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University Research Proposal Evaluated By The Coordinators			

Trash Management System Using AI

I. Pre-proposal's context, positioning and objective

Abstract

Nowadays the percentage of pollution is increasing everyday all around the world, and a way to reduce the impact of this issue is to sort and recycle the produced garbage instead of using the traditional ways of dealing with them. And for this purpose, we are willing to implement a system that can sort different categories of trash with high accuracy by using sensors for collecting data, a central computer that will analyze the collected data then give the order to the robotic arms to pick up the targeted object, and cameras to specify the geometric information of this object and those objects will be placed at the end in different bins in order to start the recycling process.

Keywords

Trash, Pollution, Bin, Sorting, Management, Sensors, Camera,
AI, Robots, IoT, Arduino, Raspberry Pi, Deep Learning.

1.1. Research Area

In 2018, the trash produced by human activities reached two billion tones based on real statistics published by the World Bank. Based on the same publication, the World Bank predict that this percentage will increase by 70% in the year 2050! Those statistics and numbers maybe will be more if the governments did not take any serious steps toward awareness the societies of the importance of sorting the trash, build, design and use useful systems to increase the capabilities of sorting and recycling process.
For this purpose, and based on several related works, we design a system for sorting different types of trash that can be introduced in the garbage recycling factories, to increase the accuracy of the sorting process.

1.2. State of The Art

There are already many available related works in the targeted domain. But for simplicity we will introduce five different projects that deals with garbage sorting in different ways, some of those projects start sorting in the houses by implementing simple sorting systems, others introduce some features to the system sorting such as garbage level monitoring within the bins, using different technologies.

In the first reviewed related work, the sorting process is based on a smart **Auto-Trash s**ystem. This system works using a Raspberry Pi module equipped with a camera to see each item placed on top of the can's rotating top. Using image recognition powered by their own custom software model built on top of Google's TensorFlow AI engine the smart trash can is able to distinguish between items and rotate the top accordingly to drop them into the correct areas of a partitioned can.

In the field of computer vision principle, a project **"Classification of Trash for Recyclability Status"**, is proposed to classify the garbage. For this purpose, two models are used, which are SVM, and CNN, depending on a dataset contains 400 to 500 images and classified the garbage into six different categories (plastic, metal, paper, cardboard, trash, and glass). As a result, the best accuracy is achieved by the SVM model and reached 63% only.

Concerning the third reviewed related work, **"A Robotic Grasping System Using Deep Learning for Garbage Sorting"** was implemented. In this project, two deep learning models are used, which are the RPN and VGG models to detect the shape of the target trash, knowing that the only targeted type of trash in this system is the plastic bottles. Also, to figure out the location of the bottle over the sorting belt, a CCD camera was introduced, to collect the geometric center coordination and the angle information of the target.

Another work was the **"IoT Based Garbage Management System"**. This system is responsible for the management of garbage into dry and wet. It keeps separation between these 2 types of wastes in two different bins through a strategy of sending alarms in case wet garbage where dumped into the dry bin or vice versa. Also, an alarm is sent incase the bin became full or in case or fire detection. All these alarms are sent as an SMS messages to a pre-chosen person who should be responsible for the waste management in the town (for example, the garbage truck driver). In order to achieve these goals, the system uses several IoT components. Moisture sensors are used to differentiate between the different types of wastes. Flame sensor is used for fire detection. Arduino UNO and ultrasonic sensor are used to check the level of garbage filled. And a Raspberry Pi is used to communicate this information to the waste managers.

Regarding the last related project, and as the previous reviewed work, it's an **"IOT Based Garbage Monitoring and Sorting System"** which also takes into consideration the same two types of wastes (dry & wet). But this system doesn't only manage to keep separation between dry and wet but also aims to sort them into 2 different bins. And this sorting process is done completely at home. This sorting technique is performed by the system using Arduino, DC Power, motor driver, LCD, Wi-Fi and gas sensors attached to a board, where the user put a trash object on this board and then the system drops it in to the suitable bin. The result of this sorting will be displayed on an LCD and is also stored into a database (The data stored in the database is used for another project "Smart City"). The system also has another functionality which is to check the level of garbage filled in the bins using ultrasonic sensor, and it displays this information as a graphical view on a built-in web page.

1.3. Targeted Technique

After presenting several related works in the field of garbage management and sorting, it's clear that most of these systems needs enhancements.
Some systems gave low accuracy in sorting different types of garbage (only 63%) or can be used only in the house, knowing that using such systems in houses may be considered as an expensive system for many families. Other systems were only able to sort a specific type of garbage, like sorting plastic bottles only, or sorting into two categories (wet and dry) instead of taking into consideration all the different kinds of wastes. And finally, some systems were not going through a sorting process but instead were only responsible for garbage management through sending alarms if some garbage mixing error was detected.
So, based on all of this discussion and points of weakness on these systems. We are willing to design a system which solves all these issues. Which thus can sort all the different types of garbage, inside the factory and with very high accuracy based on IoT and AI.

In our system, after moving the garbage from the city to the factory, the sorting process will start by adding the garbage on the sorting belt by the human workers, and the added trash should be separated from each other's as much as possible for more accuracy. Above the sorting belt, a group of sensors placed, those sensors will collect the information regarding the category of the objects, and send the collected information to a central computer. The central computer will analyze the data and make the decision concerning the category of the target trash (paper, plastic, glass, organic, cardboard, or metal), then send the order to a robotic arm. We have several robotic arms, each one is responsible for the collection of a certain type of trash, with the help of a camera beside each arm, to detect the location of the targeted object by collecting the geometric data. Following the collection of the object, the arm will drop it on the suitable box preparing each box to be moved at the end to its suitable area (Papers for recycling, organic trash for composting…).

1.4. Innovation

In short, after presenting the related works, we can say that our proposed system is considered good enough, and can reach an accuracy that wasn't offered before, and this is what the market and the environment needs since every used system has a missing part. Besides, one of the most important special features that our system has and can be considered as innovation in this field, is collecting different objects at the same time to drop them in a suitable box.

1.5. Research Issues (Ethics)

Many ethical issues rise upon the implementation of this project including:

-Health Issues: This research has a huge effect on the whole life of the planet (human beings, animals, plants…). Because the process of the garbage sorting and management will provide a solution for all kinds of pollution problems all around the world. Thus, the more accurate the modeled system is, the better effect it has on the environment. But at the same time, we have to be aware of a bad model which could cause many new problems instead of providing solutions. For example, a bad model which could drop a plastic object into the organic box could exacerbate the solid pollution problem if we decided to use this organic box of wastes as an organic fertilizer.

Mechanization Issue: Some countries are following a process of manual sorting of trash using human workers. So, upon replacing these workers by machines, we are protecting their health. But at the time they will lose their jobs. And the solution of this problem is that most of these workers can still have several new jobs in the factory. Including: the collection of the trash from the houses and streets, technical supervision and maintenance inside the factory.

II. Partenariat

Knowing that this research proposal is only processed theoretically for now, in the academic domain under the context of the "Research & Innovation" course. We don't have any partnership organization that is ready to implement our project yet. But still, we have taken a look on who might be interested in implementing our research project:

1. **Laboratorie Hubert Curien "Connected Intelligence Team"**:

The Laboratory is located in France, Saint-Etienne.
The "Connected Intelligence" team groups academics from both MINES Saint-Etienne and Université Jean Monnet. The team aims at contributing to the definition of models, algorithms and software architectures to support the inter-connection of physical, digital and social worlds in an open and

decentralized context. And the team have previously experienced and worked on many projects in the domain.

2. **Naver Labs Europe:**

It is one of the biggest industrial research labs in the domain of AI in Europe. And It is located in Grenoble, France. The laboratory has several working teams in the domains of AI and robotics. The teams consist of members from all around the world, in which they all cooperate together to build and test AI models.

III. References related to the project

- Statistics from world Bank: https://www.worldbank.org/en/news/press-release/2018/09/20/global-waste-to-grow-by-70-percent-by-2050-unless-urgent-action-is-taken-world-bank-report
- Auto-Trash project at: https://github.com/bneijt/autotrash
- Auto-Trash machine implementation at: https://techcrunch.com/
- "Classification of Trash for Recyclability Status" scientific paper at: http://cs229.stanford.edu/proj2016/report/ThungYangClassificationOfTrashForRecyclabilityStatus-report.pdf
- "A vision-based robotic grasping system using deep learning for garbage sorting" scientific paper at: https://ieeexplore.ieee.org/document/8029147
- "IoT Based Garbage Management (Monitor and Acknowledgment)System: A Review" scientific paper at: https://ieeexplore.ieee.org/document/8389250
- "IOT Based Garbage Monitoring and Sorting System" scientific paper at: https://www.irjet.net/archives/V5/i1/IRJET-V5I1158.pdf
- Hubert Curien Laboratory at: https://laboratoirehubertcurien.univ-st-etienne.fr/en/index.html
- Naver Labs Europe at: https://europe.naverlabs.com/