

Hong Kong Student Science Project Competition 2022

Template of Extended Abstract (Invention)
(Word Limit: 1,000 words, Pages: 2 pages only)

Team Number: SAPE072

Project Title: I-BIN

Project Type: Invention

To our best knowledge and after thorough literature research, as at ___/___/___, there are / are no* similar works. If there are, the reference links are as below:

The enhancement our project has made for the existing related products or research is summarized as below:

***Please delete if not applicable. HKSSPC values the originality of works. Students must conduct literature research thoroughly to ensure that their works are unique, and to list relevant reference materials to complement the research or invention.**

I. Background

- Provide background information as to learn about the audience for whom the project is addressing
- Provide highlights of **literature review** and/or related technologies or devices, with the support of pertinent and reliable references
- Provide an overview of work, create a point of view as to define the needs and insights of the audience and mention the **research or technology gap the project is trying to fill**

Rubbish has been a problem for as long as modern civilization has existed, especially Hong Kong. Humans produce a lot of garbage, which is bad for the environment and takes up previous space. According to the report of the Environmental Protection Department, Hong Kong has a 13,500 tpd waste. In accordance with the report of Plastic Free Seas, landfills in Hong Kong are expected to be in the district by 2030. Obviously, the problem of the disposal of rubbish brings no delay.

The Housing Department or the Housing Authority generally uses "straight-down" refuse chutes and houses to conveniently use "straight-down" refuse chutes. The garbage chute cleaning station is used to directly throw the garbage on the ground through the garbage chute on each floor. Over the past 12 years, five cleaners fell into rubbish chutes in Hong Kong, three of whom did not survive their injuries. The recurrent tragedy shows just how dire the situation is for such workers. For instance, on 22nd January 2021 at about 10pm, a cleaner was found dead, hours after he had plunged 35 floors down a rubbish chute in a Tuen Mun public housing block.

II. Objectives

- State the **aim(s)** of project

Over the past few decades, a lot of rubbish has been produced in Hong Kong every day, and that leads to severe garbage problems. According to the Environmental Protection Department (EPD), the daily disposal of MSW at landfills has reached 1.44 kg per person in 2020. In addition to the masks and disinfectant products discarded during the epidemic, the solid waste is increasing invisibly and brings about a huge burden to the landfills. The need to reduce waste becomes more imminent as our three existing landfills are

expected to be filled up one by one in the coming years. To promote decarbonization and facilitate low-carbon transformation, the implementation of MSW charging should be required. The charging scheme is an effective policy tool to drive enterprises and the public to practice waste reduction, and at the same time facilitate the sustainable development of related industries and the creation of green job opportunities. We hope that collecting the weight of waste and charging the mass regularly can reduce the production of garbage. In order to reduce the amount of waste generated by the public and encourage them to cooperate with the MSW charging scheme in the future, we apply artificial intelligence and the Internet of Technology to invent a rubbish bin which can compress the trash and measure its weight. Moreover, people can record the weight of garbage by swiping the card after throwing it into the bin. Then, the data will be uploaded to the Cloud and charged by weight of trash, so as to alleviate the excessive garbage problems.

III. Methodology

- Briefly describe the **approaches** used e.g. use of equipment, materials, tests and experiments
- Explain the selected implementation strategies with the **scientific theory**

The materials needed for our product are Arduino D1 evaluation board, 1602 Liquid Crystal Display (LCD) 1C, HC-SR04 supersonic sensor, RC522 RFID Card Sensor, HX711 electronic scale, MB-102 breadboard, SG90 9G servo motor, Bread line, Acrylic board.

We have tested the bin with a paper ball as the rubbish. The results of the experiment is four-folded. First, the experiment turns out that the lid can open automatically when the object is detected within a certain distance by the ultrasonic sensor. Second, it is proved that the weight of the rubbish can be shown through the LED screen after weighing by the digital lithium scale. Third, it comes out that the rubbish can be well compressed and pushed into the garbage chute after the lid is closed and the movable inclined board starts to work. Last but not least, the data of the rubbish can be uploaded to the Cloud and recorded in ThingSpeak after the user swipes the card, and the data can also be sent through IFTTT to the user.

When we put our hands on the HC-SR04 supersonic sensor which is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Thus it make the SG90 9G servo motor move and bring up the lid.

Behind the scientific theory of the HX711 electronic scale, when we put the rubbish on the scale, pressure is applied to the sensor, and the sensor changes elastically, so that the trigger changes, and the excitation voltage waveform changes, and a changed analog signal is output. The signal is amplified and output analog-to-digital The digital signal converted into the result of easy processing will be output to the CPU control. CPU keyboard commands and outputs to the LCD display.

After we know about the weight of the rubbish that you put in, with the scientific theory of RFID consists of a Radio Frequency module and an antenna which generates a high frequency electromagnetic field. On the other hand, the tag is usually a passive device, meaning it doesn't contain a battery. Instead, it contains a microchip that stores and processes information, and an antenna to receive and transmit a signal. We put the card close to the sensor and transmit the data through IFTTT on the user's phone.

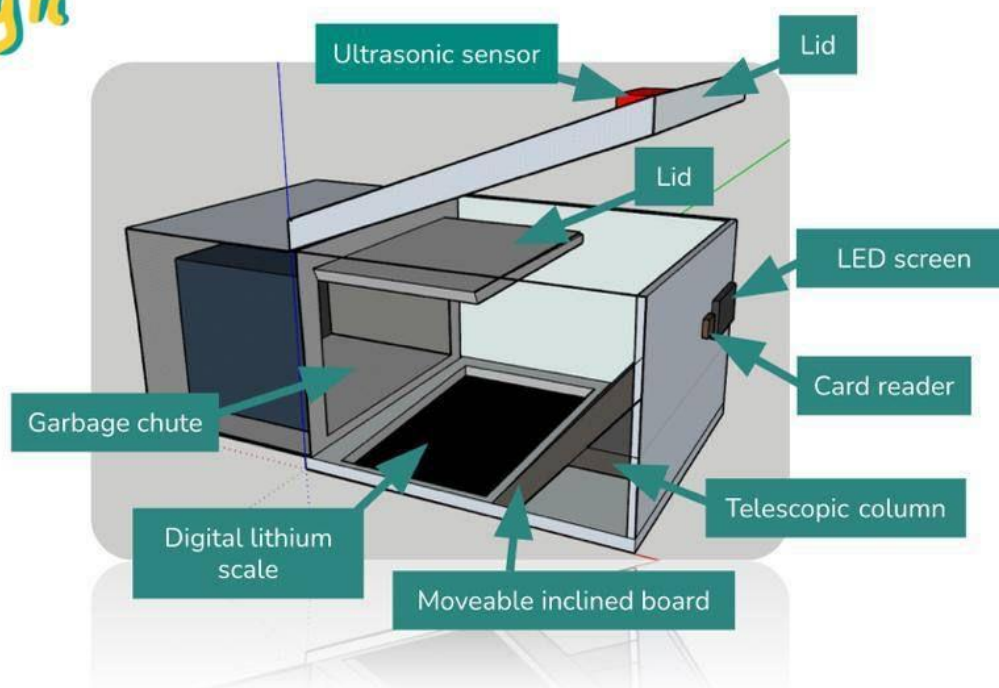
Then we can press the button in order to compress and push the rubbish into the garbage chute. In the button, there is an electromagnet adsorption device inside. When you press the button, the electromagnet inside will generate magnetism instead of electricity, and then the circuit is connected or disconnected through this adsorption device. So that the rubbish can be compressed by the extent of the telescopic column and pushed down to the chute.

IV. Design of Invention

- Describe the **design** and the **principle** of invention (e.g. The ideation of the projects, the prototypes or creative solution as far as applicable)
- Provide sketches / drawings / photos of the invention

First of all, there will be an ultrasonic sensor on the top of the lid of the I-BIN, it will measure the distance between the object and the bin and control the lid to open automatically. After users throw the rubbish, there is a movable inclined board which allows the rubbish to slide on the digital lithium scale so that the weight can be measured. Also, there is a LED screen on a side of the I-BIN which is connected to the digital lithium scale to show the weight of the rubbish. Next to the LED screen, there is a card reader. Users need to swipe the card after throwing the rubbish in order to record their data in the Cloud and let the bin do its work. After the bin is closed, the movable inclined board will be pushed up by the telescopic column and compress the rubbish. Finally, the compressor will push the compressed rubbish into the garbage chute and the data will be saved in the Cloud and ThingSpeak, and sent to the users who download IFTTT regularly.

Design



V. Application / Market Need

- Explain the area of **application** and function of invention
- Indicate the market need and impact of invention
- Discuss **limitation** and compare with existing related works (if any)

According to the written reply from the Popularity of Secretary for Housing, Planning and Lands Mr Micheal Suen to the member of the Legislative Council Mr. Albert Chan on 27th November, 2002, among the 148 public housing estates in Hong Kong, only four are not equipped with rubbish chutes. However, accidents of cleaners falling into rubbish chutes happens frequently. The solution from the government is to change

the size of the chutes, from 45cm x 45cm to 35cm x 25cm. In fact, the "straight-down" refuse chutes still put the cleaners in danger.

Therefore, the deaths of cleaners can be reduced greatly with our invention I-BIN. It can be used with rubbish chutes with four functions: weight measurement, compression of rubbish, RFID card system and the storage of records in the Cloud.

First, the weight measurement of the rubbish shows the amount of rubbish users throw and it will be recorded in the Cloud. Through the data, we hope they can push the users to make less rubbish. For the compression of rubbish, we hope it highly reduces the space of the rubbish bin and slows down the saturation speed of landfill temporarily. Furthermore, the RFID card system and the Cloud storage, and also the regular measurement of the weight of rubbish, can match with municipal solid waste charging policy very soon.

In addition, after detecting the user's hand by the ultrasonic sensor, the lid of the Bin will open to allow the user to throw the rubbish into the bin. This lowers the chance of cleaners falling into the chutes.

VI. Conclusion

- Make a **data-driven** conclusion of the project and the way forward of the invention process
- Justify if the proposed project meets the objective(s)

Our objectives are that through using our invention and charging by mass of rubbish, the public can pay attention to the deteriorating garbage problem, and hopefully slow down the landfill saturation. By compressing rubbish to reduce the space to be occupied and recording the weight of rubbish to coordinate the charging by mass, we assume that our proposed project has met our objectives. And we have also proved that our predictions about the I-BIN are achievable by using an experiment and we believe that I-BIN can be applied to a bigger scale in the future and it can reach a higher goal.

Our project is developed based on our school's previous project and the enhancement is as below: