DETECTION OF RECYCLABLE PRODUCTS

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project/internship titled **"Detection Of Recyclable Products"**, submitted by Sahajul Islam, ID No: 171-15-8924, Lifonar Afrin Lifa, ID No: 171-15-9445, Mehedi Hasan, ID No: 171-15-9194, to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 1st June, 2021.

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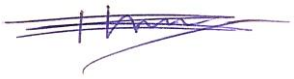

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We hereby declare that, this project has been done by us under the supervision of **Ms. Fahmida Afrin, Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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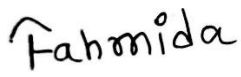

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ABSTRACT

Detection of recyclable products by artificial intelligence is an ongoing research area. Recent techniques by advanced robotics are generated by fuzzy logic systems. Fuzzy logic captures the uncertain systems perfectly. In this study, a fuzzy logic model has been designed for the detection of recyclable products. Here shape, cleanliness and materials are taken inputs for the Mamdani FIS system. These inputs are perfect for detecting any unknown objects to recyclable or not. This study also investigates similar other results. Mainly in this study, we have used some membership functions and with this, we have made some rules to get our accuracy for the result. We have gathered some information and analyzed it before assigning values to the membership function in order to achieve the highest level of accuracy. Recycling is important for our nation and the whole environment. It will help us to save our resources and money. By recycling recyclable products we can also combat global warming, decrease pollution and save the environment and wildlife. As a result of this research, it is now much easier to determine whether a product is recyclable or not.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

A city is best liked if it is safe and hygienic by people who live in it. But people are drawn to the city area in the era of an increasing population, and it is therefore challenging, the cleanliness of the city, to stay. Looking at the countries in Southern Asia, it's easy to understand how difficult it is because a town's rising population raises waste production. Although the waste management system has been developed in first-world countries, the waste management system is poorly managed in most developing countries. That is why it has been essential to take account of garbage management.

In the majority of developing countries, the overflow of garbage bins is a typical scenario. Besides, these countries' population prefers not to throw the garbage inside but outside the trash can. This is poorly hygienic and unpleasant. Going by the trash inside in this situation does not reflect a pleasant experience for people, particularly immigrants, teenagers, older adults etc. Therefore, it is obvious that uncollected garbage is presented by citizens as regards sanitation, community appeals and environmental conservation on highways or other areas of the advanced countries. "Much disease can be prevented by accessing safe water supply, adequate sanitation services and better hygiene practices," the World Health Organization [1] said. Alone, diarrheal disease is an estimated 3.6 percent of the world's overall daily burden and is the cause of 1,5 million deaths per year (WHO 2012). The estimated deaths in water, sanitation and hygiene are estimated at 58 percent of the cost or 842,000 per year and are estimated to comprise 361,000 deaths of children under five, mainly in low-income countries (WHO 2014).' Hence, a very critical subject today is to discuss the health problem related to garbage management. The high cost of waste disposal needs to be reduced as well. CBS NewYork [2] for example, has published that the City of New York spends $300 million annually for waste collection. For most developed countries, this is a significant number. We need to find out how to solve this. However, it could be possible to introduce new ideas to improve the situation. Automatic systems for the storage and disposal of waste in public spaces is one way to resolve these issues. The schemes help 1) lower waste collection costs, 2) increase tourism appeal, and 3) boost public hygiene not only for third world countries but for developed countries as well.

1.2 Motivation

We live in a country where resources are limited. If we can save resources and throw less trash into the landfills, air and water pollution can be alleviated. Though Bangladesh is a developing country and has achieved great success in some fields, it still lags behind in waste management. The people living here are unaware of waste management. We can make our lives and environment better if we can make use of recyclable products as it mitigates the need for extracting and refining and processing raw materials. Hence, we have been highly motivated to work on this.

1.3 Rationale of Study

If we complete our project properly then it will be very helpful for our country and also for whole world. Recyclable is very important for a country. If we recycle the recyclable products properly then we can

-Save resources and energy.

-Protect the environment.

-Reduce incineration.

-Mitigate global warming, decrease pollution and save the earth and animals.

1.4 Research Question

Here are some primary questions those are the key point in this thesis are outlined below:

- Can you identify the recyclable and non-recyclable products?
- Can you give the right input to make decisions?
- What are the limitations to work with Fuzzy logic system in this sector to detect objects?

1.5 Expected Outcome

Mainly by this study, we can detect recyclable products with high accuracy. In this we will require to provide some input with the help of the membership function, the output

will be shown with accuracy. We can make a decision whether a product is recyclable or not.

1.6 Report Layout

The project report is divided into six parts. The below is a summary:

Chapter 1: The introduction, motivation, rational of study, expected outcome have been discussed in details in chapter one.
Chapter 2: The background of our project which is covered with related works, scope and challenges is discussed in this chapter.
Chapter 3. In chapter three there will be a segment named “Research Methodology”.
Chapter 4: Chapter four will contain the experimental result and discussions.
Chapter 5: The impact on the society, environment and sustainability will be described in this chapter.
Chapter 6. Conclusion and implication for future research are available in this chapter.

Chapter 2

BACKGROUND

2.1 Introduction

In our country, there are no such related works was done which can detect recyclable products accurately. So the background is the current situation of waste management and the use of AI in waste management in Bangladesh.

2.2 Related Works

Latest developments in profound learning science have made a major contribution to the advancement of computer vision. Convolutional CNNs are one of the most effective algorithms in the field of depth learning with various applications in the classification, segmentation and detection of images [3-6]. CNN is, therefore suggested in this paper for the identification and recognition of garbage.

Hybrid deep-learning (MHS) multi-layer method, capable of sorting waste disposable of individuals in a public space in a city. The machine is able to sort trash products automatically as recyclable or not. AlexNet CNN[3] was used to extract main image features and optical sensors to detect additional numerical data. Multilayer perceptron's (MLP) have been used in this system in which the trash object is identified by consolidating data obtained from different canals. The proposed MHS achieved a mean precision of more than 90%, but only 22 fixed waste products can be identified in public places. Other trash items are not counted in their scheme on the lane, or in a park.

Bai et al. [8] introduced a trash collection robot that could autonomously and reliably detect trash on the herb. They used a profound neural network, ResNet[9], to detect trash and to navigate the robot. The robot will automatically clean garbage from the ground in the parks or schools with trash recognition and automatic navigation features. Their accuracy of trash identification was higher than 95%. But only on grass can the robot detect garbage. So waste cannot be detected by the robot on the road or in parking areas.

The two above research attempts at using CNN architecture have been extremely accurate. On the basis of this work, we suggest a method to classify garbage from any

public location, for example, a highway, a car park, a recreational area, a community space, etc. Based on this work. Our ultimate objective is to create a garbage collection robot that sails on the ground in a park or a public area. This study is the first step to classify the picture objects.

2.3 Comparative Analysis and Summery

Bangladesh has a huge population with less land. The people here do not have enough knowledge about waste management. They deliberately dump waste here and there. As a result, environmental pollution has increased. Although the Bangladesh government has been conducting many awareness programs on waste management, no promising results have been seen so far. Therefore, hopefully, this system will play a groundbreaking role in the context of Bangladesh.

2.4 Scope of the Problem

We recognize that a broad range of expertise is required for this entire project, ranging from image processing, visual analysis, motor control, development and potentially 3D printing, wireless communication, battery charging and database management. These subjects go far further than this thesis. This research focused on the perfection of the detection of recyclable products. As there are lots of different shaped products, with dirtiness, detection is very tough. Sometimes the error occurs. Thus fuzziness is appropriate for the representation of uncertainties. In this study, fuzzy logic (Matlab 16) is used for detection of objects.

2.5 Challenges

In this research, we work with Fuzzy Logic method. Nowadays, Fuzzy system can be used to resolve numerous decision making problems. It often gives outstanding decision inputs and knowledge based rules. Fuzzy systems are designed based on human judgment. So, the most difficult challenge is to get the right input so that the level of accuracy is high.

Chapter 3

RESEARCH METHODOLOGY

3.1 Research Subject and Instrumentation

We are working to detect recyclable product. In this study a fuzzy logic model has been designed for the detection of recyclable products. Basically, this model works according to the rule where the rules are based on data analysis.

3.2 Data Collection Procedure

Mainly we don't have any data set in our study. It will work for all kinds of products. Therefore, using data set is not required. However, we collected some data to set our rules and membership function properly. The data is collected mainly from the unused things of our daily lives that used to pollute our environment. We first analyzed which things in daily life can be reused and based on that we have collected data.

3.3 Statistical Analysis

Zadeh initially implemented fuzzy logic, algorithm and decision-making [1], [3, 4, 5, 6]. In the automatic streaming engine control, H. Mamdani [7, 8] has applied fuzzy logical. Fuzzy's reasoning was implemented [9, 10] in many fields, for instance, automated control decisions [11, 12], banks and hospitals and universities [13, 14, 15, 16]. In [18] Srinivasan et al. introduced perception-based performance analysis of higher institutions, ranking performance analysis and promotion [17] in Korea's military organizations. In this document, the authors considered expectations of students, teachers, investor researchers and the public and this model is also based on a number of parameters. The KSM index of ranking educational institutes based on fugitive systems was introduced in [19]. According to the Mamdani law, input membership values according to the weight of input data are assumed in this analysis. The simple result of the defluence in the Mamdani method is obtained. It takes lots of rules to combine more than two inputs in crisp results. In teaching, for example, Analysis received 70 percent, and Infrastructure received 50 percent. These rules are going to offer a performance. Similarly, adjusting somewhat like teaching earned 89% credit, Analysis received 72%, and facilities received 51% credit. There must also be

prepared an infinite number of laws. Realistically, Fuzzy logic is updated. Regulations are restricted as parameters in low, medium, high or few more categories are divided. There is no further survey.

3.4 Proposed Methodology/Applied Mechanism

A fuzzy set is a variation on the classical set, with each object having a degree of membership between 0 and 1. If X is not an empty set, a fuzzy set Z in X is defined as

$$Z = \{x, \mu_z(x) : x \in X\}$$

Where $\mu_z(x)$ is the x in Z membership function, and the value of $\mu_z(x)$ is between 0 and 1 in such a way that

$$\mu_z(x) = \begin{cases} 1, x\ is\ strongly\ lies\ in\ X \\ (0,1), x\ is\ partially\ lies\ in\ x \\ 0, x\ is\ not\ in\ X. \end{cases}$$

A membership function is a mapping from some input set to a membership degree between 0 and 1.The following is a description of a triangular membership function:

$$\mu_z(x) = \begin{cases} \dfrac{x-a}{b-a}\ if\ a \le x < b \\ 1\ if\ x = b \\ \dfrac{c-x}{c-b}\ if\ b \le x < c \\ 0\ otherwise \end{cases}$$

In conventional logic, an element in a set either absolutely belongs to the set or does not, resulting in a value of 0 or 1. In the natural world, we deal with ambiguities and hazy ideas, which fuzzy logic manages to navigate gracefully. Automation systems, monitoring, robotics, image detection, medical diagnosis, pattern recognition, and so on are only a few of the areas where it can be used. Many fuzzy logic-based home appliances, such as refrigerators, are being developed to reduce energy consumption.

A essential word linguistic variable is linked to fuzzy logic. It stands for words like 'temperature,' 'age,' and so on, where the temperature can be very cold or very hot. As a result, there are fuzzier membership features (Figure 1). Readers should consult the sources for further research.

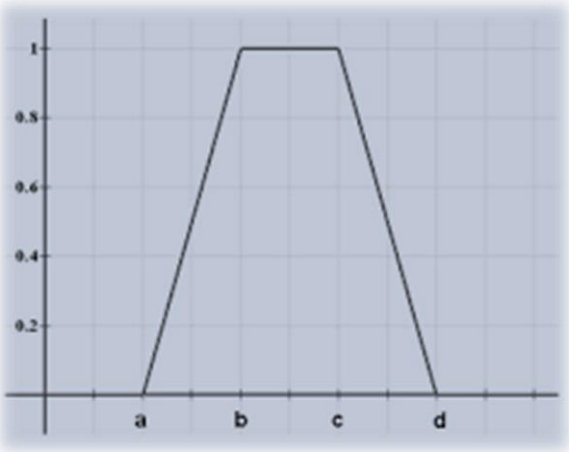

Figure 3.4.1: Trapezoidal membership function

3.5 Implementation Requirements

The fuzzy inference method (FIS) is a complete algorithm that uses fuzzy logic to convert a series of crisp inputs into crisp outputs. Fuzzification, fuzzy rule foundation, fuzzy inference, and defuzzification are the four components that make up the system. Both crisp inputs become fuzzy linguistic meaning as fuzzification is used. Then, based on these linguistic values, if-else rules are described. Then, using AND, OR, NOT, and other operations, all combinations of fuzzy rules with membership functions are performed to generate fuzzy results. Defuzzification is the process of converting all fuzzy outputs into crisp values using some tool (Centroid, MOM, etc.).A diagram for FIS is shown in Figure 2.

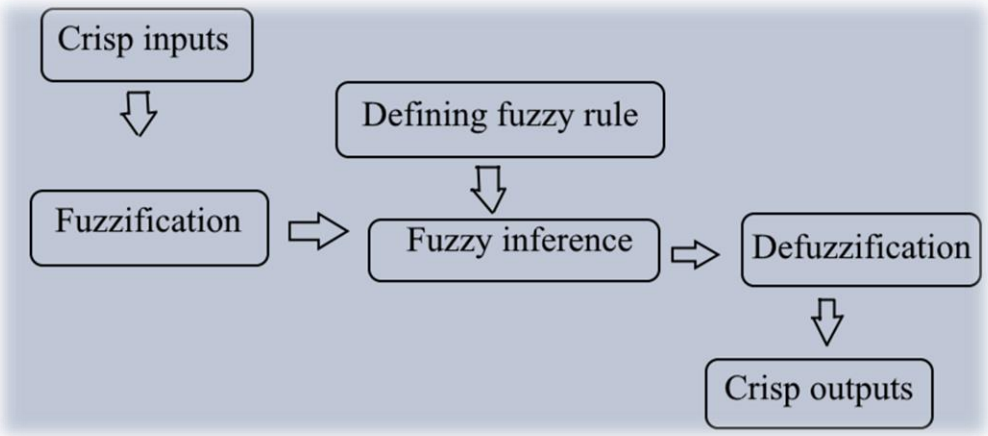

Figure 3.5.1: FIS system

Emissions, waste in the sea, and global warming are also issues that must be addressed. The current issues that affect future generations, and, thanks to the internet, people can no longer neglect the fact that our world is deteriorating at an alarming rate. Anyone will find thousands of photos close to this one with a short 10 second Google search, which is very terrific.

But, before we get into the "Machine Learning" chapter, let's find out what the problem is. For centuries, the older generations have become unconcerned about the world's future. I'm sorry if you're in your 40s or 50s, but you're right!

You certainly didn't expect the issue to grow to such proportions so quickly, but it happened! The problem is that we exist in a convenience-oriented world where we shop everything online and we're too tired to go out and purchase everything. Plastic is used in a variety of applications. Plastic objects are strewn around the area. As a result, the air is contaminated.

We agree that everybody can concentrate on the battles that they will win, and reforming the behaviors of the whole planet is not one of them. However, I will assist in speeding up the recycling process and increasing the amount of waste recycled.

Chapter 4
EXPERIMENTAL RESULT AND DISCUSSION

4.1 Experimental Setup

In short, it begins with us, both of us, throwing right garbage in the right bins. Yay! First concern! If people do not adequately separate the garbage, they can generate emissions. In this case, the only option is to get workers sorting out the garbage. This form of work is generally quite well-paid, but it is very tedious, which contributes to repetitive accidents (source). The big obstacle in recruiting workers is in the shortage of labor pool.

Since the disposal of products is expensive, as a company, it is easier for waste control firms to burn and discard the waste than to create money by taking the recycled materials.

As I previously stated, I am not attempting to manipulate people's actions, so let's ignore the first issue. And I will be able to reduce the second issue? I will do it! In reality, if almost no one wants this work, why are they not using robots to do it?

This is a difficult challenge since it is hard to configure a robot to process various items manually. Short answer, no.

If you can't teach a robot that two kinds of materials are distinct, the simplest way to describe it is to use illustrations from various materials. This way, it's possible to use machine learning to build self-learning technology that can sort materials.

Machine learning problems are the usage of just a limited collection of training data of the entity being tested. They need a ton of photos, but the issue is that it is way beyond my capability.

Recyclable of a product depends on some parameters like

1. Shape
2. Cleanliness
3. Materials

So, recyclable calculation of a product depends on some critical variables. In this article, we demonstrate a mathematical model by Fuzzy logic. Here we calculate the value of recyclable by some parameters.

4.2 Experimental Result & Analysis

Here, we calculate the value of recyclable by some parameters like shape, cleanliness, and materials. So, here are three inputs, and one output is the value of recyclable. Also, every parameter is taken as low, mid and high. The fuzzy logic system is given as follow:

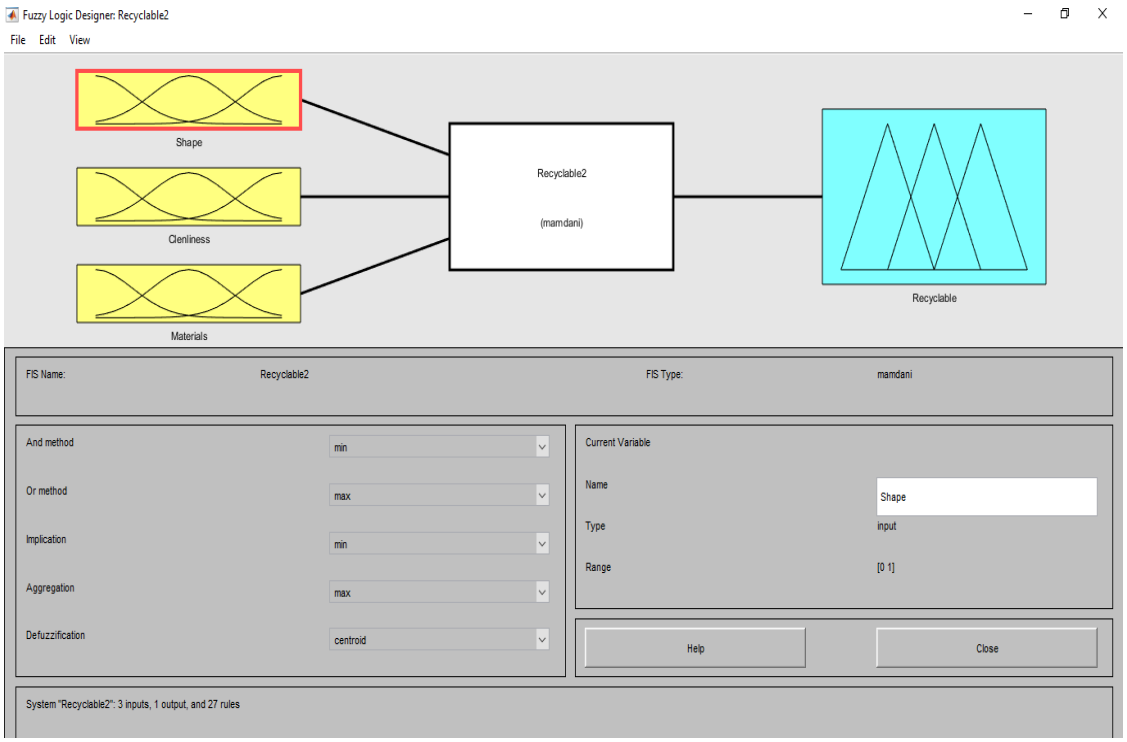

Figure 4.2.1: Fuzzy logic rule for calculation of recyclable.

In Figure 4, fuzzy rule base for the calculation of recyclable has been shown. Figure 5 demonstrated that if the inputs parameters are medium, then the value of recyclable is medium. Here, the input parameters value consider as 0.5, 0.5 and 0.5 then the output value is 0.5. The results are shown in Figures 6 that if two inputs parameters are low, one parameter is medium, and the recyclable value is low. Here, the input parameters value consider as 0.1, 0.1, and 0.5 then the output value is 0.137.

Also, Figure 7 shown that all inputs parameters are high, and the value of recyclable is high. Here, the input parameters value consider as 1.0, 1.0, and 0.9 then the output value is 0.863. Figure 10 has shown the 3D surface view of the value of recyclable.

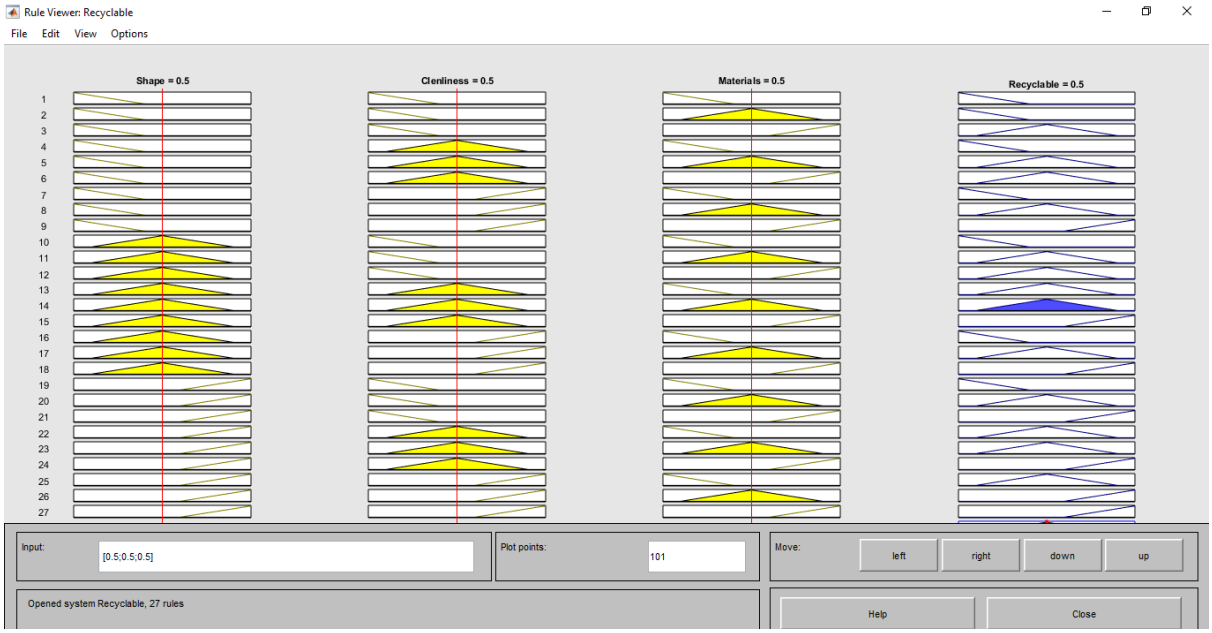

Figure 4.2.2: All inputs parameters are medium, and the value of recyclable is medium.

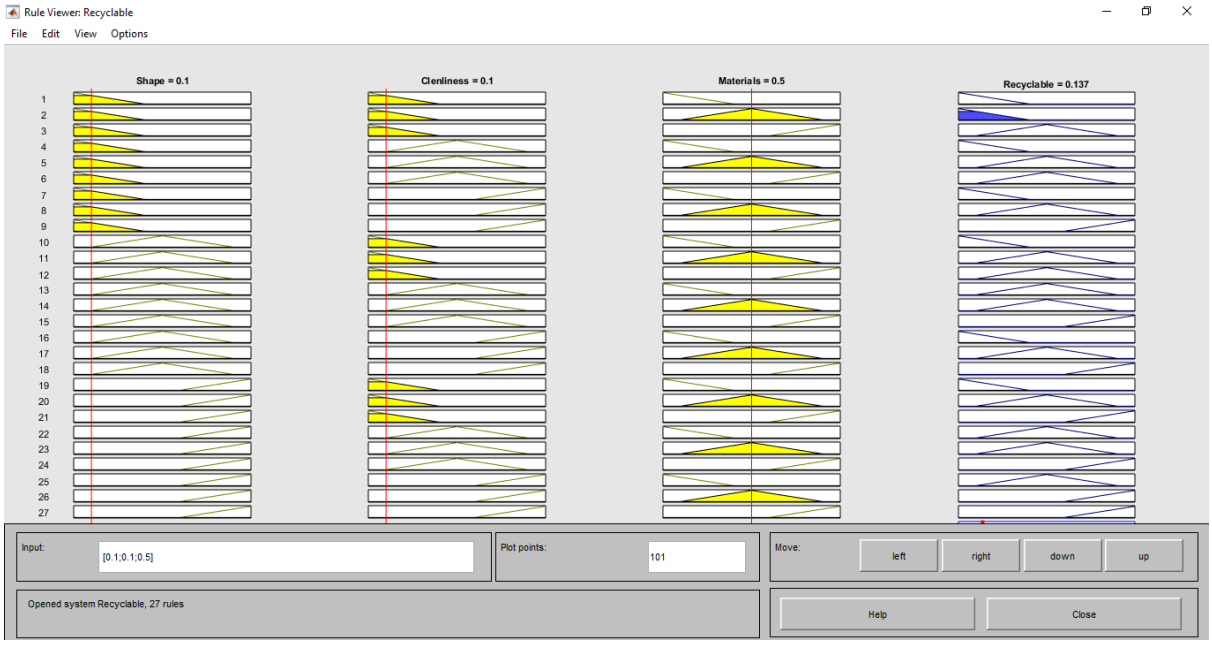

Figure 4.2.3: Two inputs parameters are low, and one parameter is medium and the value of recyclable is low

Figure 4.2.4: All inputs parameters are high, and the value of recyclable is high.

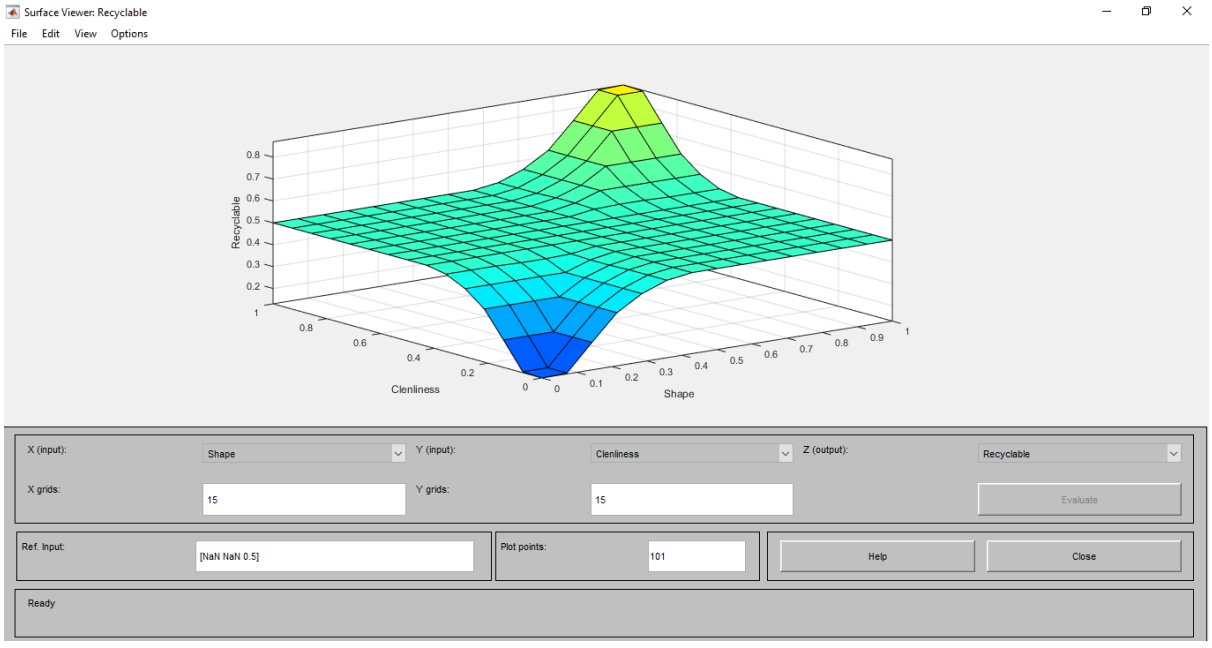

Figure 4.2.5: 3D surface view of the value of Recyclable.

The result is summarized as follows

Table 4.1: Summarization of Results

Input linguistic variables			**Output**
Shape	Cleanliness	Materials	Recyclable
0.5	0.5	0.5	0.5
0.1	0.1	0.50	0.137
1.0	1.0	0.9	0.863

4.3 Discussion

When the input is provided, the following result can happen.

- If the the value of recyclable is low then it is “Non-recyclable”.
- If the value of recyclable is medium, it is ‘Recyclable with modification’.
- If the the value of recyclable is high then it is “Recyclable”.

Chapter 5

IMPACT ON SOCIETY AND ENVIRONMENT

5.1 Impact on Society and Environment

The majority of people want to support the environment in some way. Some people do this by driving less or not purchasing items like plastic water bottles. It's great to be on the lookout for new ways to live a greener life, but old practices like recycling can have just as much of an effect on the environment. Our system will make it easier for people to help the society and environment to be clean and suitable for living.

5.2 Ethical Aspects

Global warming is a major concern for our climate and way of life. Our system can detect recyclable materials, which aids in waste reduction. Environmental sustainability and the population's wellbeing are some of the most important advantages of waste management. It facilitates the reduction of resource extraction as well as waste and energy consumption associated with the production of new materials. It is advantageous for people to earn money using recyclable equipment and materials.

Chapter 6

CONCLUSION AND IMPLICATION FOR FUTURE RESEARCH

6.1 Conclusion and Future study

In several fields, fuzzy logic has applications in decision-making and measurement processes. In this article, a suitable fuzzy logic inference model for recyclable causes is explored, and realistic conclusions are calculated. Expertise in performance measurement is used in this article. Researchers can create any evaluation-based model with the help of this paper's idea. Not only does recyclable rely on schooling. Other parameters depend on it, and this model has proven to show this. The study concludes that the recyclable has a strong and positive correlation with the various measurements of the recyclable.

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Appendix

The rules mentioned below have been used to determine whether the products are recyclable or not.

1. If (Shape is Unknown) and (Cleanliness is Hard_dirty) and (Materials is Easily_Breakable) then (Recyclable is Nonrecyclable) (1)

2. If (Shape is Unknown) and (Cleanliness is Hard_dirty) and (Materials is Too_Hard) then (Recyclable is Nonrecyclable) (1)

3. If (Shape is Unknown) and (Cleanliness is Hard_dirty) and (Materials is Soft_Plastics) then (Recyclable is Recyclable_with_modification) (1)

4. If (Shape is Unknown) and (Cleanliness is Medium_Dirty) and (Materials is Easily_Breakable) then (Recyclable is Nonrecyclable) (1)

5. If (Shape is Unknown) and (Cleanliness is Medium_Dirty) and (Materials is Too_Hard) then (Recyclable is Recyclable_with_modification) (1)

6. If (Shape is Unknown) and (Cleanliness is Medium_Dirty) and (Materials is Soft_Plastics) then (Recyclable is Recyclable_with_modification) (1)

7. If (Shape is Unknown) and (Cleanliness is Cleanable) and (Materials is Easily_Breakable) then (Recyclable is Nonrecyclable) (1)

8. If (Shape is Unknown) and (Cleanliness is Cleanable) and (Materials is Too_Hard) then (Recyclable is Recyclable_with_modification) (1)

9. If (Shape is Unknown) and (Cleanliness is Cleanable) and (Materials is Soft_Plastics) then (Recyclable is Recyclable) (1)

10. If (Shape is Known_Broken) and (Cleanliness is Hard_dirty) and (Materials is Easily_Breakable) then (Recyclable is Nonrecyclable) (1)

11. If (Shape is Known_Broken) and (Cleanliness is Hard_dirty) and (Materials is Too_Hard) then (Recyclable is Recyclable_with_modification) (1)

12. If (Shape is Known_Broken) and (Cleanliness is Hard_dirty) and (Materials is Soft_Plastics) then (Recyclable is Recyclable_with_modification) (1)

13. If (Shape is Known_Broken) and (Cleanliness is Medium_Dirty) and (Materials is Easily_Breakable) then (Recyclable is Recyclable_with_modification) (1)

14. If (Shape is Known_Broken) and (Cleanliness is Medium_Dirty) and (Materials is Too_Hard) then (Recyclable is Recyclable_with_modification) (1)

15. If (Shape is Known_Broken) and (Cleanliness is Medium_Dirty) and (Materials is Soft_Plastics) then (Recyclable is Recyclable) (1)

16. If (Shape is Known_Broken) and (Cleanliness is Cleanable) and (Materials is Easily_Breakable) then (Recyclable is Nonrecyclable) (1)

17. If (Shape is Known_Broken) and (Cleanliness is Cleanable) and (Materials is Too_Hard) then (Recyclable is Recyclable_with_modification) (1)

18. If (Shape is Known_Broken) and (Cleanliness is Cleanable) and (Materials is Soft_Plastics) then (Recyclable is Recyclable) (1)

19. If (Shape is Wellknown) and (Cleanliness is Hard_dirty) and (Materials is Easily_Breakable) then (Recyclable is Nonrecyclable) (1)

20. If (Shape is Wellknown) and (Cleanliness is Hard_dirty) and (Materials is Too_Hard) then (Recyclable is Recyclable_with_modification) (1)

21. If (Shape is Wellknown) and (Cleanliness is Hard_dirty) and (Materials is Soft_Plastics) then (Recyclable is Recyclable) (1)

22. If (Shape is Wellknown) and (Cleanliness is Medium_Dirty) and (Materials is Easily_Breakable) then (Recyclable is Recyclable_with_modification) (1)

23. If (Shape is Wellknown) and (Cleanliness is Medium_Dirty) and (Materials is Too_Hard) then (Recyclable is Recyclable_with_modification) (1)

24. If (Shape is Wellknown) and (Cleanliness is Medium_Dirty) and (Materials is Soft_Plastics) then (Recyclable is Recyclable) (1)

25. If (Shape is Wellknown) and (Cleanliness is Cleanable) and (Materials is Easily_Breakable) then (Recyclable is Recyclable_with_modification) (1)

26. If (Shape is Wellknown) and (Cleanliness is Cleanable) and (Materials is Too_Hard) then (Recyclable is Recyclable) (1)

27. If (Shape is Wellknown) and (Cleanliness is Cleanable) and (Materials is Soft_Plastics) then (Recyclable is Recyclable) (1)

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