A New Approach for Effective Biomedical Waste Segregation and Disposal

Aneri Tank, Dimpal Khambhati

Abstract: ***Biomedical waste management is a major concern in current scenario. Increase in hospital and health care facilities also generates high amount of biomedical waste. Therefore, segregation, handling and disposing of waste is crucial step to be taken. Waste segregation is to be done according to the color-coded dustbins as per the rules formed by the "The ministry of environment, forest and climate change". Segregation into color coded dustbin is done on the basis of type of category of waste. If proper segregation of biomedical waste is not done, then the further process of handling and disposing of it becomes laborious. As different kind of waste is treated (reused, recycled and reduce) in distinct way. Not only this but the waste discarded improperly can be harmful to the environment and toxic to the people coming into contact with them invariably while disposing or treating the medical waste. Thus, we are developing an instrument which segregates biomedical waste effectively and dispose it having minimum human exposure with the it while and after disposal. We start with a matrix constructed using switches and LED lights of different colors which indicate the respective color code of the dustbins. The rows and columns describe the different properties of the waste material. Each of the dustbins has an ultrasonic distance sensor attached in front of them followed by a microcontroller and servo motor. The distance sensor circuit controls the lid of the dustbin when person goes near/away from the dustbin. This is how hospital waste segregation is done fruitful and disposal of it in such a way that chances of spreading infection through medical waste decreases. Later, it can be discarded in bigger bins for storing and transporting it to waste management companies.***

Keywords: Biomedical waste, Color- Coded dustbins, Hospital waste, Waste segregation.

I. INTRODUCTION

Biomedical waste is kind of unwanted material which is potentially hazardous to environment and harmful to the person managing it. It is also known as hospital waste which comprises of solid or liquid waste. Any waste which is generated in the perimeter of hospital during analytical, surgical, or diagnostically procedures and is toxic to the environment or has chance to spread infection comes under biomedical waste. This waste is different from household and corporation waste. Hence, they need to be treated and managed in a different way. In India, due to increase in mismanagement of biomedical waste," The Ministry of Environment and Forest, Government of India, formalize the Biomedical waste (Management and Handling) Rules, in July 1998"[1]. They were revised by the Government of India as BMWM (Principle) rules, 2016, and BMWM (amendment) rules, 2018[2]. These rules and regulations were adapted to manage the hospital waste effectively.

In past years, the rate of communicable diseases has increased, recently in the year 2019 a viral infection named Corona Virus (COVID-19) caused pandemic, where every individual had to wear mask, gloves and sanitize them frequently. Doctors and hospital staff had to put on PPE (Personal Protective Equipment) kits, face shields, filtered masks, etc. while on duty. All these protective layers were used of disposable materials. According to that if we are discarding this much amount of biomedical waste on the daily purpose, by the year 2022, 775.5 tons of hospital waste will be generated per day [3]. It is therefore, necessary to manage and handle such massive quantity of waste. There are many instances where disposable mask gloves and PPE kits were thrown on damp lands and roads. It not only affects environment as these materials are non-degradable, but also virus survives up to 7 days on mask [4]. Chances of spreading of infection and diseases thus, increase through mismanagement of biomedical waste. As person suffering with such highly infectious disease needs to visit hospital, the chances of Nosocomial infection increase. “Nosocomial infections refer to any systemic or localized conditions that result from the reaction by an infectious agent or toxin"[5]. There are numerous critical patients in ICU where many procedures take place such as catheter insertions, mechanical ventilation and other invasive techniques. The waste generated from such methods is contaminated with communicable diseases or infections. If such invasive materials are kept in an open environment without any proper covering protection, they may injure to the person coming into contact with it. As a result of which they may get infected with the contaminated waste. As per the nature of how hazardous waste it they are divided into color coded dustbins, which is as Table-I:

Table-I Color coded dustbins and their waste classification

	Color of the dustbin			
	Red	**Blue**	**White**	**Yellow**
Type of Waste	Syringes, Catheters, IV sets, Plastic wastes, Gloves	Broken glass, Metals	Needles, Syringes with fixed needles, Blades	Pathological waste, Dressing material, Cotton, Cytotoxic waste, Microbiology waste

Among this (10-25) % BMW is hazardous and remaining (75-95) % is nonhazardous [6].

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Segregation thus helps us to keep away the hazardous and nonhazardous waste away from each other, which will in turn keep the environment and person handling it on a safer side. Bio-Medical Waste (BMW) management not just signifies to treat and manage the waste. Medical waste differs from the corporation waste, so the process for managing it is also distinct. BMW management involves 4 different steps, they are: Segregation, Disposal, Transportation and Treatment. Separation of waste needs to be done at the time of generation only. The purpose is to segregate medical waste properly and effectively which has to be done as soon as they are generated. This will avoid the situation of dumping of medical waste on bare lands and water bodies. After segregation comes disposal, disposing of medical waste in proper bins and bags is necessary as many wastes are discarded in puncture proof bags. If segregation and disposal is done effectively then transportation and treatment is secured.

II. METHODOLOGY

The segregation of biomedical waste is essential before disposing it off properly. We propose to develop a device which helps in segregation as well as disposing medical waste with least human contact.

The device is manufactured using different electrical components combined, such as: Switches, LEDs, Microcontroller, Distance sensor, and motor.

1. **Motor –** Motor is an AC\DC, electromechanical device which converts electrical energy to mechanical energy. The mechanical movement is the output and can be linear or rotational. Rotational movements can be used to rotate to move the object in any plane. We are using servo motor here to get output in non linear form.
2. **Distance sensor –** The distance sensor is an input device which detects change in environmental position and provides output in electrical form. Distance sensor works linearly that is in one direction (here front direction) only. As the application of distance sensor is in hospitals, we are using ultrasonic distance sensor.
3. **Microcontroller –** It is an electrical device used to control the other connected devices, while giving and taking commands for their controlled functioning. Eg; Arduino UNO, Arduino NANO, Node MCU, etc.
4. **LED –** A semiconductor diode which will glow when current passes. To represent different color of the dustbin we will use various colors of LED like Red, Blue, Green and Black
5. **Switches –** An electrical device which connects or breaks the whole circuit. To make this device we will use push buttons which can switch ON/OFF at a time.

The device consists of mainly 4 blocks as shown in figure-1 of Block diagram such as: Distance sensor, Motor, Microcontroller and Matrix block. Matrix block segregates the medical waste and Disposal is done using Distance sensor, Motor, and Microcontroller Block.

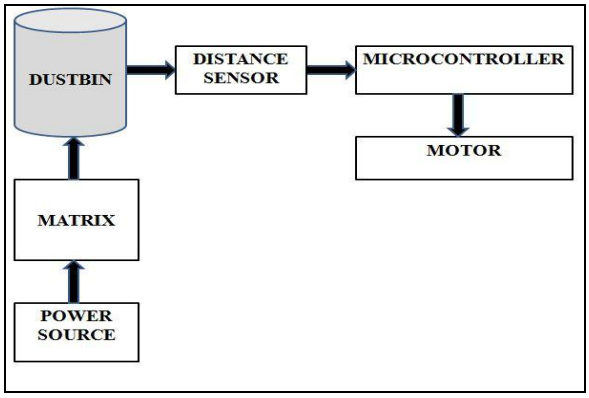

Figure 1: Block Diagram of Proposed System

Matrix with power source is found externally where as Distance sensor circuit is mounted into the dustbin and Motor is kept above the lid.

The devices circuit can be divided into two for better understanding: The matrix circuit and the distance sensing circuit. The circuit starts with a dc power supply (9V-12V) attached to the matrix which consists of switches and LEDs. Corresponding to each switch and LED there is one or more distance sensing circuit attached. Rows and columns of matrix consist of properties of the material of the waste which needs to be disposed. Each row and column of the matrix indicates switch and LED, where the color of the LED represents the color of the dustbin where waste needs to be disposed.

Following Table-II is the example of the matrix circuit:

TABLE – II Example of the matrix

	Metals	Plastics	Glass
Blood	1	2	2
Chemical	4	2	1
Dry	3	5	5

As shown in the above matrix, corresponding to each property of row and column a number is allotted with colored cell which represents the color of the LED. Considering the number as switches, person disposing waste will examine the matrix and press push button accordingly, LED attached to it will glow and indicate the color of the dustbin and therefore initiate the remaining part of the circuit. As the person approaches the dustbin indicated by LED light, distance sensing circuit which comprises of Ultrasonic distance sensor, microcontroller and servo motor senses the object coming near to it and send the signal to microcontroller and servo motor, which will open and shut the lid as per given time period. This is how waste segregation and disposal is done in an effective way.

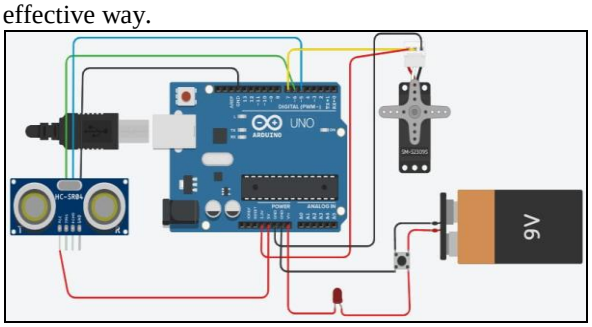

Figure 2: Circuit diagram of Proposed System

III. RESULT AND DISCUSSION

Matrix circuit formed using the LEDs and switches will help is segregation of biomedical waste as per the rules and regulations formed by the government. The distance sensing will make out the object coming nearer or going far and accordingly will control the movement of the Dustbin's lid, where the microcontroller guides with the speed and delay time for the opening and closing of the circuit. As a result of this device, segregating and disposing.

IV. CONCLUSION

Biomedical waste segregation is the principle step for biomedical waste management followed by disposal. Segregation is to be done according to the rules formed by government for biomedical waste management. Due to huge amount of waste generation, we fail to do so. Thus, our device segregates and disposes waste effectively and in less tedious way. As medical waste differs from other kind of waste, managing it should start at the waste generation site only. Device not only sorts the waste as per its category but also while and after disposal, there is minimum human contact. Therefore, initial steps for biomedical waste management are done in proper manner using this device.

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