

**School of Computer Science**

**Masters in Applied Computing (M.A.C)**

**AI based solid waste classification**

**COMP8157**

**Advanced Database Topics**

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# Introduction:

Waste management is critical for a sustainable future. But, Due to a lack of effective waste management infrastructure and methods, serious environmental effects have occurred. Our waste management project is an innovative solution that aims to address this issue by utilizing advanced image recognition technology. Our System will provide a user-friendly platform for waste classification, allowing users to make informed decisions about proper waste disposal such as recyclable or non-recyclable waste including cardboards, plastics, batteries, Bio-degradable wastes, etc.

# Problem statement:

Population burst and industrial revolution have resulted into significant rise in generation of the solid waste. According to the world bank, 2.01 billion tons of Municipal Solid Waste generated globally every year and it’s further projected to increase to 3.40 billion tons by 2050 [1]. Accounting this, traditional hand pick method for waste classification is no longer efficient in terms of time as well as accuracy. Furthermore, the former method also consist the risk that a person sorting the waste can be infected with decease. Global Covid-19 pandemic had created further difficulties in manual waste disposal system.

Moreover, development of an AI based waste classification system is also faces several challenges. One of the major challenge is the complexity and variability of waste materials which makes it difficult for an AI model to accurately classify the waste. To overcome the issue, there is a need to develop an efficient AI model that can accurately classify the solid waste based on its nature.

# Motivation for solution:

The world is currently facing a pressing issue in waste management due to the rapidly increasing amount of waste being generated. A significant challenge in this field is the accurate and efficient classification of waste to ensure proper disposal and recycling. Conventional methods for waste classification are often laborious, time-consuming, and prone to errors, resulting in inefficiencies and environmental harm. There are different strategies followed by various counties to solve the issue of waste management. For example, [2]Japan has an efficient waste management system with a "3R" strategy, encouraging individuals to sort their garbage into distinct categories. Germany has a "closed-loop" waste management strategy with over 70% of garbage recycled or composted. [2]Sweden has a unique waste management system where practically all trash is burnt to create power and heat in waste-to-energy plants, and the government aims to be fossil-fuel-free by 2040. Singapore has a strict waste management system, requiring citizens to dispose of their waste in designated bins, and providing incentives such as cash rewards and tax breaks for recycling. The United States' waste management differs by state and municipality, with some having curbside recycling programs and "pay as you toss" systems, but there is still a significant amount of garbage ending up in landfills and a growing push for more sustainable waste management practices.

The application of AI-based waste classification can bring a revolutionary change in waste management by utilizing machine learning to achieve precise and efficient classification. By automating the process of waste classification, we can enhance the effectiveness and accuracy of waste management and reduce the negative impact of waste on the environment and public health. The success of this project can represent a major milestone toward creating a sustainable and efficient waste management system and can inspire other similar initiatives to tackle the global waste crisis.

# Methodology:

1. Data Collection: Collect a large dataset of images of different types of solid waste, labelled according to their recyclability, material type (plastic, paper, etc.), and any other relevant information.
2. Data Pre-processing: Pre-process the data by resizing images, normalizing pixel values, and augmenting the dataset to increase its size and diversity.
3. Model Selection: Select a suitable deep learning model architecture for the classification task, such as Convolutional Neural Networks (CNNs) or Transfer Learning models.
4. Training: Train the model on the pre-processed dataset, using an appropriate loss function, optimizer, and hyperparameters.
5. Evaluation: Evaluate the model's performance on a held-out validation set, using metrics such as accuracy, precision, recall, and F1 score.
6. Fine-tuning: Fine-tune the model by adjusting the hyperparameters, architecture, or training data, based on the evaluation results.
7. Deployment: Deploy the trained model in a smart waste management system, either on a cloud-based server or on a local device, to classify incoming images of solid waste in real-time.
8. User Feedback: Collect user feedback on the system's performance and incorporate it into the model training and fine-tuning process to improve its accuracy and efficiency.
9. Maintenance: Regularly maintain and update the system by retraining the model on new data, improving the image processing pipeline, and keeping the hardware and software up to date.

# Technology:

* Mobile Technology: Flutter (Dart)
* Computer vision: TensorFlow Lite
* Database: Firebase
* Image Recognition: MobileNet

# References:

1. *What a waste 2.0* *Trends in Solid Waste Management*. The World Bank. Available at: https://datatopics.worldbank.org/what-a-waste/trends\_in\_solid\_waste\_management.html (Accessed: February 15, 2023).
2. OpenMind BBVA’s knowledge community Estimated reading time Time 3 to read *et al.* (2020) *5 recycling lessons from different countries in the world*, *OpenMind*. Available at: https://www.bbvaopenmind.com/en/science/environment/5-recycling-lessons-from-different-countries-in-the-world/ (Accessed: February 27, 2023).