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RESEARCH ARTICLE

Non-human Intervention Robot in Biomedical Waste Management

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ABSTRACT

Medical waste is one of the growing concerns worldwide, hidden in wolf's clothing. A wide range of medical waste is being produced daily, which should be distinguished in its disposal and treatment. Collection, segregation and treatment of these wastes is quite problematic as it may spread diseases to the workers and cause harm. Biomedical waste management using autoclave incinerators, their establishment and maintenance is highly economical. We hereby come up with the idea of employing a robot under human control to collect, segregate and treat medical wastes.

Keywords: Autoclave incinerators, Biomedical wastes, Medical management, Servo motors.

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INTRODUCTION

With the rising technology and transient lifestyle, there is a growing risk of health factors. Studies say that there are nearly 3 diseases on an average rate[1-9] that are identified every year because of which, there will be new medical waste getting generated. Treatment of this biomedical waste is quite troublesome to the people working. It requires a highly sophisticated environment. There is also a risk of disease spread and damage to the people working while carrying infectious and metallic wastes.

Here arises the need for a non-human intervention for its treatment. A robot that can segregate the waste whilst keeping it in different bags as shown in Figure 1 and treat most of the medical waste under human guidance and can reduce the risk factor to a greater extent. We ought to design a robot with a camera and motion controlled by a person that can segregate the medical wastes under his/her guidance. After the segregation, the general waste, mostly paper and plastic, which constitute 85% of medical waste, can be ground and recycled. While the metallic wastes can be sterilized. Thus reducing a greater amount of medical waste and risk of contamination by metals.[10,11]

MATERIALS AND METHODS

Amid COVID crisis the medi waste generation has skyrocketed near hospitals. It had become a huge trouble for the residents and working staff to walk through the area which was filled with contaminated medical waste. The workers were in a huge dilemma about how to clean it in fear of spreading disease. The scenario with medi waste treatment is also a big issue. Medical waste consisting of sharps or radioactive waste is hazardous to workers carrying them. Though the segregation is done in the hospitals, they are being clubbed while dumped. The wastes like human organs, and radioactive wastes needs to be treated differently but the general waste and metallic sharps, which can be treated and sterilized, are also getting dumped without any scope of treatment or recycling. In our study, our robot can only recycle and remove and sterilize metallic wastes but do not recycle or treat other types of medical wastes.[12] As per the Medical Management Rules 2016, the process follows guidelines where the waste generated from the healthcare facility must be disposed of, segregated into different color-coded

Figure 1: Segregation of medical waste in bags

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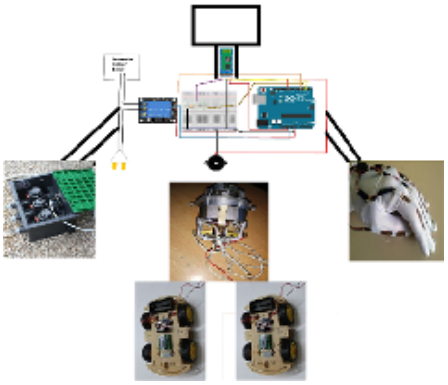

Figure 2 : Robot Cleaner

containers, and performed pre-treatment such as spraying disinfectant, sterilization, grinding and storage.[13]

It paved the way for the idea of a non-human intervention in medi waste management. A robot whose motions can be regulated under the surveillance of humans can be used to collect, segregate, sterilize and recycle the waste if possible. The body of the robot can be made using individual arduino controls - robotic cars, a blender, an arm that can sterilize the waste and a microwave that can kill the germs if present, as shown in Figure 2. Since these devices were already present and used, a combination of these can definitely bring out a satisfactory output.

Our robot with a camera enables one to view the periphery of the robot to monitor its motion using the software which can help us to control all the microcontrollers embedded in our robot. The one arm of the robot is a pick and place can help to segregate the waste while the other arm can sterilize it externally. Once the waste is segregated, the robot engulfs general and metallic waste, which undergoes heat treatment like in an autoclave to kill the contaminants. After this stage, the metallic wastes are ejected out of the body using a metal pulling mechanism and the general waste consisting of paper, plastic and cotton waste gets blended i.e. recycled, and comes out in a new form which again gets sterilized following the process in Figure 3. Thus 85% of medical waste can be treated and the remaining can get sterilized.

DISCUSSION

Biomedical waste management robot is designed to mainly treat infectious, hazardous, radioactive and general wastes without the intervention of humans with utmost success rate. Comparing this robot with others for the structured and methodical procedure, it was observed that the robot has the additional tool for spraying disinfectant, sterilization in boiler plus grinding the wastes, at the end expelling out the end wastes. This robot is simple in construction, reasonably priced, and easy to use. Any smartphone can do control of the robot and hence it is useful as a transportation aid. The grip of the arm is strong enough to hold the objects. Does its duty with efficiency and precision at work, works faster with more efficiency without requiring breaks throughout the whole

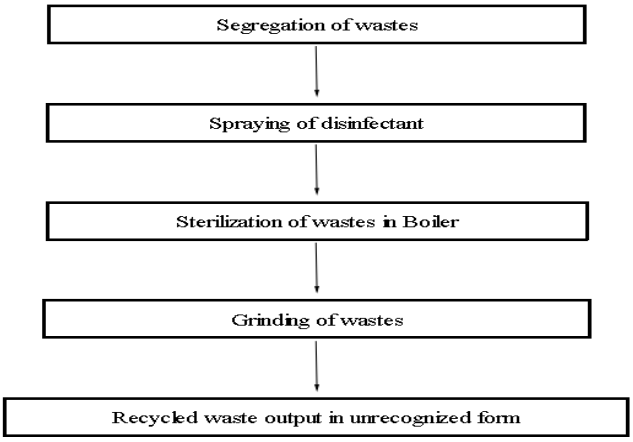

Figure 3 : Flow chart of the process

day and highly reduces the chances of disease transmissions. However, it has some limitations where the robot is in need of maintenance together with continuous monitoring as they don't have decision-making ability. The sterilization process of medical waste can be difficult because of the weighty waste in the boiler without causing any chemical reaction. While the servo motors used sometimes can be vexed as they are called for time to gear up in order to start their task, moreover, balancing the entire body plays a vital role with heavy parts.[14]

CONCLUSION

Non-human intervention in biomedical waste management robot is a modern device with an inbuilt microwave and grinder with a spray that can help in the safest sterilization and recycling of most of medical waste. Medical waste can be segregated using a remote control and desired waste can be sprayed by any disinfected and can be recycled, reducing the spread of infection and can work for the whole day. The proposed robot is estimated to cost around 7000 to 8000 in Indian currency plus the maintenance cost may differ from 2000 to 3000 rupees based on the type of issue. In contrast, the cost of medi waste treatment through conventional methods is highly economical. The cost of establishing of a waste treatment plant is nearly 4.5 crores and its maintenance also needs a sophisticated environment.[14] Having a biomedical waste management robot in the healthcare industry can avoid the transportation of waste to another area to treat, and doesn't require giving workers monthly wages, thereby minimizing the cost.

With the appropriate studies, the robot is found to be in need of continuous monitoring and are not creative, doesn't have the decision-making ability.

With greater enhancement and with additional features in the device, it can act as a savior and can help at any location while following the process of management in the medical hospital industry, pharmaceutical industry, nursing homes and biotechnology industry. Decision-making algorithms can be added to them, enabling self-assessment of its performance and increasing its features.

Further developments can be done and new features can be incorporated to the robot to extend its usage. The range of bluetooth signals can be added to control or a GPS mapping feature with a camera can be added in order to perform the activity. A flexible height manager can be added to pick and place objects at different places. Thus, its use in standard procedures can be recommended within the limitations of this study. Together with an aesthetically satisfying design will even emphasize the beneficial effect of this research in biomedical engineering.

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