A Review of the Computer Science Literature Relating to Recycling Machine Systems

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Abstract

Environmental pollution is a global issue caused directly by mankind. Almost every inorganic materials are in a problematic situation for natural recycling. The nature itself cannot easily dispose inorganic materials. Preventing such a cause can only be made of increasing awareness on recycling. REZES project will prevent environmental pollution and provide added value by recycling metal, plastic and glass using IoT (Internet of Things) Technologies, Image Processing, analyzing Big Data and implementing Gamification ideas. In an extensive scope, there will be a user login on a mobile application where users can login by a QR code, a microprocessor (Raspberry Pi-3), a mini LED display screen, Camera Modules and sensors. Combining all these parts will produce an automated recycling system where the garbage will be converted into reusable materials. In this paper there will be a broad research on Recycling, IoT, Microprocessors and Sensors and the survey will conclude with the summaries of every scanned article.

1 Introduction

According to study of Jambek et. al, they calculate that 275 million metric tons (MT) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million MT entering the ocean. Population size and the quality of waste management systems largely determine which countries contribute the greatest mass of uncaptured waste available to become plastic marine debris. Without waste management infrastructure improvements, the cumulative quantity of plastic waste available to enter the ocean from land is predicted to increase by an order of magnitude by 2025 [1].

Rapid urbanization and industrialization is causing an unprecedented rise in the generation of municipal solid waste (MSW) worldwide. MSW is often a rich source of various useful recyclable materials such as metal, paper, plastic, and glass. Effective MSW management can enable recovery of valuable recyclable materials and reduction of negative environmental impact. Waste sorting is a key step in MSW management for the recycling of materials. Researchers worldwide have been actively exploring automated sorting techniques for efficiently processing increasing quantities of MSW [2].

2 Today's Recycling Machine

We want to give an example about recycling machine. TOMRA is a one of the important companies that make recycling vending machine. Today, consumers go through almost 1.4 trillion beverage containers every year, representing a vast amount of packaging material that can be collected and reused or recycled. Proper handling of used packaging conserves precious resources like energy, water and crude oil and reduces greenhouse gas emissions.

Users get an instant reward when returning used containers to TOMRA reverse vending machines, motivating repeated use and further raising collection rates. As reverse vending machines are often an integrated part of consumers' routines, everyday recycling is made convenient, efficient and profitable for all stakeholders [3].

Reverse vending machines provide an automated method for collecting, sorting and handling the return of used beverage containers for recycling or reuse. During the 45 years these systems have been utilized, they have proven to be an unmatched success for consumers, businesses and the environment [4].

3 Computer Science in Recycling

Nowadays, recycling has an important place because of environmental pollution. With the developing technology, the functional properties of recycling are developing. Thanks to sensors and microprocessors, recycling machines continue to evolve. In our project, new features will be added to the recycling machine systems, so we will inform about the computer science in related sub-headings.

3.1 IoT (Internet of Things)

IoT (Internet of Things) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors and communication hardware to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data.

The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed [5].

3.2 Image Processing

Digital image processing is always an interesting field as it gives improved pictorial information for human interpretation and processing of image data for storage, transmission, and representation for machine perception. Image Processing is a technique to enhance raw images received from cameras/sensors placed on satellites, space probes and aircrafts or pictures taken in normal day-to-day life for various applications. This field of image processing significantly improved in recent times and extended to various fields of science

and technology. The image processing mainly deals with image acquisition, Image enhancement, image segmentation, feature extraction, image classification etc [6].

3.3 Mobile Application

Possessing every utility in a day life requires a mobile phone for sure. In our Project, we are trying to ease the process by granting access for all users in order to initiate their recycle process. The UI(User Interface) must be easy to use, fast and practical so that the user would be influenced by the application. Our only aim is to make a simple but qualified application to bring as much users as we can.

Building a different app for each platform is very expensive if written in each native language. An indie game developer or startup may be able to support just one device, likely the iPhone, but an IT department will have to support the devices that its users have that may not always be the latest and greatest. The performance argument that native apps are faster may apply to 3D games or image-processing apps, but there is a negligible or unnoticeable performance penalty in a well-built business application using Web technology.

What makes things even more complicated are the differences among the actual platform SDKs (software development kits). There are different tools, build systems, APIs, and devices with different capabilities for each platform. In fact, the only thing these operating systems have in common is that they all ship with a mobile browser that is accessible programmatically from the native code [7].

3.4 Gamification

In the past few years, gamification has emerged as a trend within the business and marketing sectors, and has recently gained the notice of academics, educators, and practitioners from a variety of domains. Even so, gamification is not a new concept, having roots in marketing endeavors, such as points cards and rewards memberships, educational structures, most notably scholastic levels, grades, and degrees, and workplace productivity [8].

Concept	**Definition**	**Goal**
Gamification	'A process of enhancing a service with affordances for gameful experiences in order to support the user's overall value creation' — Huotari and Hamari (2012).	to support the user's overall value creation by providing gameful experiences (see goal of games)
Games	Free, no material interest, voluntary, uncertain, governed by rules, interesting choices, mastery, flow — Huizinga (1955), Caillois (1958), Avedon and Sutton-Smith (1971)	to create experiences such as flow, intrinsic motivation, achievement and mastery

Loyalty Programme	'Marketing efforts which reward, and therefore, encourage loyal customer behavior in order to increase the profitability of stable customer relationships' — Sharp and Sharp (1997)	to increase customer loyalty
Persuasive Technology	Interactive information technology designed for changing users' attitudes or behaviour — Fogg (2003), Oinas-Kukkonen and Harjumaa (2009)	to change attitudes and behaviours
Choice Architecture	'To nudge people towards the right choices [to make their lives better]' — Sunstein and Thaler (2008)	to help people make better decisions
Decision Support Systems	'A computer based system to aid decision-making [for running organisations more efficiently]' — Sol et al. (1987)	to make decision-making activity more effective

Table 1. Comparison between parallel concepts related to changing attitude and behavior [9].

3.5 Data Analysis

Data analysis is a process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, while being used in different business, science, and social science domains [10].

3.5.1 The Process Of Data Analysis

Analysis refers to breaking a whole into its separate components for individual examination. Data analysis is a process for obtaining raw data and converting it into information useful for decision-making by users. Data is collected and analyzed to answer questions, test hypotheses or disprove theories.

There are several phases that can be distinguished, described below. The phases are iterative, in that feedback from later phases may result in additional work in earlier phases [10].

- Data requirements
- Data collection
- Data processing
- Data cleaning
- Exploratory data analysis
- Modeling and algorithms
- Data product

3.6 Machine Learning

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.

The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly [11].

3.7 Raspberry Pi

A Raspberry Pi is a credit card-sized computer originally designed for education, inspired by the 1981 BBC Micro. Creator Eben Upton's goal was to create a low-cost device that would improve programming skills and hardware understanding at the pre-university level. But thanks to its small size and accessible price, it was quickly adopted by tinkerers, makers, and electronics enthusiasts for projects that require more than a basic microcontroller even arduino.

The Raspberry Pi is slower than a modern laptop or desktop but is still a complete Linux computer and can provide all the expected abilities that implies, at a low-power consumption level [12].

3.8 Sensors

There are two distinct ways for recognizing a material, one is sensors and the other one is image processing however they both have their own trade-offs. Determining the best option requires a test on both platforms. Testing on sensors requires a choice; we may use some infrared sensors, motion sensors or directly material recognizing sensors.

The simultaneous detection and quantification of physical, chemical, and biological information from the ambient with mobile/autonomous/remote sensing systems is easier accomplished when using complex platforms that integrate several dissimilar sensors; ideally all those required by a specific application. The first step towards flexible multi-parametric sensing platforms should be, and actually was, the development of different kinds of sensors on plastic substrates [13].

The kinetic response was studied by continuously monitoring the colored complex spectra of cage sensors after the addition of analyte ions at varying times.

Chemical sensors are molecular receptors that transform their chemical information into analytically useful signals upon binding to specific guests. These sensors are attracting attention owing to their potential for easy detection and quantification of the pollutant species in many fields of application, such as waste management, environmental chemistry, clinical toxicology, and bioremediation of radionuclides. The kinetic response was studied by continuously monitoring the colored complex spectra of cage sensors after the addition of analyte ions at varying times.

Different brands of motion sensors detect steps differently; therefore, caution must be used when comparing step counts between studies that have employed different brands of motion sensors. Taking into consideration the results of both studies and the initial walking test used for instrument screening purposes, it appears that, of the three pedometers tested, the YAM pedometer is most consistently accurate under both controlled and free-living conditions. Future research must consider presenting motion sensor accuracy in absolute terms so that the magnitude of error is not underestimated [13].

4 Future Work

As a future work, we plan to design our recycling machine systems (REZES) using computer science technologies such as IoT, Machine Learning etc. By making these components a new generation smart recycling machine concept, we aim to recycle waste more efficiently and systematically.

5 Conclusion

On such a project as we are dealing, just a single scope on a specific matter is never enough. It should be handled in parts. Among all these parts, recognizing the material that was dropped by the user was the most crucial one. Sensors are named as hardware and they have a raw cost no matter what. On the other hand, image processing does not. Until the testing part with two distinct methods comes up to a conclusion, it is not easy to pick a method. Another matter was the QR code generation and matching codes. In this issue, Raspberry Pi-3 is the actor; it is not an appropriate way to put a huge desktop right next to a box taking waste materials as input. Raspberry Pi will act as a computer in our project. The process does not need great properties in a computer. Some simple operations will be enough. Another part of the project is mobile application for users. It seems as we will develop an application on an Android platform first however in the future, it will also be implemented. As indicated in the survey, a startup company may not be funded enough to afford two mobile platforms at the same time. Some other surveys shows us that on a project like ours, we shall definitely have a user-friendly interface to keep them linked with the application. Increasing the attention is another problem on the project. Gamification is a solution for advertisement. Reaching out to an audience requires analysis of the audience. REZES is designed to operate in huge scales, so; analyzing such data would not be so easy. Big data analysis includes attributes for grouping on common platforms. For determining the correct audience on a specific spot is only possible by data analysis. On the other hand, there are several different ways for applying gamification. All these ways improves the quality of the project. In a nutshell, when all these parts are handled and gathered together, there will be an incredible result as in making the World a cleaner and healthier place.

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