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The development of intelligent solid waste trap machine using arduino uno

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ABSTRACT

Poor drainage system in Malaysia is not a newly phenomenon among our society. The unethical activities of dumping rubbish into the drain, literally causing the flash flood due to clogged drains, in particular within the urban areas. The Intelligent Solid Waste Trap Machine Using Arduino is designed to collect rubbish in the domestic drain and capable in collecting rubbish up to capacity of 10kg. This automated machine is 50% mechanics and 50% electronics, functioning based on two microcontrollers. This waste trap machine is the most reliable and effective for promoting the sustainable drainage management in Malaysia at a lower cost. By adding IoT to this machine in future, some manual process can be carried out remotely. Thus, it helps local authorities to collect data on the trend of dumping into drains in certain areas.

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Introduction

The growth population accompanying the consumption trends, has led to an uncontrolled exploitation of natural resources, and the appearance of several environmental problems such as an increase in solid-waste generation. Solid waste typically refers to trash or garbage that does not exist in liquid or gaseous form. For the sake of environmental sustainability, solid waste disposal necessitates a good and sustainable management system. Solid waste management is one of the most important concerns for developing nations (Anuar et al, 2015). Proper garbage collection, treatment, and disposal, with an emphasis on sustainable management, are among the concerns.

Data from Department of Environment (DOE) declared that 13 rivers from 45 rivers severally polluted, 23 slightly polluted and 9 rivers are clean (Sarimin, et al, 2020). DOE also listed 40% source of water pollution in Peninsular Malaysia are from food and beverages industries (Satro, 2019). The SWCorp Mind Transformation Plan 2015-2020 report shows that the drains that were supposed to drain the surface runoff have been misused causing water flow to be disrupted. In 2014 Kuala Lumpur City Council (DBKL) cleaned 11,680 metric tonnes of solid waste from garbage traps installed in 26 rivers that cross the city of Kuala Lumpur. The Klang River is recorded as the dirtiest river and the most rubbish, estimated at 77,000 tonnes of rubbish annually. As a result, the government has to spend millions of ringgit every year for the purpose of maintaining and cleaning the river (SWCorp, 2015).

The main drainage or river that meanders through downtown city centre or township areas is thrown with tonnes of rubbish every day despite of "clean-up" campaigns. The cleaning of drainage systems or rivers

needed to be carried out in a systematic programme, and it requires a large amount of budget. According to Solid Waste Management and Public Cleansing Corporation (SWCorp), the amount of waste generated by our country has increased to 33,000 tons per day in 2013 compared to 19,000 tons per day in 2015. This means that the average increase in solid waste generation per year is 6.7% higher than the global average of 3%. The individual solid waste generation rate in our country is 1.17kg/day compared to 1.2kg/day in developed countries. Thus, an efficient solid waste management is important as domestic development. Several proposals using different methods such as the garbage trap system and Finite Element Analysis (FEA) have been used to trap solid waste in rivers (Sarimin, et al, 2020 and Naamandadin et al, 2019). With respect to the environment and concern about lack of control and insufficient management of solid waste generated many places in Malaysia, the intelligent waste trap model has been proposed.

Therefore, the main objective of this project is to develop the intelligent waste trap model associate with solar panel and Arduino GSM module system and to provide a cost effective decision support systems to help support the relevant authorities. Several models have proposed widely to trap solid waste before it flows to the drainage or river. Study by (Satro, 2019), a trash trap is designed to float in waterways in order to capture litter before it flows farther downstream by using the current to guide debris into the trap. The performance is floatable control technology without any mechanical assistance to capture floating litter. The robot using GPS unit is developed to track a specific path and using sensor to detect location, power level, tank capacity. The prototype can collect the debris but cannot be kept in collection chamber. The debris only hang around the top of the devices. Meanwhile, Malleswari and Nanda (2020) proposed a Smart Wastage Segregation. Smart Wastage Segregation using Arduino UNO used a DC motor to move the conveyor belt and carry the waste through the sensor to the waste bin. This project focuses on separating metal waste from other waste. Waste will be separated in different bins according to different sensor detection. Smart Wastage Segregation using Arduino UNO used a DC motor to move the conveyor belt and carry the waste through the sensor to the waste bin. On the basis of current models and a concern for the efficacy of waste management, it is recommended that the Intelligent Solid Waste Trap Machine be installed in the main drains of residential areas. The automated machine was designed with 50% mechanics and 50% electronics, functioning based on two microcontrollers. This intelligent machine can hold trash up to 10kg, stored with one solar panel and equipped with Arduino GSM module.

Method

The idea of waste trap is designed to prevent trash from entering main drainage in residential areas. This machine consists of a main structure, conveyor, raking mechanism and electronic parts to control the machine. Figure 1 shows block diagram of Intelligent Solid Waste Trap Machine. Input 5V is directly from DC power supply. The main process of this project is Arduino and microcontroller. The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. At this point, Arduino and microcontroller is programmed to control the output of motor and sensor. Figure 2 show the circuit of the project.

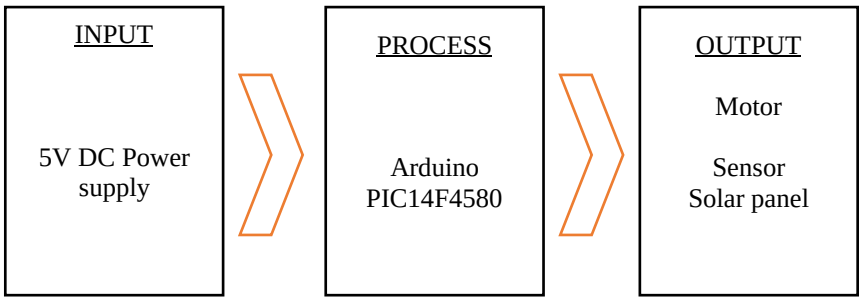

Figure 1. Block Diagram of Intelligent Solid Waste Machine

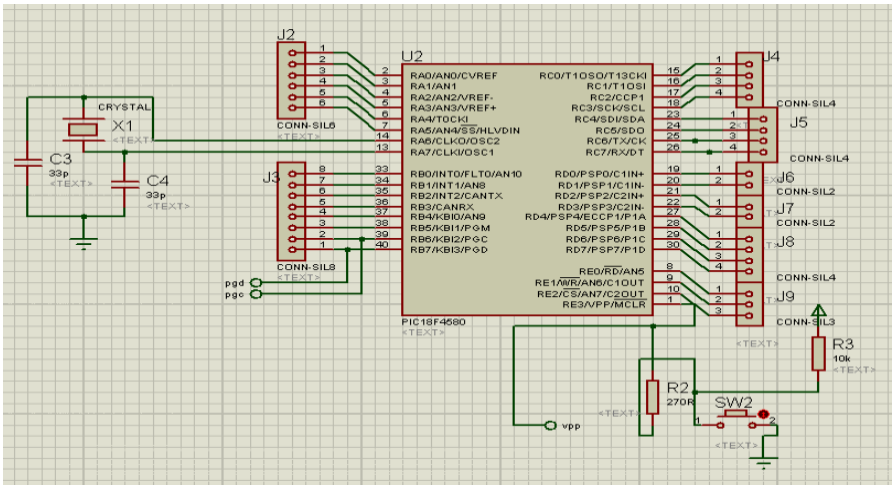

Figure 2. Circuit Diagram

The conveyor trash trap machine is installed in the domestic drain to collect the trash and fill in the stainless steel basket. The level sensor used to detect the trash at a range of 0.5 meters. The machine can hold the trash up to 10 kg then will alert the authorities to collect using GSM module. Rechargeable battery (12Volt and 25Watt) is used to sufficiently supply power to the conveyor raked mechanism. Energy stored in one solar panel will recharge the battery for successful completion of trash collection. This machine is equipped with the Arduino GSM module to send message to the relevant authority for immediate action. Figure 3 shows flowchart of Intelligent Solid Waste Machine.

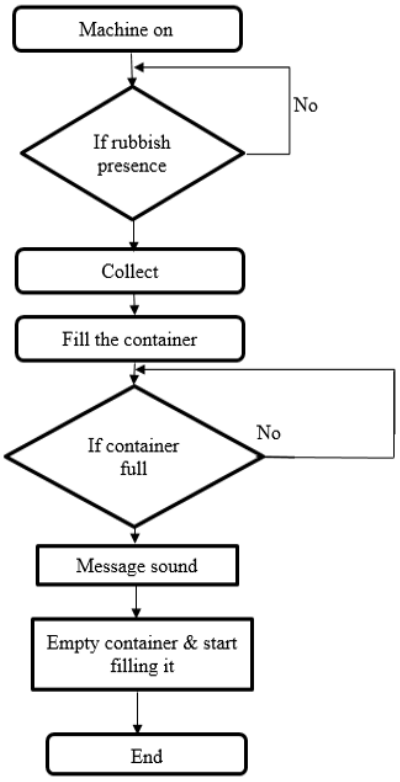

Figure 3. Flowchart of Intelligent Solid Waste Machine

The 2-dimensional (2D) figure 4 and 5 of an Intelligence Waste Trap Machine is sketch using AutoCAD 2021. All the dimension is referred to the standard size of U-Shape drain with 600mm internal width x 600mm internal depth used in domestic drainage system.

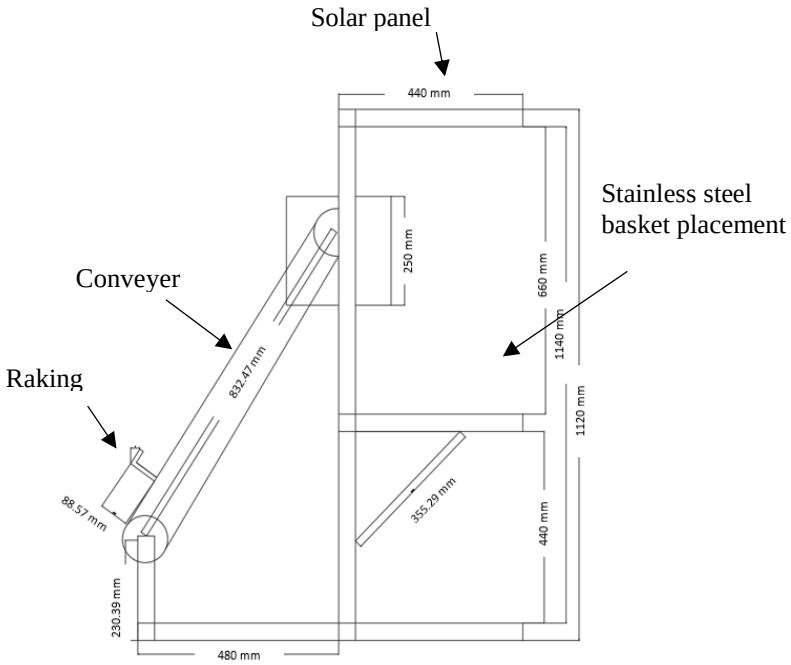

Figure 4. Intelligent Waste Trap machine side view

Figure 2 shows the design of an Intelligent waste trap machine. The size of the of the machine is made to be fit with U-Shape drain which is commonly used in residential areas.

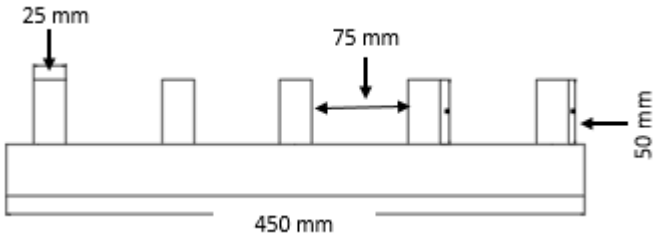

Figure 5. Raking Mechanism part

Figure 5 shows the size of raking mechanism part mounted on the machine to collect the debris.The materials in development of Intelligent Waste Trap is selected according to the surroundings to ensure the durability of the machine. The main structure of the machine and the trash basket is suggested to use of the galvanized steel grade metal to prevent rusting in the water. For the conveyor, PVC galvanized welded wire mesh size 1cm x 1cm is suitable to prevent rusting and less maintenance for the authorities. A size of 1cm x 1cm was chosen to prevent small debris passed the rake mechanism from entering the drain. The joint is should solder tightly, anti-corrosive and anti-rust. Galvanized steel (GS) grade metal is a suitable material to be used in the construction of this machine because of its resistance in water for a long time compared to ordinary metal. The lifespan for GS is less than 10 years if in wet or submerged conditions, 34 years if relative humidity is 100% and 211 years for relative humidity below 60% (Suzumura et al, 2004 and El-Mahdy et al. 2000). Therefore, the use of GS is potentially for cost-effective and durability of long time period.

Results and Discussions

Figure 6 is an illustration of the prototype for the Intelligent Solid Waste Machine. All the electronics parts and motor will installed at the side of the main frame. When the gear rotated, the trash trap at the conveyor

will throw directly into the basket at the back of the conveyor. Solar panel is placed at the top of the frame as a backup power supply.

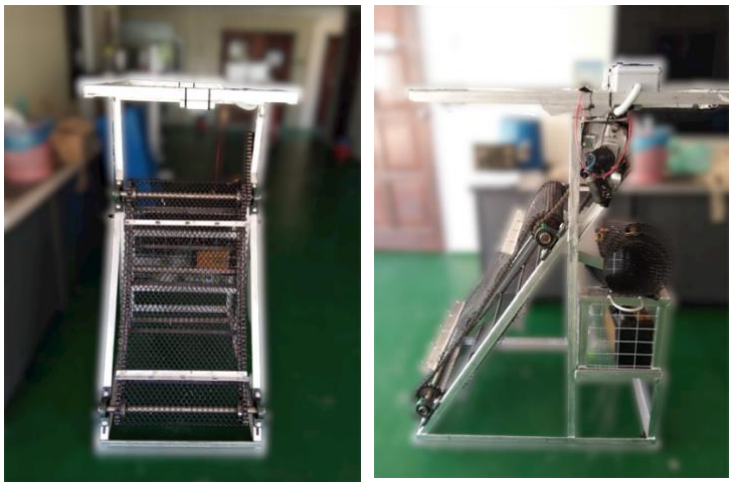

Figure 6. Intelligent Solid Waste Machine prototype

The level sensor will trigger once it detects the presence of trash at a range of 0.5 meters and conveyor raked mechanism activates for collecting the trash fill into the stainless steel basket. The basket can hold up to 10 kg trash at a time, once its full GSM module will alert the authority to collect the trash and clear the basket. Table 1 show the configuration of the cases.

Table 1. Configuration of the prototype

Sensor	Motor	Action	Explanation
Trash > 0.5 meters	OFF	Nothing happen	Conveyor in standby mode.
Trash < 0.5 meters	ON	Conveyor rotating	Conveyor will fill the trash basket. When the basket reach 10 kg, GSM will sent message to authority.

Conclusions

Waste trap machine is designed for reliable and effective sustainable drainage management, with lower cost and can be monitor at real time. The effectiveness due it trapping trash, where almost trash that goes into the drain will be caught and fill in the available containers. The machine is designed to caught rubbish up to capacity of 10kg. Also, the intelligent waste trap model provided cost effectiveness due to association with solar panel Arduino GSM module system that will aids authorities concern trash problem based on real-time (on-line) monitoring decision support system. The process of cleaning to be more efficient by directly channel information to local authorities in real time via mobile phone without waiting for periodically cleaning.

For further study, this machine can be improved by adding IoT so that the manual work process can be carried out remotely. In addition, cooperation with relevant authorities such as Local Council, Drainage and Irrigation Department to mobilize the model at field for collecting real data.

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