing techniques. This includes the collection of garbage with initialization with the original dataset.

The collected garbage are pre-processed to obtain the exact information regarding the biodegradable and non-biodegradable garbage. Thus the pre-processing stage proceeds to the feature extraction in which the information

are collected from the images [22]. The complete functioning is done through genetic algorithm techniques.

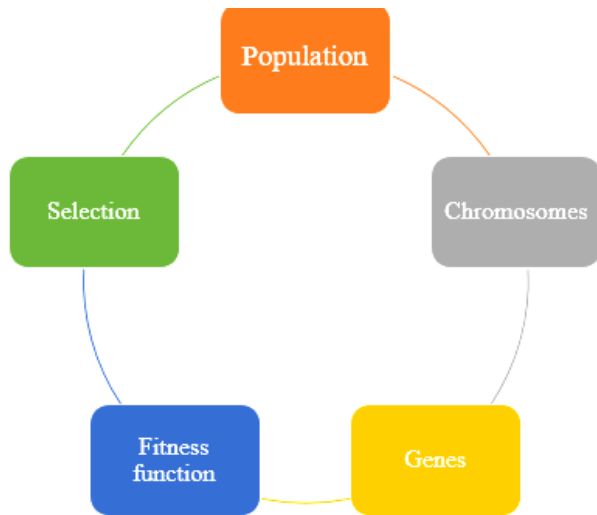


Fig 5: Genetic algorithm

The figure 5 demonstrates the genetic algorithm. This includes selection, population, chromosomes, genes, fitness function and selection. The genetic algorithm is a heuristic optimization tool to extract the solution for the complex problems [23].

They are obtained based upon genetics and mutations. They are performed based upon the theory of natural selection. They are used to extract the solution for the complexity nature of problems to extract the optimum output [24].

Algorithm representation:

- STEP 1 : Initialization of populations
- STEP 2 : Decide fitness of population
- STEP 3 : Until convergence reiteration is initiated
- STEP 4 : Select parents from population
- STEP 5 : Crossover and generation of new population
- STEP 6 : Accomplish mutation on new population
- STEP 7 : Calculate fitness for new population

The population is referred as the subset that is used to solve the obtained problem. Then collection of gene generate chromosomes. The gene forms the element in the chromosome structure. The fitness function, genetic operators and the selection and mutation forms the important stages in the process of solving the complex problems.

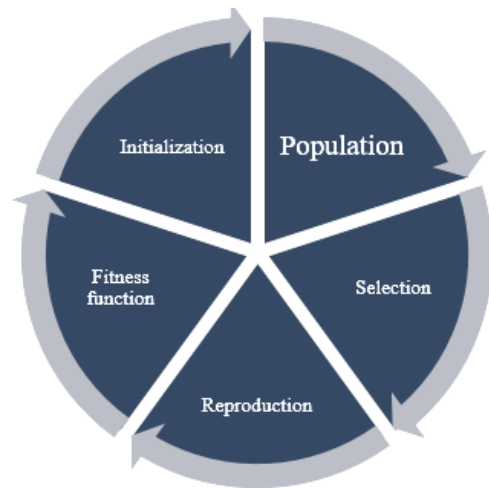


Fig 6: Functioning of GA

Figure 6 demonstrates the functioning of the genetic algorithm. These factors helps in the determination of the solution through these functioning factors. This helps to obtain the solutions with accurate results. This includes the collection of garbage which are recognized through the image processing techniques.

### 1. Initialization

Initialization is the process of generating an individual set of data in the dataset. They are denoted as population. The combination of the existing parameters are denoted as genes. The integration of genes tends to form chromosomes [25]. Here the random binary strings are used for the initialization process.

### 2. Fitness function

The fitness function is denoted as the strength of the individual to perform the functions and compete with the neighbouring individuals. They are obtained through fitness values. They are estimated through the probability functions through evaluating with individuals.

### 3. Selection process

The process of selection helps to obtain the newer individuals. They are arranged in pairs to accumulate and produce newer data. This helps to transfer the information from one phase to the another phase.

```

vector<Individual> population;
bool found = false;

// create initial population
for(int i = 0; i < POPULATION_SIZE; i++)
{
    string gnome = create_gnome();
    population.push_back(Individual(gnome));
}

while(! found)
{
    // sort the population in increasing order of fitness
    sort(population.begin(), population.end());

    // if the individual having lowest fitness score ie.
    // 0 then we know that we have reached to the target
    // and break the loop
    if(population[0].fitness <= 0)
    {
        found = true;
        break;
    }
}
    
```

Fig 7: Evaluation of fitness function

Figure 7 demonstrates the evaluation of the fitness function. The lower fitness value is considered because it targets a particular index.

#### IV. CONCLUSION

The detection and classification of garbage can be differentiated through the proposed system. This is evolved through artificial intelligence with deep learning techniques. The control and monitoring functions are obtained through optimization techniques. The collection of garbage with solid waste management using artificial intelligence and the Internet of Things is named a smart waste management system. The Internet of Things (IoT) helps to communicate from one end to another to enhance reliability in the systems. Thus the smart solid waste management system helps to classify and decompose the garbage without any consequences to the environment.

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