SANITATION WITHIN THE SLUMS OF MANILA, PHILIPPINES

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Introduction and Research Question

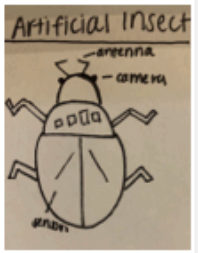
The city of Manila, in the Philippines, is facing extreme overcrowding. In fact, we are talking about one of the most populated cities in the World, the population totaling over 1.6 million people and a fertility rate of 3.1 children per woman. With this comes high density, low quality housing, and a lack of sanitation; all of which cause many problems. One major point is that Manila is one in five countries that produce half of the world's plastic waste. In our project we explore the lack of sanitation, specifically poor waste management. The problem is that trash is everywhere in this city; there is no proper area for the waste produced, and trash cans have become too full to take it all in. Tackling how to get rid of this waste is the issue we decided to pursue because of how prevalent the problem is, and because a lot of garbage itself contributes to overcrowding as well as the spread of infections and diseases.

From this, we question:

What engineering based solution can we design and execute to help control and manage waste in this very populated city?

Background Information and Research

The TC robot is designed to pick up trash in underdeveloped areas. The robot measure three feet tall and two feet wide. It will be able to withstand extreme weather, such as heavy rain, muddy conditions, and heat by the use of Omni Wheels. The Omni wheels will be made of a combination of rubber and fillers, which provides more friction between the ground and the robot itself during the more wet conditions. Since the TC robot is rectangular, the most suitable way to distribute its weight evenly was to attach two wheels per side. In terms of movement, these are the fellow components that will help it detect proximity, distance, and contact: Inductive Sensor Piece, Tamiya 6P Toggle Switch, and a Dexter distance sensor. In terms of direction, there will a GPS installed so that it knows when to return to relax the motor or where in the slums it should begin to collect trash based off a longitudinal and latitudinal coordinate system. The TC Robots will not only have an exact location but will also be guided with a specific route every time it functions in order to avoid any obstacle. This will be useful for when it becomes full of trash and must go to a dump site. As for its battery life, the TC robot will run off a mechanical motor. In order to prevent overheating, the robots will essentially have shifts. They will be programmed to work for either the morning or night and will "switch shifts" with other robots. Despite the robot being rather small, it will be able to hold up to three times its weight. Aside from the mechanical components, the TC Robot will be programmed through Python. There will be a small chip inserted onto the side of the robot that will contain specific codes to help it function properly. With Python, the robot's data will be analyzed and produce different kinds of output. The cost to make one robot is approximately $1,472.



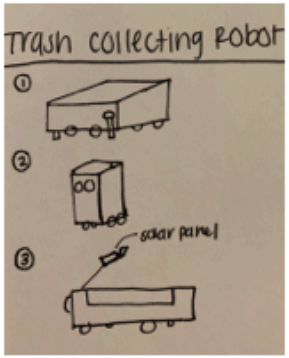
Methodology

Once we had determined that Sanitation would be the issue we would be targeting, we began researching statistics, data, and how much trash was being produced in Manila. Following this, we began to narrow down the issue to what we learned was the biggest problem within this; people disposing of their trash all over the street and public areas. We immediately began thinking of solutions for this that included an artificial insect, smart trash cans, and a trash collecting robot. We came a decision using the decision matrix, testing for different criteria such as cost, desirability, efficiency, feasibility, time, convenience, knowledge, availability, and manageability. These criteria were used to find the most effective solution. This matrix yielded the trash collecting robot as the best option, which was our final decision. The original design of this robot included utilizing solar energy, however we collectively decided that a mechanical motor would be most effective in order to ensure use throughout the day and night. After this, we produced a final design including two wheels, a box where collected trash would be stored, and the spaces that sensors as well as cameras would be included. After making the final prototype, the area where the sensors and cameras would be located can be visualized.

Proposed Solution

Through the decision matrix method, we tested each solution that we created by certain criteria, to see which one would be the best for us do. Ultimately, the trash collecting robots came out to be the highest of our three solutions, making this our final choice. From here, the issue can be particularized as follows:

The Trash Collecting (TC) Robots are to come to designated areas and collect garbage. They will be programmed to go to certain dump sites where they will dispose of their collected garbage when they are full. Paper, plastic, and cardboard items, can be recycled and used for composting as well.



Weighted Decision Matrix

Decision Factors		AI Insect	Smart Trash Can	Trash Picking Robots
Criteria	Wt.	3	4	5
Cost	5.0	5	5	5
Desirability	5.0	3	4	5
Efficiency	5.0	5	5	5
Feasibility	2.0	2	3	4
Time	3.0	3	5	5
Convenience	5.0	3	5	5
Knowledge	5.0	5	5	5
Availability	4.0	5	4	4
Manageability	4.0	3	5	5
Weighted Total		102	164	240

Results and Conclusion

The prototype itself is a simple final draft of what the design of the actual robot would look like. The size and dimensions have been minimized and the areas where sensors as well as cameras would be placed can be visualized. The robot is stable, and if the body is carefully removed, it can be seen where the trash would be collected. As seen through the research, any robot in general requires quite a bit of thought. These are very complex machines that require the acknowledgement of each component, whether small or large.

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