IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

INFECTIOUS MEDICAL WASTE SURVEILLANCE USING IOT

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Abstract: In recent times, the world has been experiencing an increase in medical cases. These medical cases are due to the inappropriate disposal of hospital wastes. Medical wastes are not minded properly that contain hazardous wastes that lead to different viruses. Medical waste is some waste that is generated in healthcare centers, such as hospitals, clinics, and laboratories. Medical waste can contain chemicals, such as mercury, lead, and other hazardous materials that can leach into the soil and water, leading to environmental pollution. This pollution can also cause health problems for people living in the surrounding areas. The medical waste may contain infectious or hazardous materials that can pose a risk to human health and the environment. Hazardous waste in hospitals may include: Chemical waste that includes expired or unused chemicals, such as laboratory reagents and solvents, that can pose a risk to human health and the environment if not properly managed. Pharmaceutical waste which includes expired, unused, or contaminated medications, as well as chemotherapy drugs, which can be toxic and harmful if not properly disposed of. Radioactive waste which includes materials that contain radioactive isotopes, such as medical equipment used in radiation therapy or nuclear medicine. Infectious waste includes waste contaminated with infectious agents, such as blood-soaked bandages, used needles, and cultures from laboratory experiments. Sharps waste that includes used needles, syringes, and other sharp objects that can cause injury or transmit infection. Proper management and disposal of hazardous waste in hospitals is critical to protect the health and safety of patients, healthcare workers, and the environment. This may include segregating hazardous waste from non-hazardous waste, providing designated containers for different types of waste, labeling containers appropriately, and ensuring that waste is stored and transported safely to prevent contamination. Hospitals may also use specialized treatment methods, such as incineration or autoclaving, to treat hazardous waste before disposal.Medical waste is potentially dangerous. So, we have proposed a modified method of Sorting of medical wastes in the dustbin is very important. In this Continuation, we framed different rules to apply to treatment of different types of waste. We designed the Smart hospital waste management dustbin by using different sensors for different purposes. The bins are classified based on color. Four colors Red, Blue, Yellow, and Black indicate the different wastes in the Hospital. Sensors such as Ultrasonic measure the distance of the waste to be disposed of and it works along with the Servo Motor for the opening and Closing of the lid. Here, the Camera module for Arduino UNO is attached for the waste Image Recognition and classifies according to the color of the bin. The Gas sensor is set with the maximum range of the gas that stinks from the bin and it alerts the worker by ringing the buzzer. The Buzzer also works when the dumpster is filled. It must be properly managed to protect the general public. Specifically, healthcare and sanitation workers who are regularly exposed to biomedical waste as an occupational hazard. Additionally, a GSM module is connected for the SMS Alert to the frontline workers when the bins get filled and when it stinks. This helps the workers for the immediate action. Healthcare facilities should follow proper protocols for segregation, treatment, and disposal of medical waste to ensure the safety of their employees, patients, and the environment. Hence, disposal and accumulation of waste in the proper manner is of great value as it can lessen direct and indirect health risks to people and damage to flora, fauna and the environment.

Index Terms **- Arduino UNO, Ultrasonic Sensor, GSM Module, Image Recognition.**

I.INTRODUCTION

Medical waste disposal is an essential process that helps protect public health and the environment. With the increasing measure of medical material being generated every day, it has become crucial to find innovative and efficient ways to manage it. One potential solution is using the Internet of Things (IoT) technology to improve medical waste disposal processes. IoT is a network of devices that can communicate with each other over the internet, exchanging data and performing actions without the need for human intervention. In the context of medical waste disposal, IoT devices can be used to monitor waste containers, track waste disposal activities, and provide real-time data to waste management teams. By using IoT sensors, waste containers can be monitored

to determine when they are full, reducing the need for human intervention and ensuring timely waste removal. This can help prevent overfilled containers and the risk of waste spills, which can be hazardous to both human health and the environment. IoT technology can also be used to track waste disposal activities, providing real-time data on waste generation, collection, transportation, and disposal. This data can be used to determine inefficiency in the waste disposal process, optimize waste management operations, and ensure compliance with regulatory requirements. Overall, the use of IoT technology in medical waste disposal can help improve the efficiency, safety, and sustainability of waste management processes. It has the potential to revolutionize the way medical waste is managed, leading to a cleaner, safer, and healthier environment for everyone. Medical Waste is exploding in our day to day life. There are many classifications for medical waste. All of them should be disposed of properly. Mainly the wastes produced in the healthcare sector contain highly hazardous and if it is not treated properly, they will lead to the spreading of infectious virus. So, the waste should be classified by different color bins. YELLOW, RED, BLUE, and BLACK. The Yellow bin is used for infectious materials, body organs, cotton, human organs, tissues, medicines, and laboratory wastes. The Black bin is used for disposing of expired medicines, radioactive materials, and toxicity waste. The Blue bin is used for disposing of sharp and infectious wastes like glass bottles and metallic implants. The Red bin is used for disposing of used blood bags and plastics like rubber, gloves, infectious IV sets, etc. This will help reduce the spreading of viruses and diseases as these wastes are highly prone to contamination. The dustbin would then segregate the waste into separate compartments based on the classification, making it easier for waste management workers to collect and recycle the materials. However, there may be challenges to overcome in implementing this technology, such as ensuring the accuracy of the image classification algorithms and addressing any privacy concerns related to the use of cameras or sensors to capture images of waste items. Overall, the idea of a smart dustbin that can classify and segregate waste is a promising development in the field of waste management.

1.1 IMAGE PROCESSING AND MACHINE LEARNING

Image processing and classification techniques can be combined with machine learning algorithms to develop a system for the classification of waste management in hospitals. This system can use images of waste items to classify them into different categories such as biomedical waste, chemical waste, and general waste. The process typically involves the following steps:
Data collection: Images of waste items are collected using a camera or other imaging device.
Preprocessing: The images are preprocessed to improve their quality, remove noise, and enhance the features that will be used for classification.
Feature extraction: Features such as color, texture, shape, and size are extracted from the preprocessed images. These features are used to represent the images in a way that can be used for classification.
Classification: Machine learning algorithms are trained using labeled data to classify the waste items into different categories. Popular machine learning algorithms for image classification include Convolutional Neural Networks (CNNs), Support Vector Machines (SVMs), YOLO (You Only Look Once), SSD (Single Shot Detection) and Random Forests.
Post-processing: The classification results are post-processed to eliminate errors and improve the accuracy of the system. By combining image processing and classification with machine learning algorithms, it is possible to develop a highly accurate and automated system for waste classification in hospitals. This system can help hospitals to manage their waste more effectively, reduce the risk of contamination and infection, and ensure compliance with regulatory guidelines.

1.2 TRAINING IMAGE DATASET

A training dataset is a set of data used to train a machine learning model to make predictions or classifications. The training dataset is a subset of a larger dataset that is collected, curated, and preprocessed to be used specifically for training a machine learning model.In machine learning, the process of training a model involves feeding the algorithm a set of input data, along with the correct outputs (or labels) that correspond to those inputs. The model then learns to associate the input data with the correct outputs, making it possible to make predictions or classifications on new, unseen data.The quality and size of the training dataset is crucial to the performance of the machine learning model. A larger and more diverse training dataset can help the model generalize better and make more accurate predictions on new data. However, the training dataset should also be representative of the real-world data the model is expected to encounter.To ensure the quality of the training dataset, it is often necessary to perform data cleaning, preprocessing, and feature engineering. This may involve removing duplicates, filling missing values, normalizing data, or transforming features to better represent the underlying patterns in the data. Overall, the training dataset is a critical component of machine learning and plays a essential role in the quality and generality of the resulting model.

1.3 INTEGRATION OF TRAINED IMAGES TO CAMERA MODULE

Integrating the trained and test images to the camera module of Arduino for recognition of hospital wastes images involves several steps:
1. Train a machine learning model: Develop a machine learning model, such as a deep neural network, to recognize different types of hospital waste images. The model can be trained using a large dataset of labeled images, with the output being the classification of the waste type.
2. Test the machine learning model: Test the model with a separate dataset of images that were not used in the training phase to evaluate its accuracy and performance. This can help to refine the model and improve its accuracy.

3. Integrate the model into the camera module of Arduino: Once the machine learning model is trained and tested, it can be integrated into the camera module of the Arduino board. This involves writing code to interface with the camera module and to process the images captured by the camera.
4. Capture and process images: The camera module can be set up to capture images of the hospital wastes as they are disposed of. The images can then be processed using the machine learning model to identify the waste type.
5. Output the waste type: Once the waste type has been identified, the Arduino can output the information to a display, a speaker, or other output device to alert the user of the correct disposal method.
Overall, integrating the trained and test images to the camera module of Arduino for recognition of hospital waste images involves a combination of machine learning, image processing, and hardware integration techniques. The result is an intelligent waste disposal system that can help to improve the efficiency and accuracy of hospital waste management.

1.4 OBJECTIVE OF THE STUDY

The main objective of this project is to introduce proper disposal of medical waste by segregating bins. To decrease the chance of getting diseases by contamination of wastes. To evacuate the containers at the proper time. This improves the medical waste monitoring system to perform efficiently. To Implement strategies to reduce the environmental impact of medical waste, such as recycling, composting, or repurposing waste for energy generation. To improve public health and the environment by minimizing the risks associated with medical waste disposal, reducing waste production, and improving the sustainability of waste management processes.

1.5 AREA OF USE

The hospital waste management and surveillance system using IoT can be used in various areas, including:
Hospital waste management: The system can be used to manage the hospital waste generated by the hospital. The system can monitor and control the waste disposal process, including segregation, collection, transportation, and disposal.
Infection control: The system can monitor and track the movement of waste and ensure that it is disposed of properly to prevent the spread of infections and diseases.
Environmental protection: The system can ensure that hospital waste is disposed of in an environmentally friendly manner, reducing pollution and the risk of environmental damage.
Resource optimization: The system can help optimize resource utilization in hospitals by monitoring waste generation patterns and developing strategies to reduce waste production.
Cost reduction: The system can help hospitals reduce their waste management costs by identifying and eliminating inefficiencies in the waste management process.
Safety and security: The system can improve the safety and security of hospital waste management by monitoring the waste disposal process, preventing unauthorized access to waste storage areas, and ensuring that hazardous waste is disposed of properly.
Overall, the hospital waste management and surveillance system using IoT can help hospitals to manage waste more efficiently and effectively, while also promoting environmental protection, resource optimization, and cost reduction.

II. LITERATURE REVIEW

The Garbage in cities has to be effectively and efficiently implemented. Various proposals were put forward and some of them were already implemented. So the survey was done among the different proposals and survey among different methods for smart garbage monitoring systems using IoT.

In[1] Dr. Pooja Raundale et al. Proposed IoT-based Biomedical Waste Classification, Quantification, and Management system by making utilization of recent advancements in technology and wireless connectivity could help to fully automate this system. For purpose of automating this system IoT devices can easily be used as they are very cheap to invest in and setting them up is easy. Generally, the IoT COTS components are used.
In[2] Chao Wang et al. Proposed an IOT Monitoring System of Medical Waste Based on Artificial Intelligence based on face recognition technology and system engineering principle.
In[3] Gayathri B et al. Presents the Smart Garbage Monitoring System for Hospitals using IoT. Zigbee and Global System for Mobile Communication (GSM) are used in this Project. The overflow of garbage is indicated using ARM 7 sensor.

In[4] Hui Wang et al. made a research on Medical Waste Supervision Model and Implementation method based on Blockchain. By building a decentralized system architecture and setting intelligent contracts, they integrated and recorded the medical waste disposal regulatory information in different phases on the blockchain to form the supervision of the medical waste chain.
In[5] Biomedical Waste Monitoring System And Recycling Method For Hospital Using Iot by Priyavarthini S^1, Kamali K^2, Kailainathan S^3, Gopika Ram P^4.

III. ANALYSIS

3.1 EXISTING SYSTEM

In the present system, the high-hazard biomedical waste is being monitored and waste is demolished by the arena workers. Due to this manual inspection of compost heaps for their status from their determinant for arena workers and they are exposed to defile disease. On the other, the trash bins are filled periodically and the overflow of waste and deluge are highly dangerous and

create health issues in the case of biomedical waste deluge found unseen. Due to this hospital workers and patients are mostly affected.

3.2 PROPOSED SYSTEM

In the proposed system, we have connected all the bins with Ultrasonic Sensors to detect the level of bins which is to be filled. With the help of this system, medical waste can be monitored and automatically disposed of, it is done based on IoT with the help of sensors such as a calorimetric gas sensor, a global system for mobile communication module, vesper sensor to intimate the frontline workers. In this project, we are using the camera module to capture waste images using an image recognition algorithm that classifies the waste based on the categories of bins waste collected by the workers and recycles the material such as ensuring the accuracy of the image classification algorithm and addressing any privacy concerns related to capturing the image of waste items.

IV. ARCHITECTURE

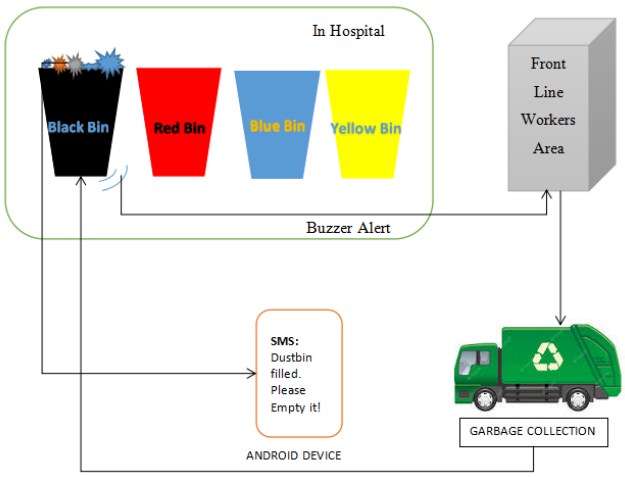

Figure 4.1 General Architecture

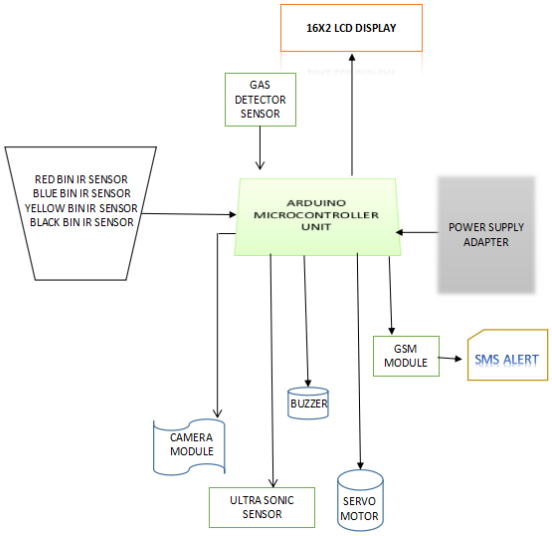

Figure 4.2: Hardware Architecture

In Figure 4.1, The General Architecture shows the classification of four colour Bins in the Hospital. When one of the dustbins get filled, the buzzer starts to alert the hospital frontline workers and the team. Also, SMS is triggered to the phone linked to GSM Module. To empty the bins, the Garbage collection team comes and empty the dumpster.

In Figure 4.2, the dataflow can be seen and the working process is mentioned. The flow starts from the sensors to the Microcontroller and thus it is clear that the microcontroller process the sensor signals to produce the desired output. The sensors are connected to the Aruino UNO ATMEGA 328P Microcontroller Unit and LCD display is connected for the results to be displayed. The GSM Module is inserted with working SIM for the message Alert. The Camera Module of the Arduino is Integrated with deep learning algorithm and loaded with trained datasets of waste images. This helps to automatic identification and classification of the waste to the respective bins. The Buzzer alarms the front line workers to alert the team when the dumpster is filled or if stink occurs.

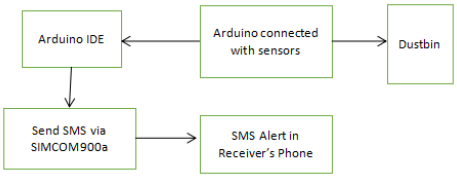

Figure 4.3: Software Architecture

In the Figure 4.3, the Software Architecture depicts the workflow that happens inside the software where the program is loaded. In the Arduino IDE, the C++ code is uploaded by porting the USB Arduino ports. The uploaded code will run and the output is displayed. The SMS Output are sent to the respective mobile numbers of the workers. The SMS are sent via SIMCOM 900a.

4.1 RESULTS AND DISCUSSION

ARDUINO IDE:

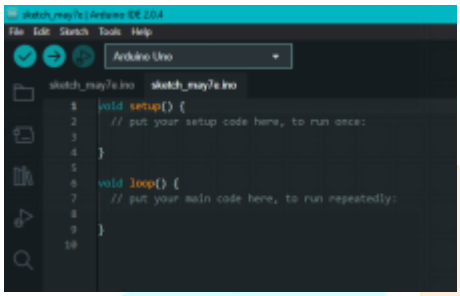

Figure A.1 Arduino IDE Page

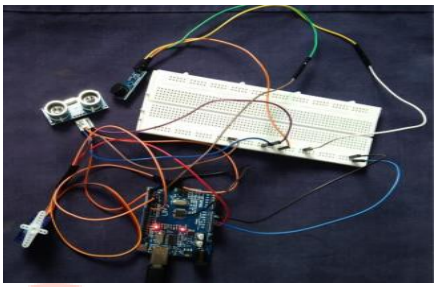

Figure A.2 Working of Servo motor

SIMCOM 900a CONNECTION AND WORKING:

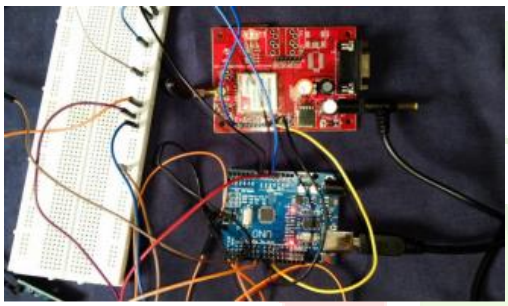

Figure A.3 SIMCOM 900a Working Model

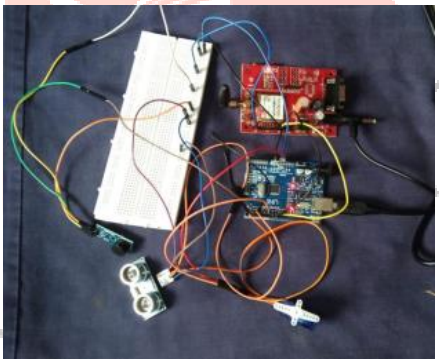

Figure A.4 Waste level detection and sending SMS Alert

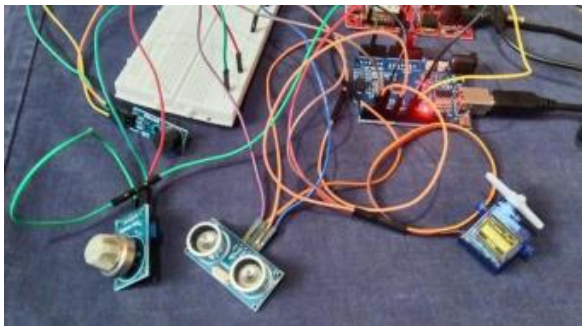

Figure A.5 Gas Detection

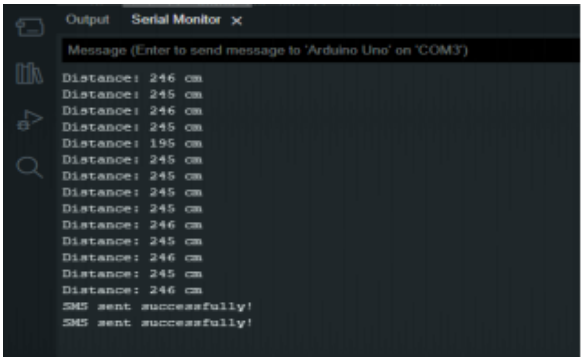

Figure A.6 Sending SMS

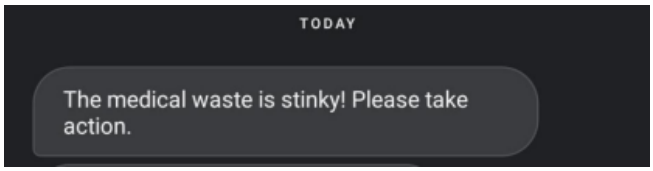

Figure A.7 Output Model 1

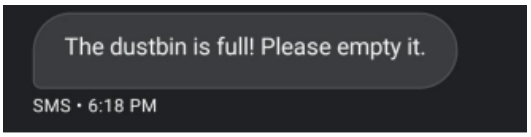

Figure A.8 Output Model 2

Figure A.9 Training Image Dataset

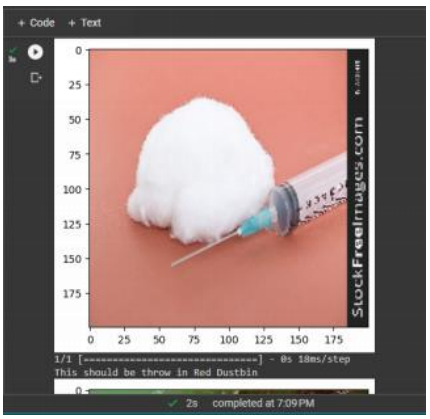

Figure A.10 Output Model 3

The image datasets are collected and labeled. The datasets are trained and then validated. Another set of image dataset is given to the testing folder. The testing folder is called and verified with trained sets.

These Images and Screenshots are the output of our project, which was taken while accessing the model.

V. Conclusion and Future Enhancement

Thus by implementing this system, infectious medical waste can be monitored and tracked easily. This prevents the contamination of waste and the spreading of diseases. There will be proper disposal of waste. Once the bins get filled, it is then triggered by an SMS alert. Also, We are using the camera or sensor to capture an image recognition algorithm to classify the waste based on the categories of bin waste. It ensured the accuracy of the image classification algorithm and addressed any privacy concerns related to capturing the image of waste items. By this system of methodology, the spread of contamination disease has been controlled and we can easily evacuate the waste as soon as it has been filled with the help of SMS and Buzzer.

In future, they can use various technologies and sensors for the improvement of infectious waste surveillance for the hospitals to prevent the people from getting many diseases. In this project we used an IR sensor , UltraSonic sensor , servo motor and camera module to find out whether the dustbin in the hospital is filled or not and to identify the wastages are correct in each dustbin without getting mixed. In future, new sensors can be added and rain sensors also attached for the prediction of rain in the locality which helps to prevent contamination of wastes. With the help of future advancements and greater technologies, the smart bins can get modified with new tools.

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