# EcoExpress

Robotic Trash Management System (RTMS)


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Rap the Scrap

fun robotics
A Mind Fitness Club

# Content...

# Abstract

As the population increases rapidly the amount of the trash increases faster. As a result, the need to manage this huge amount of trash is urgent!

The Robotic Trash Management System (RTMS) keeps the city clean all the time; it works on its own and once the trash bins become full, it moves to the full trash bin only, picks it up and starts the sorting process. Also, it gives statistical information about the type and the quantity of the trash in each area in the city, where this information will help in the trash managing process. With its battery-operated system, RTMS is an environmentally-friendly vehicle; so no more air pollution with this electric sorting system.

We built our robot through different steps. We created and tested each unit separately starting from the moving base ending with the sorting mechanism, where we used LEGO sensors and controllers with littleBits electronics to complete the communication link between the robot and the trash bins.

# Research

There are about 7.5 billion people on the planet producing mass amounts of wastes estimated to be around 1.9 billion tons. This includes domestic, industrial, medical, electronic, radioactive, toxic and hazardous waste. These are harmful to the environment and all other living organisms; and to manage this massive amount of trash we need time, effort and energy. All this results in increasing pollution and especially air pollution.

Our research was concentrated on the managing process of the trash and we found that there are massive number of trash bins distributed through the cities and the roads. These bins contain different types of trash that need to be sorted out to be recycled later. We worked on process, where the needed time and effort used in the sorting process will be decreased in the general sorting facilities.

We thought about making an eco-friendly mobile vehicle that saves more time and effort by going around and collecting all garbage bins which are full and sorting out this garbage into different categories.

We made a robotic truck that collects garbage and uses the electrical energy to move and work on its own.

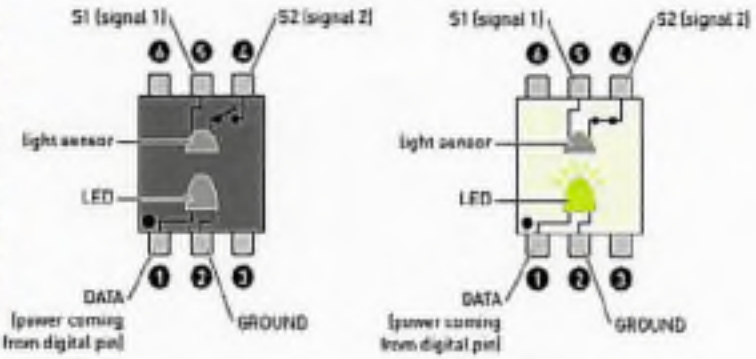
# Engineering & Design Procedure

RTMS is designed through several steps:

1. The machine body: the frame of the robot is built using LEGO structure with two main parts:
   a. The container: this part holds the trash sink, the chain mechanism, the sorting mechanism, the back wheels' gearbox, the wireless receiver unit, and the robotic arm.
   b. The steering head: this part controls the direction of the robot; left and right.

2. Testing the movement mechanisms of step (1) using the EV3 software. We have two motors; the first motor powers the four back wheels back and forth using Differential Gearbox, and the second motor controls the steering head left and right using gear down mechanism. We need to use two color sensors to follow the line; this will boost the following accuracy.

**Wireless Receiver Unit:**
Gets information from the littleBits transmitter as an indication of a Full Trash Bin. Its principle of operation is inspired by the Optocoupler electronic chip.



**Steering Mechanism:**

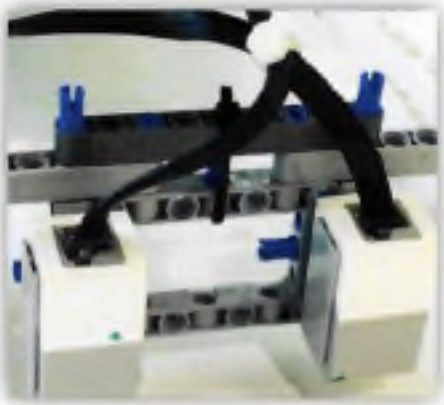
Turns the head of the robot, using Gearing Down arrangement for more torque.

**Differential Gearbox:**

The mechanism that powers the back wheels, while maintaining constant torque ratio between shafts at any given moment.

**Line Following Color Sensor:**

Helps the robot to follow the track, using two color sensors for more safety and stability.



3. Building the robotic arm: this robotic arm holds the trash bin and discharges it in the trash sink.

**The Arm:**

Picks up the bin and discharges the garbage into the sink, using Worm Drive arrangement for more torque and stability.

4. Testing the robotic arm using program to hold a prototype module of the trash bin, this robotic arm has two motors; the first motor grabs the trash bin, and the second motor discharges it in the sink. We need to use a gear down mechanism to increase the needed torque to lift up the grabbing mechanism and the trash bin weights.

5. Crafting the trash sink using Styrofoam sheets, this material is relatively strong enough to hold trash, and we use it because of its light weight.

6. Creating the chain mechanism that transfer the trash from the sink to the sorting mechanism, this chain is powered using one motor.

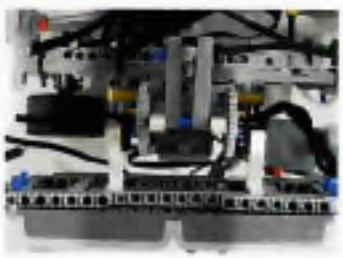
7. Testing the chain mechanism using simple program with different speeds.

8. Creating the sorting mechanism that sorts the trash according to its color (type), this mechanism has two medium motors, and here is how it works:

There are three cabinets, one for each trash category, and there are two rotary doors operated using two motors, the first door is located between the first and the second cabinets, the second door is located between the second and the third cabinets.

The program operates the motors as follows: If the trash is related to the first cabinet then the first door will open to pass the trash to the cabinet, if the trash is related to the second cabinet then the first and the door will close and the second trash will open to pass the trash to the cabinet, finally, if the trash is related to the third cabinet then the first and the second doors will open to pass the trash to the last cabinet.

9. Solar Panels: This is the LEGO Solar Panel. We used it to charge the EV3 Bricks. It closes and opens according to the light intensity. It also checks if the battery is already full. If there is enough light **and** the EV3 Brick is not charged, it charges it by opening itself (exposing itself to the light source).



10. Light Sensor: This light sensor is used to detect the light intensity and tell the robot whether or not there is enough light for the solar panels to be charged.

11. Energy Meter: This helps check if the EV3 is already charged and only lifts up the solar panel when there is less than 50% charging.

12. Smart Trash Bin (STB): This is the smart trash bin. It calls the robot to collect the trash from it when it is full. It contains littleBits, which checks whether the trash bin is full or not and if it is full, it calls the robot to collect the bin or else it continues to check till it gets full.

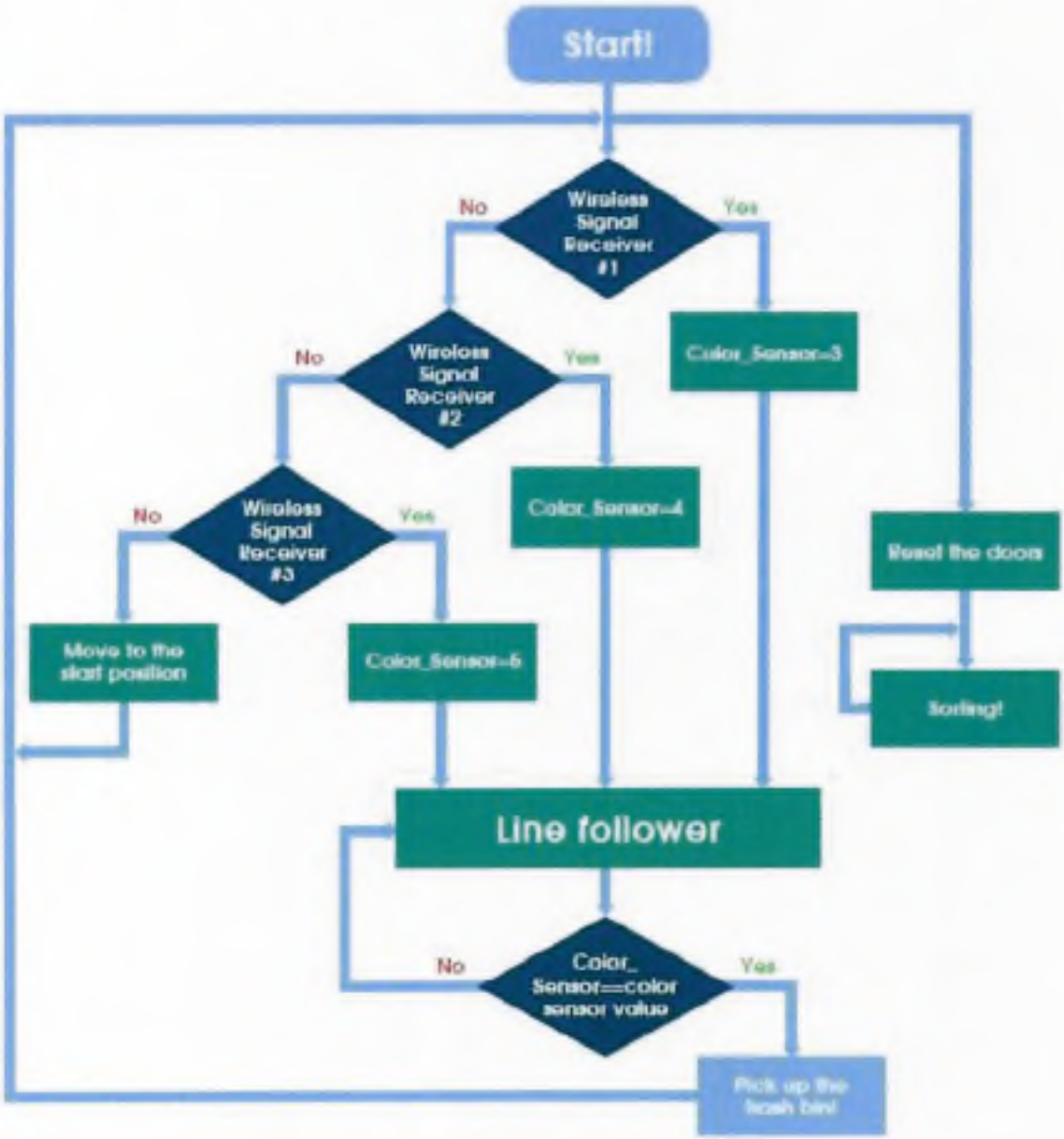
**How it works?**

- The light source emits light on top of the trash bin.
- This light goes through the trash in the bin.
- If there is no trash; all the light reaches the light sensor.
- But if the bin is full only a limited amount of light reaches the light sensor sending information to the robot to call it.

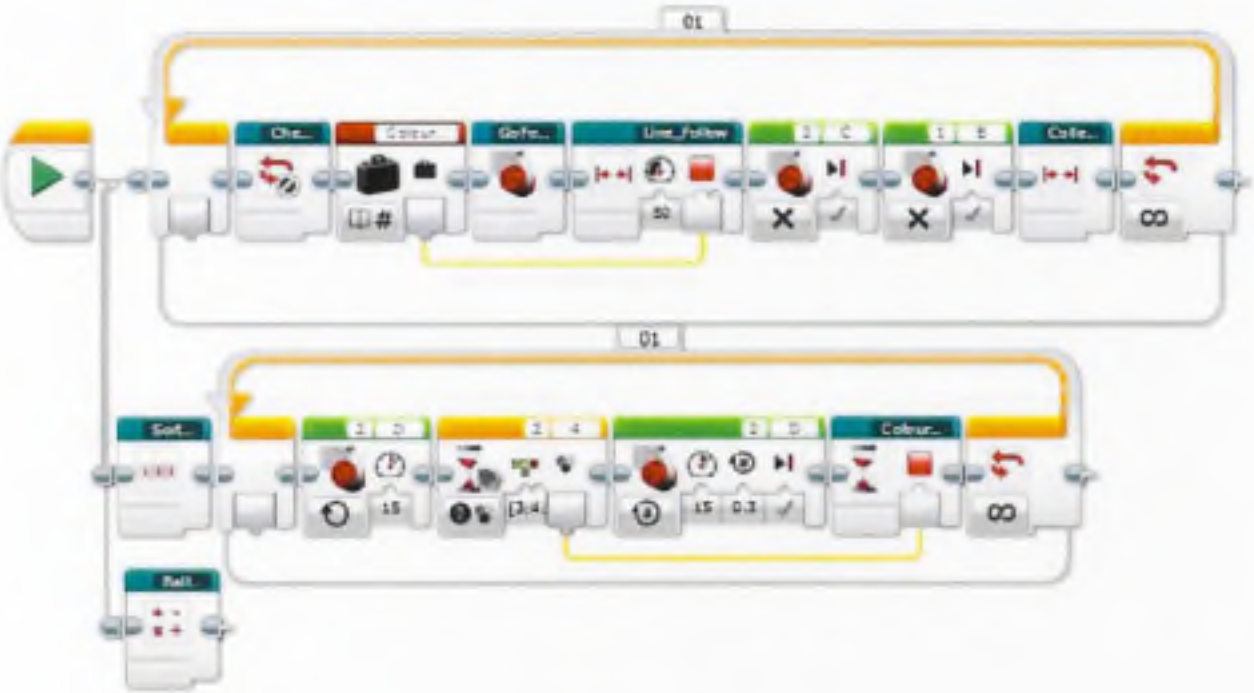
  On receiving the information the robot goes to the designated bin and collects the trash.

# Programming

We used the graphical user interface EV3 software to program this robot using two bricks connected with each other using the Daisy Chain technique such that the master brick controls the slave one. Where the master brick controls the robotic arm, the line- follower mechanism, and indicates the trash bins' areas. On the other hand, the slave brick controls the sorting mechanism, the differential gear box, and receives the wireless signal from the trash bins controller. As shown below in the flowchart:



**Main Program**: This is the main program. That operates the robot, it contains all the myBlocks:



The main program contains six main myBlocks each having a different function. These functions are described below:

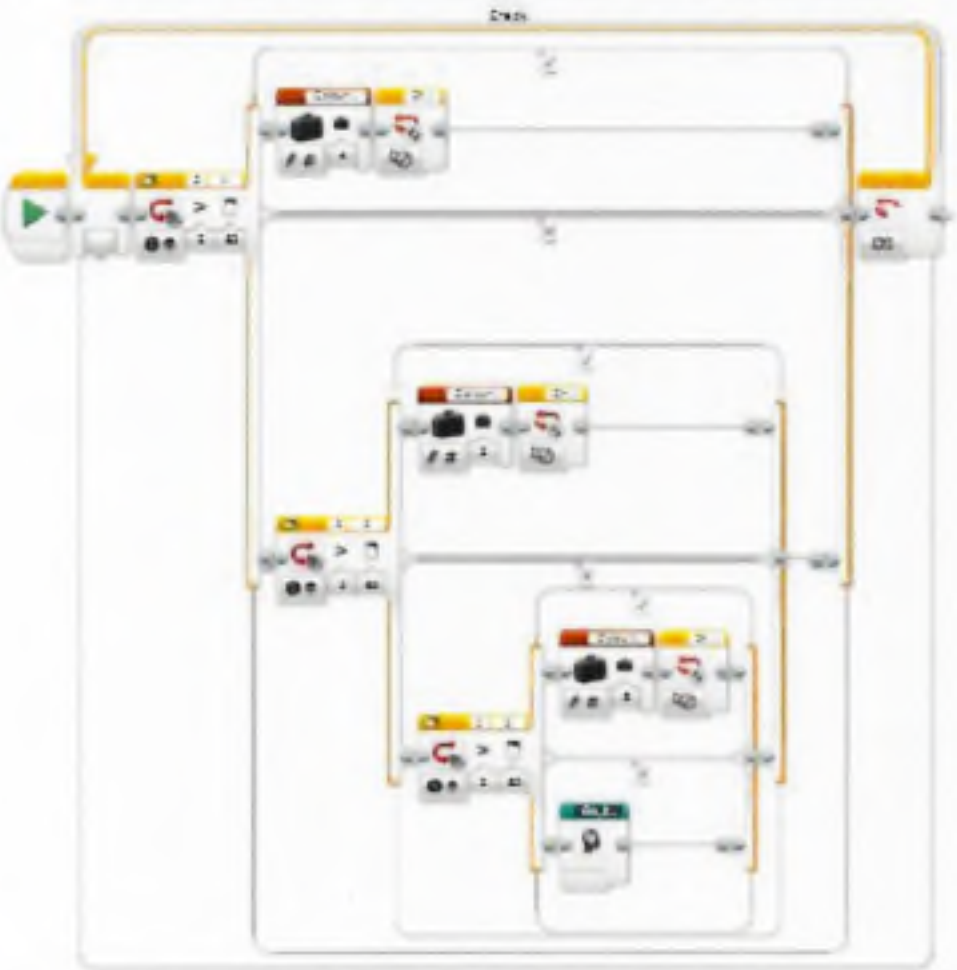
1. Check_Bin: This block gets signals from the bin and then enables the Line_Follow program to stop the robot at the trash bin location.
2. Line_Follow: This block follows the line on the road until it reaches the trash bin area.
3. Collect_Bin: The myBlock picks up the bin and discharges the garbage inside the trash sink for sorting.
4. Sorter_Pos: This block resets the inner gates position of the trash sorting mechanism; located in the sorting room.

5. Colour_Sort: This block sorts the trash inside the truck according to the type (color).
6. Ball_Value: This block counts the percentage of each type of trash.

All the myBlocks are described below in more details:

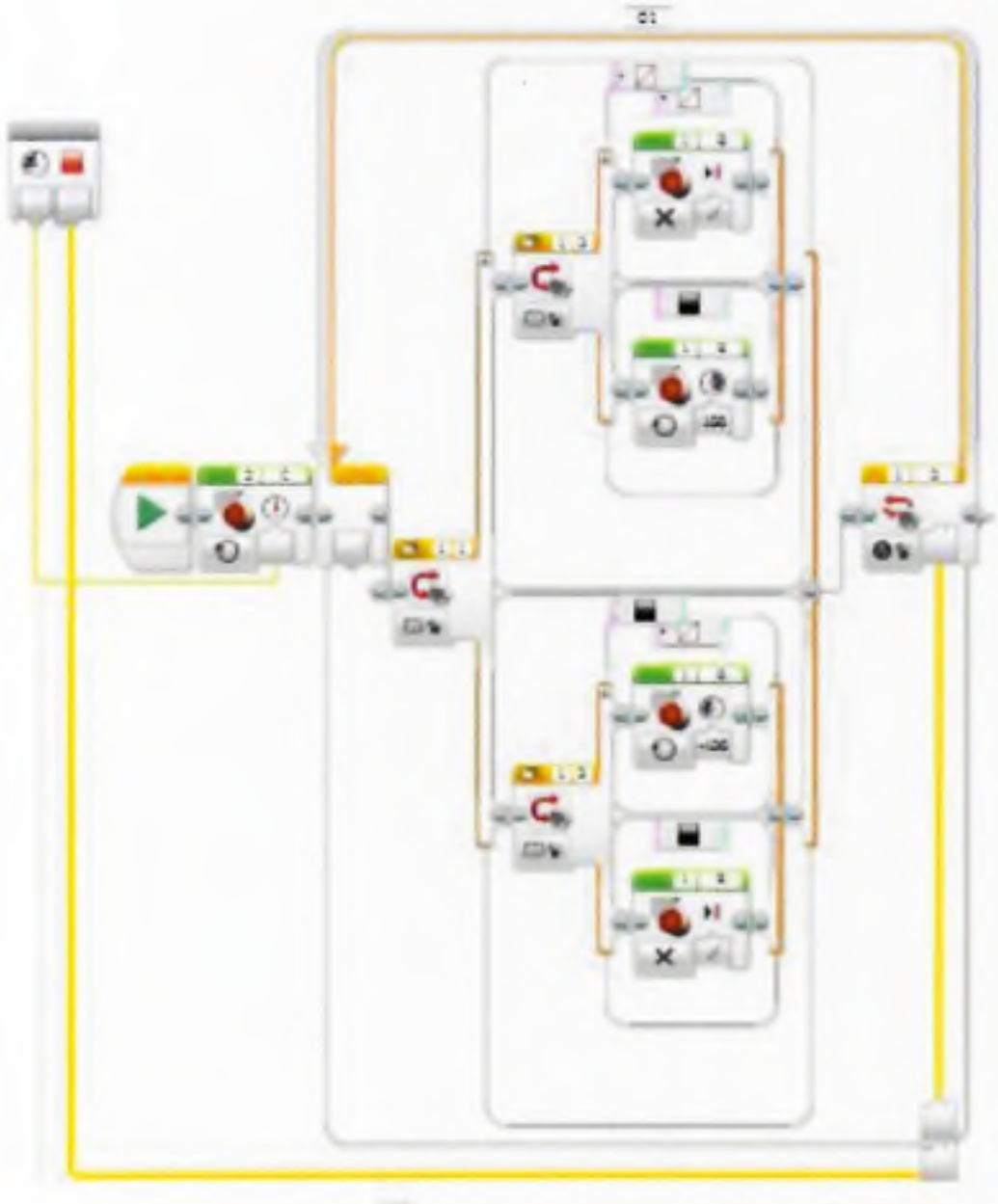
1. Check_Bin:

The check_Bin Block gets signals from the full bin through littleBits electronic wireless transmitter, but if the robot does not receive any signal it goes to its starting point and waits to receive a signal. After receiving the signal, it stores the location of the bin (Red, Green, or Yellow).



2. Line_Follow:


This Block guides the robot to move on the road properly. It contains two inputs; one is the speed of the truck and the other one is the location where the robot has to stop. It gets the information on where it has to stop from the Check_Bin block.



3. Collect_Bin:

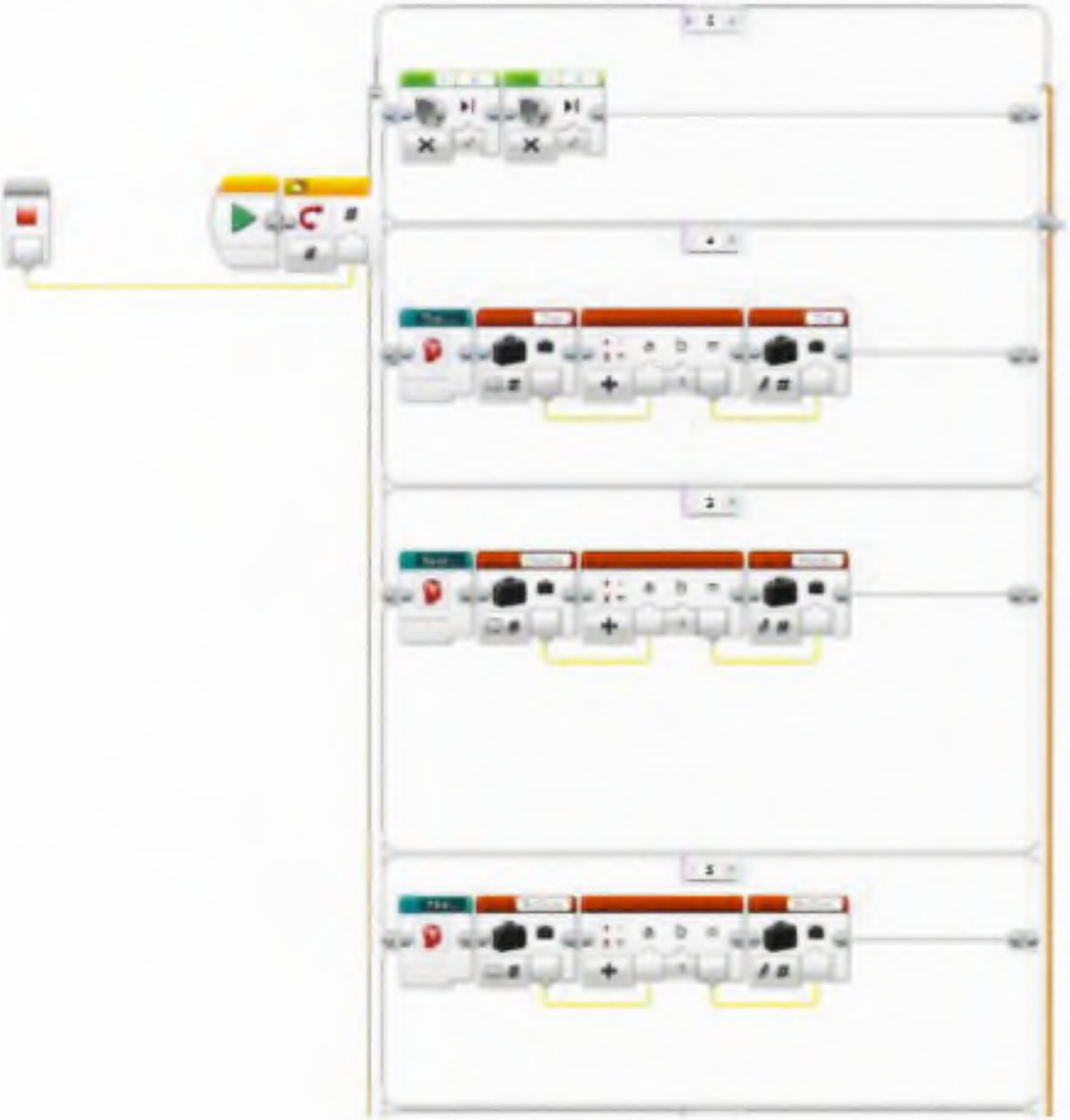

This myBlock picks up the bin and discharges its entire content inside the sink of the robot to be sorted.

4. Sorter_Pos:

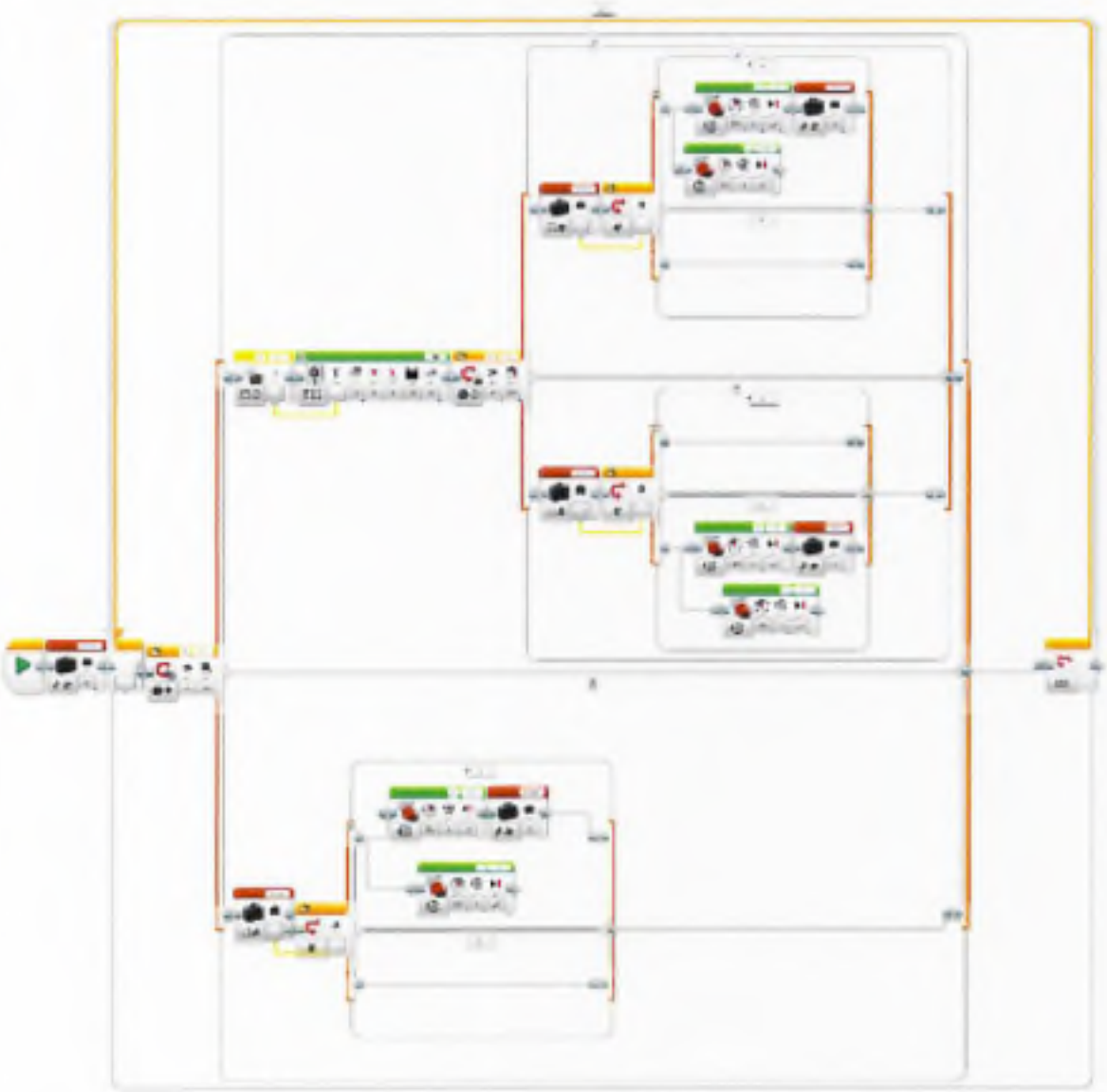

This program resets the position of inner gates in the sorting mechanism.

5. Colour_Sort:


This block sorts out the trash into categories (Plastic, Paper and Metal); three different colors.



## 6. Solar_Power_Panel:



# Result

As a result, the Robotic Trash Management System (RTMS) provides better way to manage the trash with its automatic system:

- RTMS keeps the city clean all the time; it works on its own once the trash bins become full.
- RTMS decreases the time and the effort needed in the sorting process by the main sorting stations.
- RTMS gives statistical information about the type and the quantity of the trash in each area in the city.
- RTMS can be charged using solar panels which require little maintenance and is energy efficient and environment friendly.
- RTMS reduces the air pollution with its battery-operated system; it is an environmentally friendly vehicle; so no more pollution with this electric sorting system.

# Future Direction

As a next step we will create a statistical information system that sends the sorting data in terms of quantity, type, and timing to the user and to the responsible authorities for this purpose.

Regarding the number of trash categories, we will increase the number of the cabinets in the machine; to boost the sorting resolution.

This robotic system can be easily adopted and modified for collection, transportation and sorting of other types of wastes such as Industrial waste, biomedical waste, textile waste, etc.

It can be developed further to spray germicide, disinfectants on the trash bins to remove the foul odour and kill germs.