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A NOVEL SMART GARBAGE SYSTEM FOR SMART CITY

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ABSTRACT

This is generally seen that garbage bins are placed at various public places in the cities to reduce the amount of garbage thrown on the streets, due to increase in the waste every day; it creates unhealthy condition for the people and creates bad smell around the surroundings. It also leads to many diseases and human illness. So to avoid this, smart bin system is proposed in this paper which will intimate the amount of garbage level through the tags placed on the smart bins called as RFID technology. RFID is used to intimate the storage capacity of smart bin. It may also be responsible for the type of waste to be managed either biodegradable or non-biodegradable. Garbage management system is the main issue in the field of Internet of things. The absence of efficient waste management has caused serious environment problems and cost issues. Smart bin includes plasma decomposition process, in which plasma decomposes all the waste and converts it into syngas. This is new technology of decomposing waste when the smart bin is full of garbage and reaches its threshold value then the sensors will send the notification to the lid to close and it will notify plasma to start its functioning and starts decomposing the waste and then gasoline air converter further converts the syngas into fuel (natural gas). Plasma torches are used in many machines works. This paper includes the new garbage management system.

INTRODUCTION

The improper disposal of waste has a serious and dangerous impact on many areas. Garbage thrown in the street or in open spaces creates a problem for the people to survive; it stinks and also spread diseases. Non-biodegradable materials thrown into open drains make their way into the sewerage system, it clogs pipelines and damages infrastructure. The hazards posed by the removal of industrial waste are even greater, with the release of pathogens and toxic compounds harmful not just to human life but also to plants and animals. Garbage dumped in the countryside ruin the landscapes and unique habitats of flora and fauna are lost. [1]. The traditional way of manually monitoring the wastes in waste bins is a complex, cumber some process and utilizes more human effort, time and cost which is not compatible with the present-day technologies. So new methods are required to introduce to reduce garbage waste and this can be done technically.

In this paper analytics is integrated in order to create optimal changes in the conventional methodology of waste collection with the large amount of data that is being produced by the smart bin networks. The movement of waste across the whole city can be tracked and thus can be monitored by a system efficiently and concretely. This system can prove to be a revolution for the whole urban waste management system of upcoming smart cities. A technology named Zigbee GSM (), that enables the remote monitoring of solid waste bin in real time and which will inform the authorized person when the garbage bin is about to fill. These technologies are good enough transport monitoring management facilities and storage waste collection. It does not have any user interaction site like websites and android application, and that's why RFID is used to detect the tags and aware the people in their android application. [2].

Smart bin also describes the application of managing waste collection system of an entire city. The sensors enabled smart bins generate a large amount of data, which is further analyzed to see the condition of waste disposal and notify when the garbage is at its threshold value. It is difficult to implement in large cities. The IR sensor placed inside the trash sense the level of trash and there are another sensor will sense the amount of toxic gases. Once the trash is filled, notification is send. The RFID placed inside the trash will intimate about the overflowing of trash. Some researchers proposed that there are many dustbins located throughout the city or the campus, these dustbins are provided with which helps in tracking the level of the garbage bins and a unique ID will be provided for every dustbin in the city so that it is easy to identify which garbage bin is full. Tags are placed to detect the dustbins. When the level reaches the threshold limit, the device will transmit the level along with the unique ID provided [3, 7]. The concerned authorities can help us in making the people aware about the smart bin.

Problems with existing smart bins: -

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- Overflowing of bins
- Bacteria, insects and vermin thrive from garbage Air pollution and respiratory diseases
- Contaminates surface waters, which affects all ecosystems

Direct handling of overflowing waste exposes for health risks inefficient waste control is bad for municipal well being

INTERNET OF THINGS

The internet of things is the network of devices, which allows things to connect, interact and exchange data. Internet of things (IOT) involves extending internet connectivity beyond standards devices, such as desktops, laptops, smart phones and tablets, to any range of traditionally dumb or, non- internet- enabled physical devices and everyday objects, these devices can communicate and interact over the internet, and they can be remotely monitored and controlled. It connects things with internet and data can be exchanged within the systems. The entire network-based technologies need IOT to share information required.

Architecture of IOT

The bottom most layers consist of your devices and things which include the plasma torches which can be used to decompose all the waste material and converts it into syngas. The functioning of garbage bin starts from here, on the top of the device there is a layer called device communication layer, devices can communicate with each other or upper layers using this layer. This communication layer communicates in the way it sense the amount of garbage present in the garbage bin. And when it crosses its threshold value it starts its functioning. It warns plasma torches to function and decompose as fast as possible. The third layer is the aggregation layer. A message will be sent here. There is an aggregation layer between the garbage waste which is not decomposed and the garbage waste which is decomposing and which is in the process. And event processing layer is very important component and this is generally cloud. The data can be stored, analyzed and processed here. So in garbage system the event processing layer will the RFID (Radio frequency identification), which is used to track various objects. So it is used in tracking the garbage bins at what distance the garbage bin is placed and it is connected through an android application which will help us in tracking the bin by code which is placed on the garbage bin. It also ensures at what level the garbage bin is full and the storage capacity of the garbage bin [4] [8]. And these are how human can be connected through applications. The top most layers are the external communications layer, a human being can communicate with the devices using this layer, and this may be with the help of dashboard and apps. In this how human being can communicate with the devices through their mobile phones and by throwing garbage in the dustbins. This is to identify who all hare accessing the data and if they have the permission to do so. Management needs to check whether the device is working properly or not. And the syngas which is produced can be reformed and converted into fuel so that it can be used further by many industries. The gas is transferred into another chamber in which gasoline air converter helps in converting the syngas into fuel (natural gas) [5]. An IOT architecture has been shown in Fig 1.
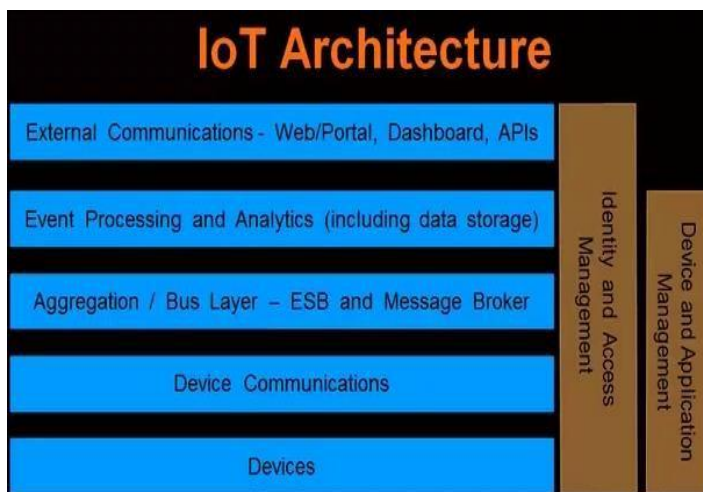

Fig. 1: IOT architecture

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Advantages of IOT

Environmental monitoring- It measures the amount of water and the soil which is required for the better plant growth. It warns the people about the disasters and prevent damages and can helps in pre-precautions need to be taken. It can also detect the amount of garbage thrown and can reduce it. It helps in maintaining the environment clean.

Infrastructure management- It is useful for tracking if there is any problem in urban or rural infrastructure such as bridge, railway to reduce risk of danger and any failure in strength would be cured.

Industrial applications- They investigate the quality of product in order to check whether product fulfil the demands of the customer and is gaining much in the market.

Energy management- Energy management is how the energy consumption can be reduced when connected with the internet and reduce power consumption such as cloud based, remote control for oven, lamp and etc. [6].

Medical and healthcare Systems- Healthcare systems help to improve patient state better by monitoring and controlling their heart rate or blood pressure or even for their diet. IOT helps in improving health of the patient as soon as possible.

Building and home automation- It maintains the appliances such as air condition, security lock lightening, heating, ventilation, telephone system, TV to make a comfort, secure, with low energy consumption [11].

APPLICATIONS OF IOT

Smart home: Smart Home has become the revolutionary ladder of success in the residential spaces and it is predicted Smart homes will become as common as smartphones. The cost of owning a house is the biggest expense in a homeowner's life. Smart Home products are promised to save time, energy and money. With Smart home companies like Nest, Ecobee, Ring and August, to name a few, will become household brands and are planning to deliver a never seen before experience. For example, Amazon Cloud Cam, LifxMini Wi-Fi Smart Bulb, Ecobee4 etc. Fig 2 depicts the smart home.

Fig. 2: Smart Home
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Wearables: Wearable devices are installed with sensors and software's which collect data and information about the users. This data is later pre-processed to extract essential insights about user. These devices broadly cover fitness, health and entertainment requirements. The pre-requisite from internet of things technology for wearable applications is to be highly energy efficient or ultra-low power and small sized. For example, Samsung Gear Fit2. Fig 3 shows the typical smart watch based on an IoT mechanism.

Fig. 3: Smart Watch

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Connected cars: The automotive digital technology has focused on optimizing vehicles internal functions. But now, this attention is growing towards enhancing the in-car experience. A connected car is a vehicle which is able to optimize it's own operation, maintenance as well as comfort of passengers using onboard sensors and internet connectivity. Most large auto makers as well as some brave startups are working on connected car solutions. Major brands like Tesla, BMW, Apple, Google are working on bringing the next revolution in automobiles. Fig 4 denotes the concept of smart cars.

Fig. 4: Smart cars

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Industrial internet: Industrial Internet is the new buzz in the industrial sector, also termed as Industrial Internet of Things (IoT). It is empowering industrial engineering with sensors, software and big data analytics to create brilliant machines. According to Jeff Immelt, CEO, GE Electric, IIoT is a "beautiful, desirable and investable" asset. The driving philosophy behind IIoT is that, smart machines are more accurate and consistent than humans in communicating through data. And, this data can help companies pick inefficiencies and problems sooner. IOT holds great potential for quality control and sustainability. Applications for tracking goods, real time information exchange about inventory among suppliers and retailers and automated delivery will increase the supply chain efficiency. According to GE the improvement industry productivity will generate $10 trillion to $15 trillion in GDP worldwide over next 15 years. The traditional usage of industrial internet is being shown in Fig 5.

Fig. 5: Industrial Internet

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Smart cities: Smart city is another powerful application of IoT generating curiosity among world's population. Smart surveillance, automated transportation, smarter energy management systems, water distribution, urban security and environmental monitoring all are examples of internet of things applications for smart cities. IoT will solve major problems faced by the people living in cities like pollution, traffic congestion and shortage of energy supplies etc. Products like cellular communication enabled Smart Belly trash will send alerts to municipal services when a bin needs to be emptied. By installing sensors and using web applications, citizens can find free available parking slots across the city. Also, the sensors can detect meter tampering issues, general malfunctions and any installation issues in the electricity system. A typical smart city mechanism/design is being depicted in Fig 6.

Fig. 6: Smart cities

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Smart retail: The potential of IoT in the retail sector is enormous. IoT provides an opportunity to retailers to connect with the customers to enhance the in-store experience. Smartphones will be the way for retailers to remain connected with their consumers even out of store. Interacting through Smartphones and using Beacon technology can help retailers serve their consumers better. They can also track consumers path through a store and improve store layout and place premium products in high traffic areas. Fig 7 shown the concept of Smart Retail chain.

Fig. 7: Smart Retail

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PROPOSED WORK

The problem nowadays is about litter of garbage around the streets when the garbage is full. And due to this there are many diseases that occur, so to prevent the losses Smart bin is introduced. The proposed system is about smart garbage in which the garbage gets decomposed by using plasma and gets converted into syngas which further purified as natural gas and released in atmosphere. To deal with the

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problem of waste disposal a system was proposed to identify the waste products to be thrown and these could be differentiated as, plastic garbage bags, chips and stickers. The followings are used in the proposed system.

RFID- Radio frequency identification

RFID is used to identify and track tags attached to objects. The tags contained information stored in it. Active tags have a local power source and RFID can be operated from a distance from the RFID reader. RFID is one method for automatic identification and data capture, RFID is used to aware the person that the smart bin is at its threshold value and cannot store more garbage and storage capacity is limited.

RFID system is made up of two things- a tag and a reader. RFID tags include a transmitter and a receiver. The RFID component on the tags has two parts- a microchip that stores information, and an antenna to transmit a signal. To read the information encoded on a tag, a two- way radio transmitter-receiver called an interrogator emits a signal to the tag using an antenna. The interrogator will then transmit the read results to an RFID computer program [9, 10].

There are two types of tags- passive and battery powered. A passive RFID tag will use the interrogators radio wave energy to interrogate. A battery powered RFID tag is embedded that powers the relay of information. In an RFID- based garbage collection system, an RFID collection bin includes a communication module to communicate with a central server, automatic garbage entrance, and a scale function to measure the weight of the food waste. However, the collection bin communicates only with a server [15].

Plasma

Plasma is a state of matter. Plasma is created by ionization process by adding energy to a gas so that some of its electrons leave its atoms. The results are negatively charged (electrons), and positively charged (ions). The charged particles in plasma react strongly to electric and magnetic fields. If plasma looses heat, the ions will re-form into a gas, and emits the energy which had caused them to ionize. Plasma is found in stars. It requires very high temperatures to break the bonds between electrons and the nuclei of the atoms.

A plasma waste converter is a plasma torch applied to garbage which converts the garbage waste into syngas and the syngas can be used further in the form of fuel in the industries. A plasma torch uses a gas and powerful electrodes to form plasma. The temperatures generated by a plasma torch are hotter than the surface of the sun. Molecules break down in molecular dissociation. When molecules are exposed to intense energy, the molecular bonds holding them together break apart. Only elemental components of the molecules are left [13].

Organic molecules become volatilized, or turn into gases. This syngas can be used as a fuel. Inorganic compounds melt down or converted into a glassy substance. Metals melt down and combine with the inorganic matter called as slag. The heat evolved from plasma converters causes pyrolysis. It is a process in which organic matter breaks smaller compounds and decomposes. Plasma torches can operate in airtight vessels also. [12].

Plasma waste converters can convert almost any kind of waste. It can treat medical waste or contaminated waste and gases and slag are left as residue. The waste breaks down in basic elements; they can be disposed of safely. A plasma converter can break down every type of waste but can't break down heavy radioactive material, such as the rods used in a nuclear reactor. If you put such material in a plasma furnace, it would catch on fire or even explode.

Workstation

Conveyor system- garbage is loaded on the conveyor and is pushed into the furnace

Pre-treatment mechanism- Pre-treatment process is required for efficient working of plasma torch.

Furnace- furnaces have an airlock system which allows garbage to come in and prevent the hot gases in the furnace from escaping into the atmosphere.

Plasma torch- the plasma torches used in these facilities are custom-built.

Slag drainage and afterburners- molten slag pools at the bottom of the furnace and it maintains the high temperature inside the gasification chamber.

Gas ventilation- the furnace also has a vent system to allow gasifier components to pass into another part of the system.

Afterburner- gases can pass through a secondary chamber [14]. These extremely hot gases then pass through a heat recovery steam generator system where they heat water to form steam.

Syngas cleaning- e gases from the furnace enter a chamber where they are cooled. The gases pass through a spray of water, which scrubs the gases of pollutants.

Components of smart garbage bin:

- Bottom layer at which lid is placed which collects all the waste required for decomposing and plasma torches are placed in the same layer which decompose the same waste side by side. The devices are found in this layer.
- Another component is layer which is present at the top called as device communication layer, at this layer sensors are present used to detect the amount of garbage stored, and it ensures when the garbage cross its threshold value the sensors sends the notification to close the lid and starts functioning of plasma.
- There is another chamber where decomposition of garbage takes place and plasma converts it into syngas and then gasoline air converter converts syngas into fuel.
- Aggregation layer is the third component which separates the waste which is yet to be decomposed and the waste which is being decomposed by plasma.
- The topmost layer is the garbage collection layer. It is the external communication layer, where humans can communicate with the device through the app. It notifies them about the storage capacity of the bin.
- Then is one more layer named as event processing layer, ensures about the usage of RFID. The tags placed on the smart bin can easily track the bin and notify about the bin [17].
- Another chamber attached to the dustbin is gasoline air converter which converts syngas into fuel (natural
- gas) which can further be used in industries.

Tools/equipment required:

- Garbage container in which garbage is thrown
- Two Sensors (one at upper lid one at lower lid) are used to detect the threshold value up to which garbage bin is full
- RFID is used to detect the dustbin with the help of tags placed on the bin and notify about the amount of garbage stored in it.
- Two lids are used. (One on the top of the bin which is half open and half closed, and another on the third most layer of the garbage bin to open and start functioning [16].
- Plasma torches
- Gasoline air converter

SYSTEM DESIGN OF PROPOSED SMART DUSTBIN

A smart bin is created which works on RFID technology and also made up of high-tech materials which do not get melt through plasma. The waste is decomposed and converted into natural gas. This has been introduced before but now this can be used in the form of smart bin [18]. Garbage thrown in the smart bin can be toxic and non- toxic, plasma convert all types of waste into gas and also helps in decrease of diseases. Smart bin is automatic and works on neural networks technology. An app is created which can function all the automatic operations of smart bin. Sensors can be introduced which can sense the amount of garbage around the surrounding. The automatic functioning of the smart bin makes sure when the lid is open or closed. The proposed mechanism/idea of smart garbage bin in shown in Fig 8 in the form of flowchart and its corresponding parts/components is shown in Fig 9.

WORKING

The bottom most layers consist of the devices and things which include the plasma torches which can be used to decompose all the waste material and converts it into syngas. The functioning of garbage bin starts from the top most layer where there is a cover lid present on the top of the dustbin which usually remains closed so that it does not stink. There will be a small opening on the cover so that the garbage should be thrown from that. When the bin gets full and as the garbage gets above the marked level the sensor attached to the upper lid sends signal to lower lid and the lower lid gets open, the garbage from the upper chamber moves to the lower chamber where decomposition takes place through plasma beam which is attached in the lower most level [19]. The decomposed garbage gets converted into syngas which flows to the third chamber in which the gas is transformed into fuel. Syngas is composed of hydrogen and carbon monoxide and gasoline air converter converts the syngas into fuel which can be used for further purposes in many industries.
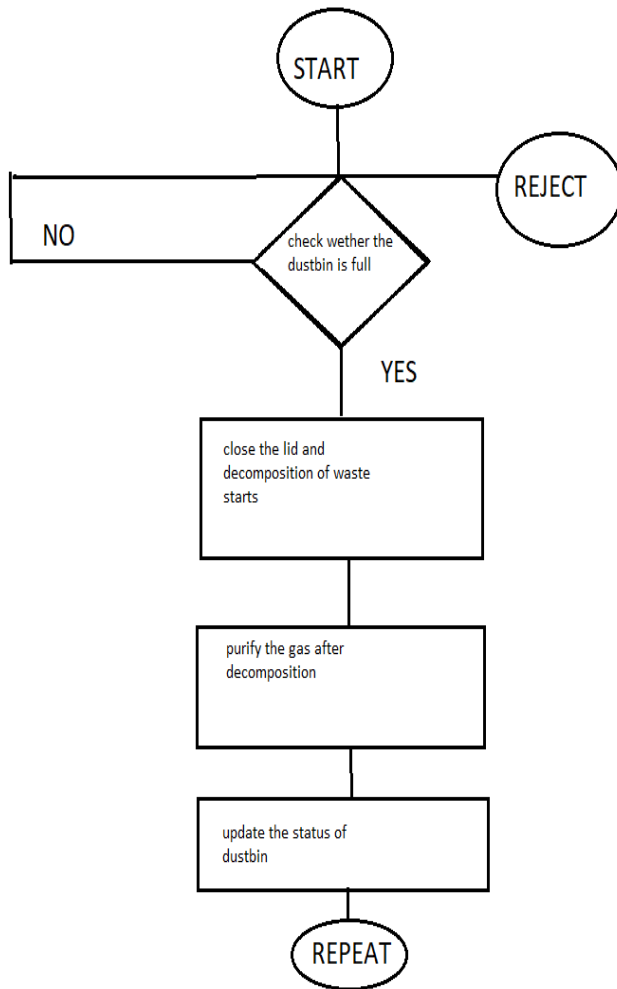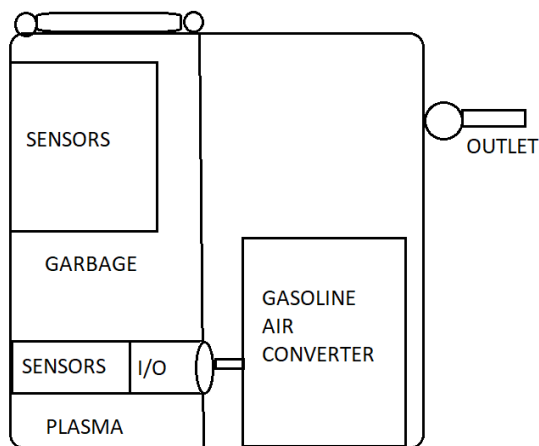
Fig. 8: Flowchart of Smart garbage bin

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Fig. 9: Smart Garbage Bin

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BENEFITS OF PROPOSED DUSTBIN

▪ Keeps the environment clean and fresh: The greatest advantage of waste management is keeping the environment fresh and neat.

▪ Reduces environmental pollution: Waste management not only eliminates the surrounding waste, but also will reduce the intensity of the greenhouse gases which is emitted from the wastes accumulated. The gas converter will convert these gases into non-toxic gases.

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- Reduces human workload: As everything is automatic the human effort in waste disposal is reduced and burning of waste is avoided which in return affects the environment.
- Time saving: It takes only few minutes to decompose the garbage present in the dustbin
- Reduces cost: So much money wasted in waste disposal and still not disposed of correctly is reduced with our smart dustbins as it is only one time investment.
- Conserves land: The large acres of land wasted and destroyed in just for waste disposal can be conserved using smart bins [20, 21, 22].

CONCLUSION

As we know that India comes at third position in pollution and garbage mismanagement, so to avoid this we introduce smart bin which on sensing the threshold value of garbage decompose it automatically and can reduce littering of waste products and materials. The data collected from various surveys noticed that most of the garbage waste do not get decomposed and left as a residue which cannot be recycled. Plasma converters may be used to convert the garbage waste into syngas. The syngas is evolved in the form of hydrogen and carbon monoxide. As in various industries gasoline air converters are used which converts syngas into fuel (natural gas). The smart bin also does have the capability to sense the amount of garbage present in the surroundings. This may have great impact in the environment, diseases can be reduced to an extent and this can be used in routine purposes. Having such a huge mountain of garbage collected from various places in Delhi can also have the solution to the problem. And the gas which is evolved gets converted by the gasoline air converter into fuel which can also be used in the environment. This would also help in reducing the amount of diseases.

CONFLICT OF INTEREST
There is no conflict of interest.

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