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Semi-Automated Garbage Linen Chute System

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A B S T R A C T

Garbage management is the biggest issue we deal with on a daily basis as a third world nation. In the absence of a proper garbage management system, there may be many problem arises such as health issues, environmental pollution , waste of space and hindrance to cleanliness. All around the world, urban regions are rapidly expanding their supply of high-rise residential structures. In Sri Lanka also there are many high-rise buildings facilitating spaces for housing and shopping malls and other amenities. Chutes systems for waste in bags are a modern method of removing waste from buildings. In many of these chutes, a bag containing normal household waste is thrown directly into the gravity-fed chute. But the main problem is to sort the garbage after collecting the output from the chute. In the present study an automated garbage chute system that involves automated garbage sorting as well.

Keywords: High rise buildings, Chute, Garbage sorting

1. Introduction

Cities all throughout the world are expanding quickly, creating clear environmental and economical problems. This dynamic urban growth can generate significant stress on city administrations who need to provide the necessary basic infrastructure and public services to expanding neighborhoods and new settlements. Due to its ability to house numerous people close to urban centers, high-rises are the most prevalent style of development in cities. One of the main issues in urban cities including high rise buildings, is garbage generation. The administration uses the landfill system to dump the garbage. But in Sri Lanka there are limited spaces available for garbage dumping and at the same time recycling is also one of the national concern. In order to recycle the waste, it should be sorted. Waste sorting is a process by which waste is separated into different elements such as polythene, paper, food waste, glass, etc. Although this process could be done manually or automatically, manually sorting is not practical for industrial purposes due to high labor costs and time wastage. If the garbage can be sorted out at the stage of dumping, that would save time, money and unnecessary health hazards occur by manual garbage sorting. When considering the technologies of already existing machines for garbage/waste sorting, all around the world, either manufacturing or maintaining, or importing costs are not bearable for most Sri Lankan companies.

Chutes with waste in bags are a more recent technique of waste removal from high rise buildings. A garbage chute system is a long vertical space that passes through each of a building's floors. Residents can dispose of their garbage waste into the chute through a door on each floor. On each floor, this entrance is normally located in a small room. Garbage falls into a compactor or dumpster at the bottom of the chute. The waste is collected in bags and sent directly to the building's basement via the chute tube (where the technical rooms tend to be). The chute can be adjusted to have an outlet either directly at the collecting containers or the garbage can be re-sorted and compressed, depending on the conditions. Chutes are supplied in various diameters. The chute diameters used most often for this purpose are 500mm and 600 mm. Ventilation, disinfection, washing, and fire-extinguishing devices are available for larger buildings chute systems. Mechanical or electromagnetic locks can be installed on the door. Fig 1 illustrates the chute system that are commonly used for the buildings.

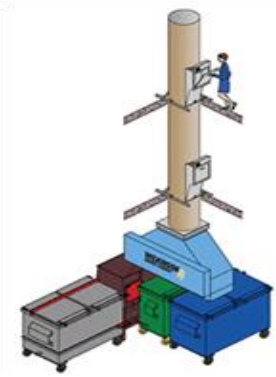

Fig. 1 - Commonly used garbage chute system [9]

Available Systems

The garbage chute system is a method of collecting and transporting solid household waste from multi-story buildings. It consists of vertical pipes with inlets on each floor, through which the waste is deposited. The pipes convey the waste to a central collection chamber at the ground level, from which it is periodically removed. This system is both convenient and safe for disposing of waste in large buildings (Archi-Monarch, 2020). The refuse chute system has four main parts: the chutes, the inlet hopper, the collection chamber, and the cleaning and disinfecting features. These components are illustrated in Fig. 2.

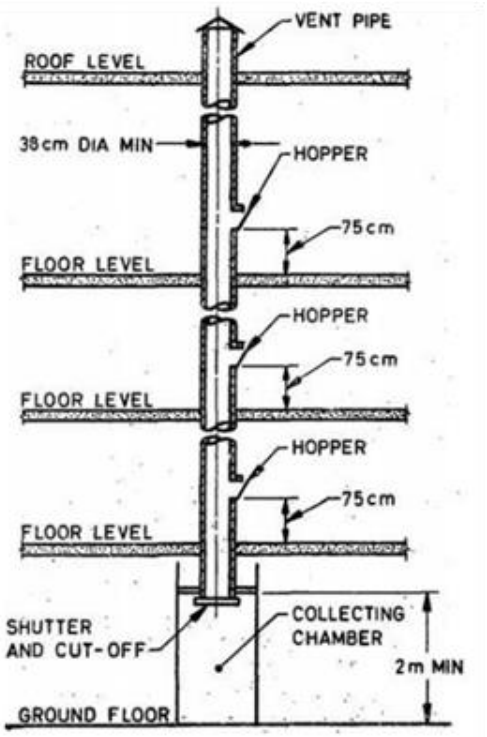

Fig. 2 - Main components of the system [2]

As high-rise residential buildings become more common in cities around the world, effective methods for disposing of garbage in these buildings become increasingly important. In these buildings, the large population can generate a significant amount of waste, making proper hygiene and collection a major concern. One solution that is often used in high-rise residential buildings is the use of automated trash chutes. These chutes have inlets on each floor where waste can be deposited, and the garbage is then transported via pressurized tubes to a central collection point at the base of the building. From there, the waste is processed, disposed of, and recycled at a central plant. In the automated building waste collection system, there are two main parts:

Pneumatic waste collection system - Vertical or inclined plane, channel, or passage through which objects are moved using gravity. Fig.3 shows the Pneumatic waste collection system.

Fig. 3 - Pneumatic waste collection system.

Vacuum collection system – consists of underground pressurized tubes to automatically transport waste collection chambers to the containers at the central plant. The vacuum collection system is shown in Fig.4.

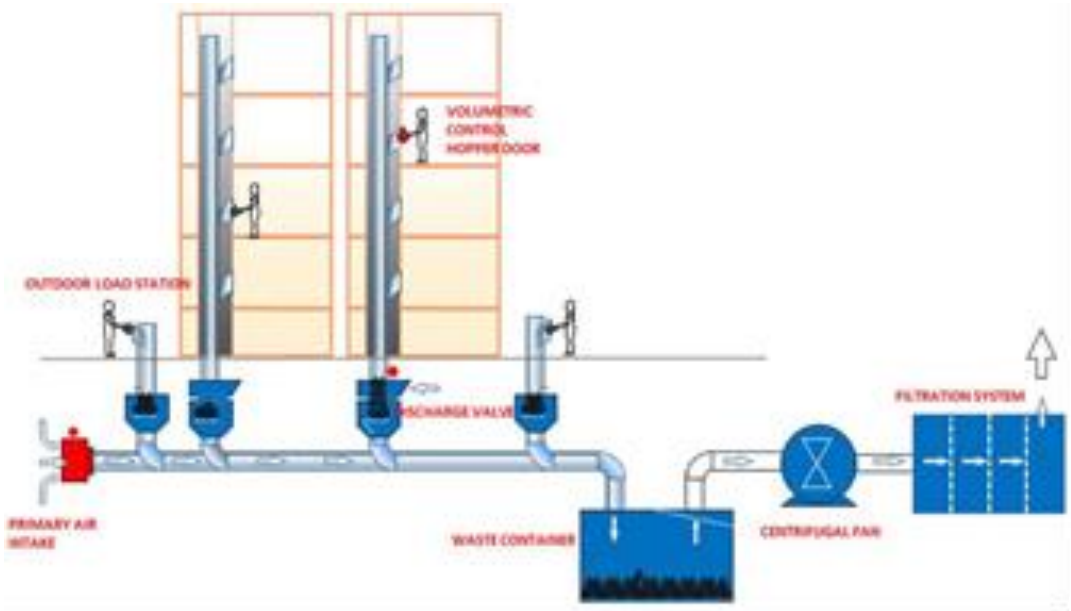

Fig. 4 - Vacuum collection system

All tables should be numbered with Arabic numerals. Every table should have a caption. Headings should be placed above tables, left justified. Only horizontal lines should be used within a table, to distinguish the column headings from the body of the table, and immediately above and below the table. Tables must be embedded into the text and not supplied separately. Below is an example which the authors may find useful.

3. Proposed Site and Methodology

A car park of famous hospital in Sri Lanka was selected as a place for implementing the system. The car park consists of 14-floors. The building structure work has already been completed. A chute system is built so that the residents put all the garbage in one bin. In figure 02 the door panel of the garbage system is shown. This system is mainly categorized into four parts which are master controller, slave controller, Motor slave controller, and washer & Blower controller. These main controllers, their working and wire connection are shown in the block diagram in Fig.5. In the proposed method, waste is disposed in four separated bins at the outlet of the chute. These are categorized under glass garbage, plastic and polythene garbage, wood and paper garbage, and wet garbage. By disposing of garbage separately blockages can be reduced, and it is easiest for the municipal laborers to pick up the corresponding garbage. Also, disposing of glass with other bags can cause damage and tear the other bags by rubbing each other. This can be prevented by using separate bins.

The resident has to select the type of garbage that is disposed by pressing the suitable button provided in the panel. According to the button pressed by the user, a signal containing, detail of the button type and the floor number will be sent to the master controller. The controller used at the selection panel of garbage type at each flow is called “slave controller”. More specifically the slave controller in each flow send the data to the master controller. The flow chart in Fig 7. shows the operating sequence of the process of the slave controller. Master controller Flowchart is given in Fig. 8. According to the flowchart, this process starts by receiving data from the slave controller. This data is detected by the master controller. That encoded data decoding by the master controller. Read decoded data, send the other floor controller to check whether doors are locked and display busy.

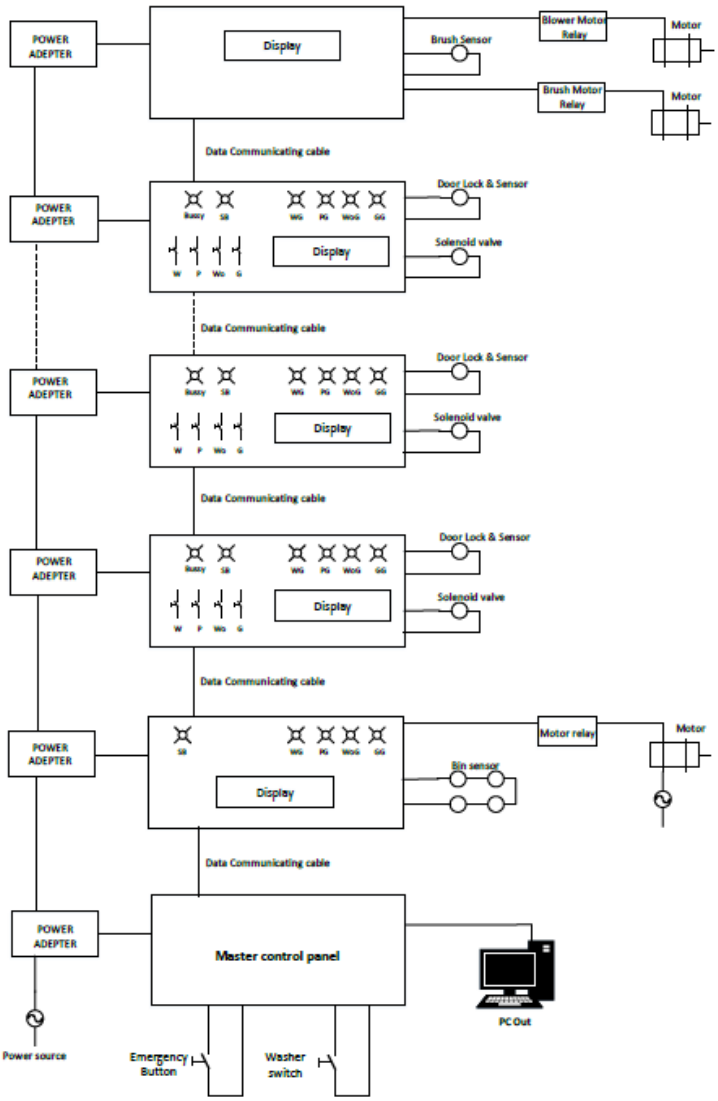

Fig. 5. Hardware design and wire system of the proposed system

Fig. 6. Door panel of the chute system

If other doors are locked on the other floor, without relevant door, if any lock is in open condition on any floor, that sends data to another floor controller, lock and display busy continuously. (In this situation, the other floor door is not open for the press button) send data to the relevant floor to open the lock for the door. According to the resident press button category, like wet garbage, plastic garbage, wood garbage, and glass garbage, the motor rotates for relevant bin that waste must be put.

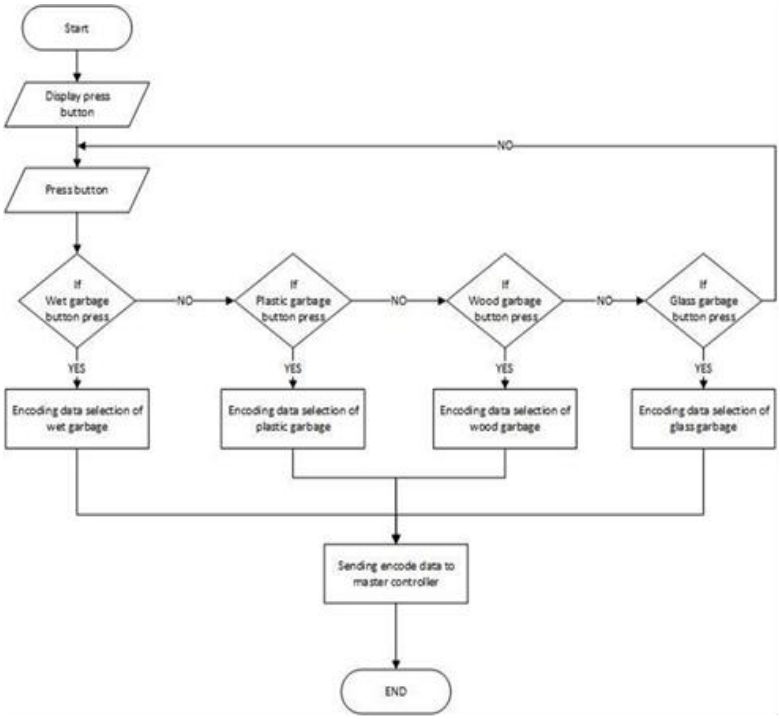

Fig. 7. Operating flow chart for the slave controller.

4. Design

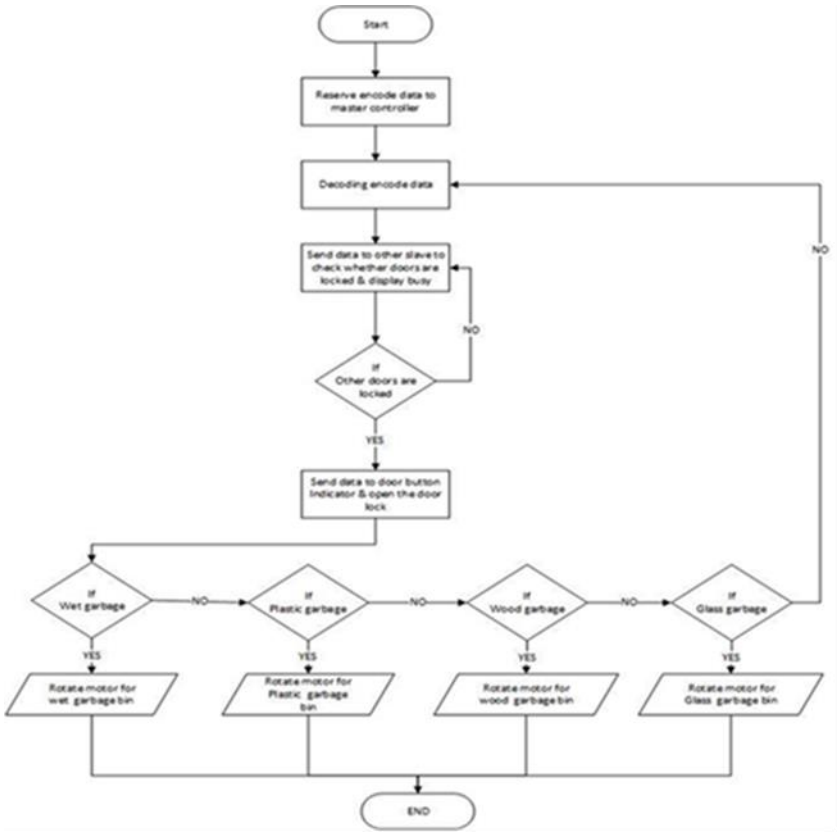

Fig. 8. Operating flow chart for the master controller.

The garbage, disposed from each flow will be dump to four bins at the end of the chute using an offset pipe. A 600mm internal diameter stainless steel pipe is welded to form the offset. Chute offset's discharge unit is 450 angled as shown in the fig. 9. The weight of the pipe system above the offset is

balanced by hinging to the wall. Therefore, there is no effect of that weight on the offset. And the pipe above the offset and the offset are joined together by a bearing. The offset is hinged to the whole by a bearing and spring system. The spring is used to absorb the resultant force due to falling garbage bags from a height that acts inside of the pipe surface. A motor is connected to the upper area of the offset and the motor shaft is connected with a timing pulley.

V belt is going around the pipe which is connected to the timing pulley to rotate the offset. When offset has rotated to the relevant position it makes a collision with a limit switch and motor rotation stops.

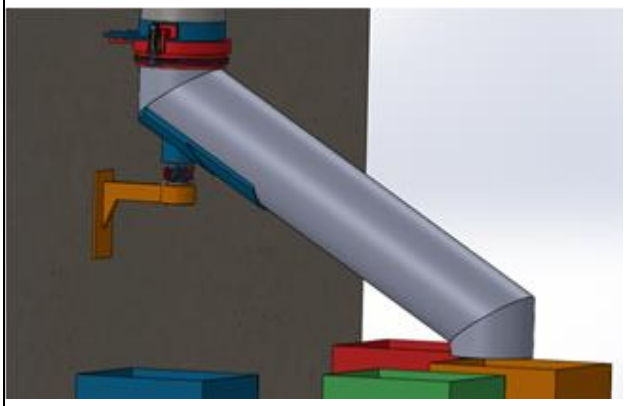

Fig. 9. Offset pipe of the chute

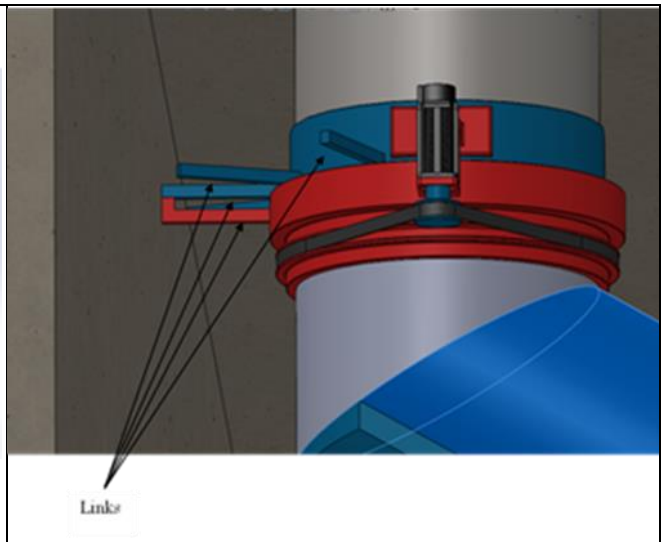

Fig. 10. Sensor system

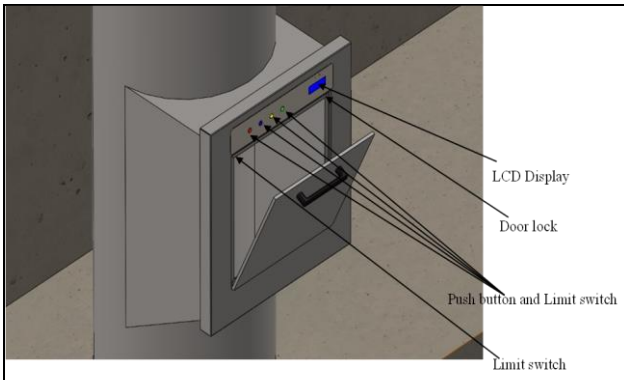

Fig. 11. Chute intake

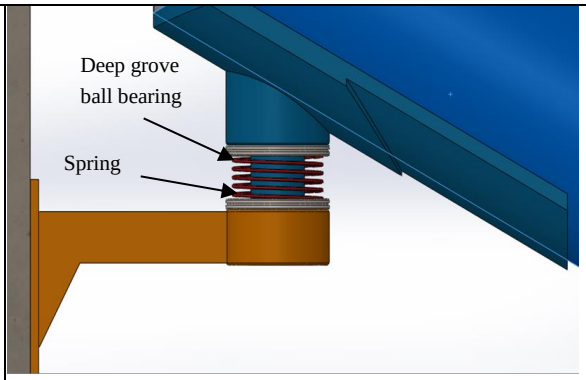

Fig. 12. Spring, Bearing system

Data communication uses cat 6 cables. Cat 6 cable consists of four pairs that this system uses three pairs for master and slaves' communication. One pair transmit clock signal, another pair transmit data (TX), and other pair received data (RX). Distance between master and slaves is high for the high-rise buildings. Due to wire resistance, voltage dropping. Therefore low voltage system can not be used for data transition this system. So that this system must use high voltage to reduce this problem. But too high voltage made high rise time. So that System delay. As a result, this system uses medium voltage as 12 volts for data communication. Also this system uses asynchronous communication. Which means it has a data transformation system along with the clock. It sends the clock in one pair and the remaining pairs are used to send the data. There are two pairs to send data receiving and data transforming. It uses balance communication to reduce the interference to the others. Communication is controlled by the master. It transmits the slave address in order to keep the communication. At that time data are transmitted to each slave by the TX. However, slaves receive only the data relevant to each slave address. When the signal of the clock turns from low to high, it reads the bit of the data line at that time. It uses eight clocks to read 1 byte. This is the data transmit signal patterns. When the master sends the address and commands, the relevant slave receives the command and it sends the data back to the master. First of all, it is checked whether the slave is lined or not by the master. If there is no any reply from the relevant slave after sending the data by master, the same procedure is repeated for three times. After sending the data for third time, if there is no any reply from the slave, it out the slave as dead. Fig. 13 and 14 show the PCB design and printed design of the slave controller.

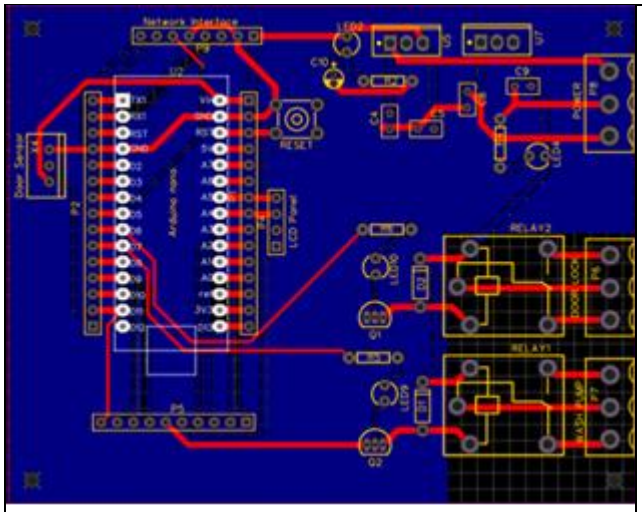

Fig. 13. Slave controller - PCB design

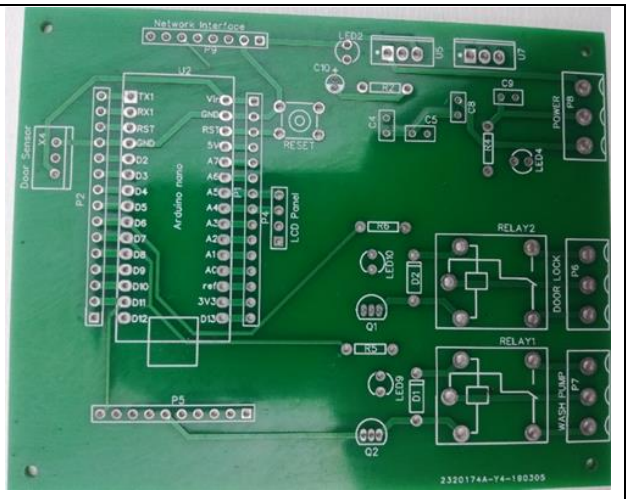

Fig. 14. Slave controller - Printed design

A model was built to test all the controllers and sensors as shown in Fig. 15 and Fig. 16, as it is difficult to test the setup in the real time environment.

5. Conclusion

The present study proposed and developed a semi-automated garbage sorting system for high rise apartments and hotels in Sri Lanka. The developed system sorts the garbage into four categories organic, plastic and polythene, wood and paper, and glass. People who are living in the apartments can collect the garbage separate bags according to four categories. Then when they put the garbage into the system by selecting the appropriate button, it will sort the garbage into selected chute. The developed testing system can bear the weight of 1kg at a time. It is one of the major limitations in the system. Moreover, the user has to separate the garbage before putting them into the system. In future, a weighing system can be introduced to measure the weight of garbage bag before put in to the system, so that the users can get an idea about the amount of waste they dump.

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