**PROJECT/THESIS TITLE**

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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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**DAFFODIL INTERNATIONAL UNIVERSITY**

**Dhaka, Bangladesh**

**May 2023**

**APPROVAL**

This Project titled “----------------------------------”, submitted by (Name) to the Department of Computer Information System, 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 May 2021.

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I hereby declare that, this project has been done by me under the supervision of **Md Zahid Hasan, Assistant professor, Department of CSE,** Daffodil International University. I 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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Finally, I must acknowledge with due respect the constant support and patients of my parents.

**Abstract**

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**LIST OF FIGURES**

|  |  |
| --- | --- |
| **FIGURES** | **PAGE NO** |
| Figure 1: Working process of the proposed model | 7 |
| Figure 2: Different Classes of Edible Mushroom | 8 |
| Figure 3: Different Classes of Inedible Mushroom | 9 |
| Figure 4: Different Classes of Poisonous Mushroom | 9 |
| Figure 5: (a) Original low contrast image (b) Converted the image BGR to greyscale and (c) Apply Contrast-enhanced technique CLAHE (CL=0.1, BS=8x8) | 11 |
| Figure 6: Basic Structure of ANN Architecture | 12 |
| Figure 7: Architecture of Convolutional Neural Network. | 14 |
| Figure 8: A 5x5x1 image convolved with a 3x3x1 kernel to become a 3x3x1 convolved feature | 15 |
| Figure 9: Representation of Max Pooling Layer with Hyperparameters 2 X 2 filters and Stride size 2 | 16 |

**LIST OF TABLES**

|  |  |
| --- | --- |
| **TABLES** | **PAGE NO** |
| Table 1: Confusion matrix of CNN architectures using contrast-enhanced image | 22 |
| Table 2: Performance matrices of CNN architectures using raw image | 22 |
| Table 3: Performance matrices of CNN architectures using contrast-enhanced image | 23 |
| Table 4: Comparative analysis | 25 |

**CHAPTER 1**

**Introduction**

# 1.1 Introduction

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Mushrooms are in rich of an unassuming measure of fiber and over twelve minerals and nutrients with copper, potassium, magnesium, zinc, and vitamin B nutrients. It is cholesterol-free along with low in calories and fat. Mushrooms are additionally high in antioxidants such as selenium and glutathione. It can keep anyone fit and protect the Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum [2].

**1.2 Problem Statement**

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**1.3 Research Objectives**

1. To investigate research gaps of the existing machine vision-based systems to correctly classify different categories of mushrooms in their classes.
2. To apply a straightforward machine vision-based approach for improving the accuracy for separating them in their class.

**1.4 Research Questions**

1. How can we investigate the gaps of the existing machine vision-based systems that can correctly classify different categories of mushrooms?
2. How can we develop a machine vision-based approach for improving the accuracy of differentiating different kinds of mushrooms correctly in their class?

**1.5 Report Layout**

Chapter 1 presents the research introduction, objectives, and key research questions.  
Chapter 2 highlights a detailed review of the related literature.  
Chapter 3 describes the proposed methodology with a detailed description.   
Chapter 4 explains the result analysis and comparison with existing work.  
Chapter 5 concludes the present research along with a direction for future work.

**CHAPTER 2**

**Literature Review**

**2.1** **Related works**

Previously several researchers have made several attempts by applying different techniques for the classification of mushrooms but didn't get a satisfactory result. Humans have been recognizing poisonous mushrooms considering the shape, color, odor, and secretion skins by experience for many years [3]. But the accuracy of this intuitive method is very low and the annual poisoning events have proven it. Thus, it's not a solid technique for recognizing whether mushrooms are toxic. Besides, this technique depends on background knowledge procured by people. Individuals get a great deal of background knowledge and capabilities with the goal that the acknowledgment precision rate is high. Otherwise, the exactness rate is low.

LaBarge [4 Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Besides distinguishing mushroom diseases, Chowdhury et.al [6] acknowledged a manner Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborumfrom images of both with backgrounds and without backgrounds but got a better result with background images exclusively while applying KNN algorithms along with Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborumenough.

According to the work [9], Yingying et al. focused only recognize the mushroom toxicity using visual features of mushrooms. Cap shape and color of mushrooms were used as the features of this Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborumthe other two classifiers.

As several studies had been made in the past by several researchers but most of the studies had made a comparison or just classified mushroom types as well as distinguishing mushroom diseases rather than identifying which mushroom is edible, non-edible, and poisonous. The main purpose of our study is to fill this gap and correctly classify the edible, non-edible, and poisonous mushroom types.

**2.2 Scope of the Problem**

Researchers tried for many years in several ways to identify mushrooms based on their shape, color, odor, and secretion skins by experience but they didn’t reach a satisfactory result. There are more than 100 different types of mushrooms are available in the world as known as edible, inedible, and poisonous. Some of the studies mentioned that for identifying a mushroom, the system depends on background knowledge which is obtained by people and it is a very time inefficient process. Some of the works mentioned the mobile or web-based application where they didn’t have sufficient data to correctly classify the mushroom in their types. Some researchers talked about the recognition of toxicity levels in different mushrooms using machine learning techniques. Some of the works focused on classifying different mushroom diseases using machine learning methodology and some were identifying the separate classes’ prediction like edible and poisonous where their accuracy level was very low.

**2.3 Challenges**

There are some researches challenges focused on this study which are following:

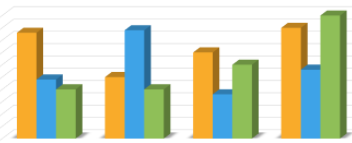
1. **Data Collection:** There is no benchmark dataset available online for classifying. Therefore, it was very arduous work to accumulate the image data from the mushroom’s field.
2. **Raw Image Processing**: Images collected from different sources were sometimes low or high contrast or noisy. So, the challenge is to prepare the images perfectly for classification which will be contrast-enhanced and noise-free.
3. **Select Machine Learning Approach**: Several researchers use different machine learning techniques to complete the tasks effortlessly. So, the selection of optimum machine learning technique which can correctly classify different categories of mushroom.
4. **Accuracy Improvement:** Another challenging issue is to improve the accuracy of the machine learning model as well as selecting the optimum model.

# CHAPTER 3

**Materials and Methods**

**3.1 Working Process**

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Mushroom Dataset

Image Collection

Resizing Image

Raw Image Input

Contrast Enhanced Input

Apply CNN

Feature Extraction

Classification

Result Analysis



Figure 1: Working process of the proposed model

**3.2 Dataset Preparation**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
| **Cortinarius rubellus** | **Cortinarius semisanguineus** | **Galerina arginate** | **Gyromitra esculenta** | **Hebeloma crustuliniforme** |

Figure 4: Different Classes of Poisonous Mushroom

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**3.3 Image Pre-processing**

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**3.3.1 Image Enhancement Technique**

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**3.3.2 Contrast Limited Adaptive Histogram Equalization**

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborummethod has been applied with clip limit 0.1 and block size is 8X8.

|  |  |  |
| --- | --- | --- |
|  |  |  |
| **(a)** | **(b)** | **(c)** |

Figure 5. (a) Original low contrast image (b) Converted the image BGR to greyscale and (c) Apply Contrast-enhanced technique CLAHE (CL=0.1, BS=8x8)

**3.4 Artificial Neural Network**

Artificial Neural Networks (ANNs) are mainly considered as computational dispensation structures that are highly enlivened by the way biological nervous structures (for example the ANN model is shown in figure 6.

We would weigh the input to the input layer typically as a multidimensional vector that will disperse it to the hidden layers. The hidden layers will at that point settle on verdicts from the preceding layer and weigh up in what way a stochastic variation inside itself

Input Layer

Logical Hidden Layer

Classification Layer

Output Layer

**Merge node**

**Taps**

**32 Layers**

**Modulation order**

Figure 6: Basic Structure of ANN Architecture

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**3.5 Convolutional Neural Network**

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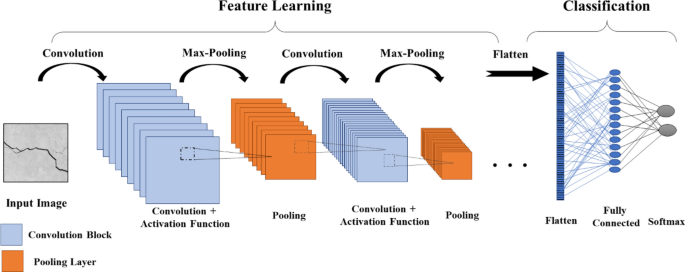


Figure 7: Architecture of Convolutional Neural Network.

**3.5.1 Convolutional Layer**

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The following equation is used for this calculation:

Here, V stands for e input size of the volume such as height×width×depth, R and Z stand for the accessible field size, and the volume of zero padding set separately. S denoting to the stride. If the premeditated outcome from this equation isn't equivalent to an entire number formerly the stride has been inaccurately fixed, since the neurons will be not able to fix perfectly through the prearranged input.

|  |  |  |
| --- | --- | --- |
| 4 | 3 | 4 |
| 2 | 4 | 3 |
| 2 | 3 | 4 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |

|  |  |  |
| --- | --- | --- |
| 1 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |

3x3x1 Kernel

Figure 8: A 5x5x1 image convolved with a 3x3x1 kernel to become a 3x3x1 convolved feature.

**3.5.2 Maxpool Layer**

The main objective of the pooling layer is to progressively lessen the dimensionality of the demonstration along with additional reducing the number of parameters as well as computational intricacy of the archetypal.

of max-pooling layers along with kernels of dimensionality of 2 × 2 smeared with a stride of 2 laterally the spatial dimensions of the input. This measures the activation plot despondent to 25% of the unique size - at the same time as sustaining the depth size to its customary size.

|  |  |
| --- | --- |
| 6 | 8 |
| 3 | 4 |

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 5 | 2 | 7 |
| 6 | 1 | 4 | 8 |
| 3 | 2 | 1 | 0 |
| 1 | 2 | 3 | 4 |

2 X 2 filters and

Stride size 2

Figure 9: Representation of Max Pooling Layer with Hyperparameters 2 X 2 filters and

Stride size 2

**3.5.3 Fully Connected Layer**

The fully-connected layer comprises neurons that are unswervingly associated with the neurons in the two neighboring layers, deprived of being associated with any layers inside them. This is undifferentiated from the way that neurons are orchestrated in conventional types of ANN.

**3.6 Transfer Learning**

Transfer learning is mainly a machine learning technique that uses the knowledge of the last three layers of predefined networks.

**3.6.1 VGG16**

VGG16 is a Convolutional Neural Network (CNN) archetypal which is offered by K. Simonyan and A. Zisserman from the Oxford Visual Geometry Group in the ILSVRC-2014 with stride 2 and finally, 3 fully connected layers are connected with the SoftMax activation function [11].

**3.6.2 Resnet50**

Another Convolutional Neural Network model which is ResNet50 is suggested by He who accomplished the ILSVRC-2015 competition in 2015 to illuminate the issue of different non-linear layers not learning individuality maps and debasement issues. Every 2-layer block is supplanted in the 34-layer net with this 3-layer bottleneck block, bringing about a 50-layer ResNet and the input image is of fixed 224 × 224 pixels. This architecture has over 23 million parameters [12].

**3.6.3 InceptionV3**

Inception V3 is another Convolutional Neural Network architecture that is presented by Szegedy and developed by Google (Figure 10). Inception V3 is the third announcement within the deep learning evolutionary structures arrangement. Batch normalization was executed as parameters, concats, dropout, and fully connected layers. Finally, the SoftMax activation function is connected with FC and shows the output. The input image shape of this architecture is 299 × 299 pixels [13].

**3.7 Training and Testing**

Initially, the whole dataset was distributed among two parts such as training as well as testing dataset. This dataset splitting method was done randomly where the training set consists of about 7500 images, where 80% was used for training the model and the remaining 20% images were used for validating the model. And in the testing part, 690 new images were used to evaluate the performance of the model where each class contains 230 images. The same experiment was performed once with raw images and once with contrast-enhanced images.

All the models are trained with a transfer learning approach where categorical cross-entropy was utilized as the loss function shown in equation (1). The learning rate was set for 0.001,

|  |  |
| --- | --- |
|  | (1) |

with Adam optimizer where SoftMax was used as the activation function for all the architectures shown in equation (2).

|  |  |
| --- | --- |
|  |  |

The whole working process of the experiment is given in figure 1.

Entirely the experiments are executed on a 64-bit Windows operating system, Intel Core i5-7200U, CPU processor with 8 GB RAM, and 1 TB hard disk using the python programming language in an anaconda environment.

# CHAPTER 4

# Experimental Results and Discussion

**4.1 Results and Discussion**

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Figure 11: Test Accuracy of different Transfer Learning Architecture

For assessing the test viability of the multitude of models, a confusion matrix is utilized (Table I). The Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborumprediction of the model. Accuracy, sensitivity, recall, precision, and the F1 score are calculated based on the confusion matrix utilizing the following equation (3-6),

|  |  |
| --- | --- |
|  | (3) |
|  |  |
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The raw Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborumarchitectures utilizing contrast-enhanced images.

1. Performance matrices of CNN Architectures using raw image

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Architectures** | **Accuracy (avg)** | **Precision (avg)** | **Recall (avg)** | **F-1 score (avg)** |
| **InceptionV3** | .82 | .82 | .82 | .82 |
| **Resnet50** | .58 | .69 | .58 | .53 |
| **VGG16** | .84 | .84 | .84 | .84 |

1. Performance matrices of CNN Architectures using contrast-enhanced image

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Architectures** | **Accuracy (avg)** | **Precision (avg)** | **Recall (avg)** | **F-1 score (avg)** |
| **InceptionV3** | .88 | .88 | .88 | .88 |
| **Resnet50** | .58 | .69 | .58 | .58 |
| **VGG16** | .84 | .85 | .84 | .85 |

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborummap of the raw image and feature map of the contrast-enhanced image respectively. Feature maps are apparent that contrast-enhanced images convey better performance over raw images.

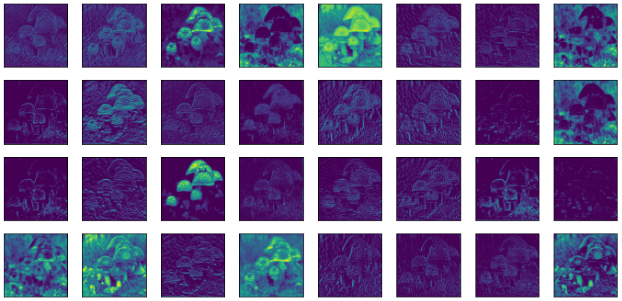


Figure 12: Feature map of the raw image without contrast-enhanced technique

**4.2 Comparative Analysis**

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborumfungi. ANFIS performed much better by obtaining 80% accuracy in comparison with ANN and Naive Bayes which obtained around 70% accuracy. A gradual change in the pattern of mushroom behavior over a period termed ‘enzyme growing’ is defined via a machine learning technique such as SVM to detect if sample mushrooms are fresh for consumption or not. This study achieved overall 80% accuracy [15]. For classifying 45 several types of poisonous as well as edible mushrooms [16], the CNN model was utilized and achieved an accuracy of 74% which is not satisfactory enough.

1. Comparative Analysis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Problem Domain** | **Images used** | **Classifier** | **Accuracy** | **References** |
| classification | 8124 | ANN, ANFIS, Naïve Bayes | 80% | [14] |
| classification | 135 | SVM | 80% | [15] |
| classification | 8556 | CNN | 74% | [16] |
| classification | 8190 | **Inception V3** | **88.40%** | **Proposed Model** |

# CHAPTER 5

# Conclusion and Future Work

**5.1 Conclusion**

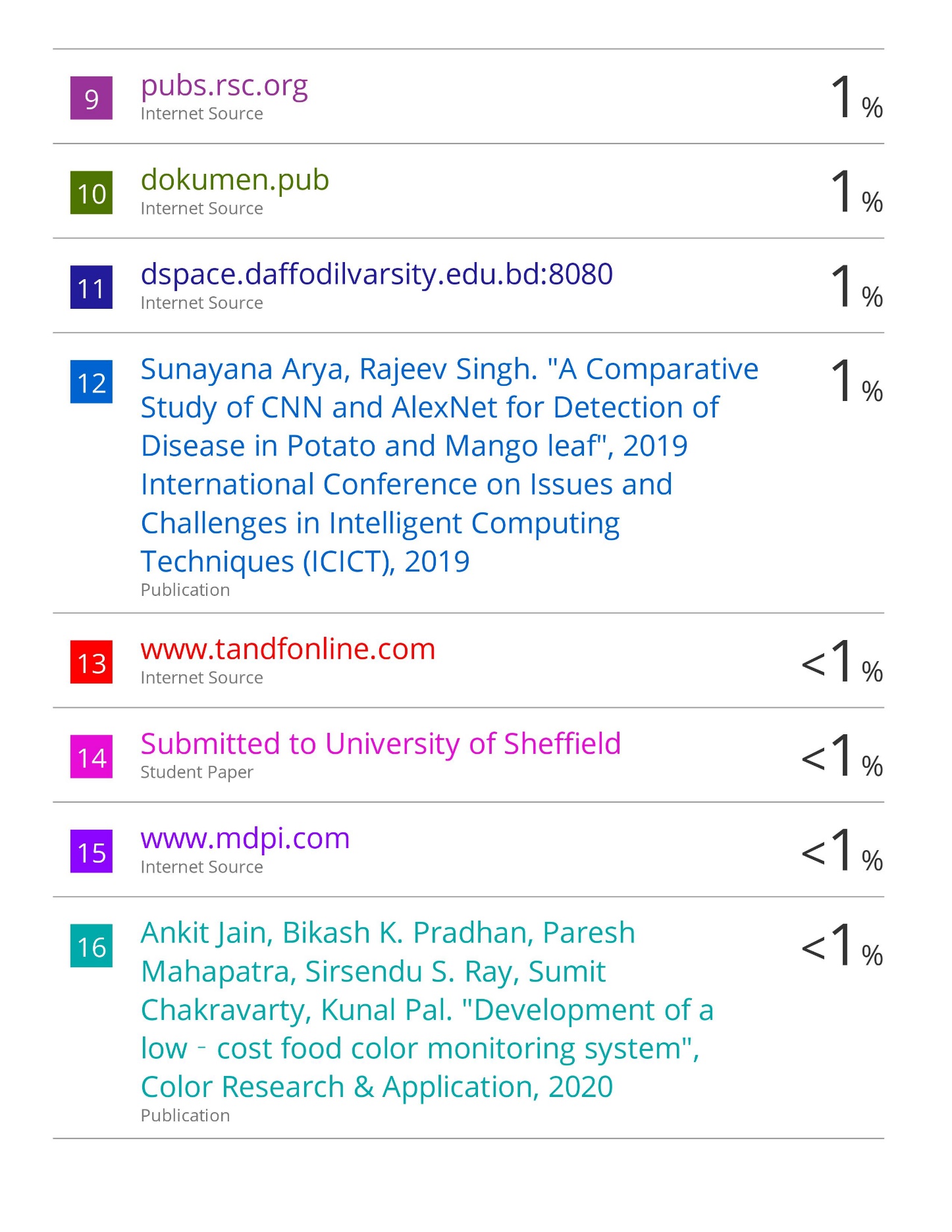
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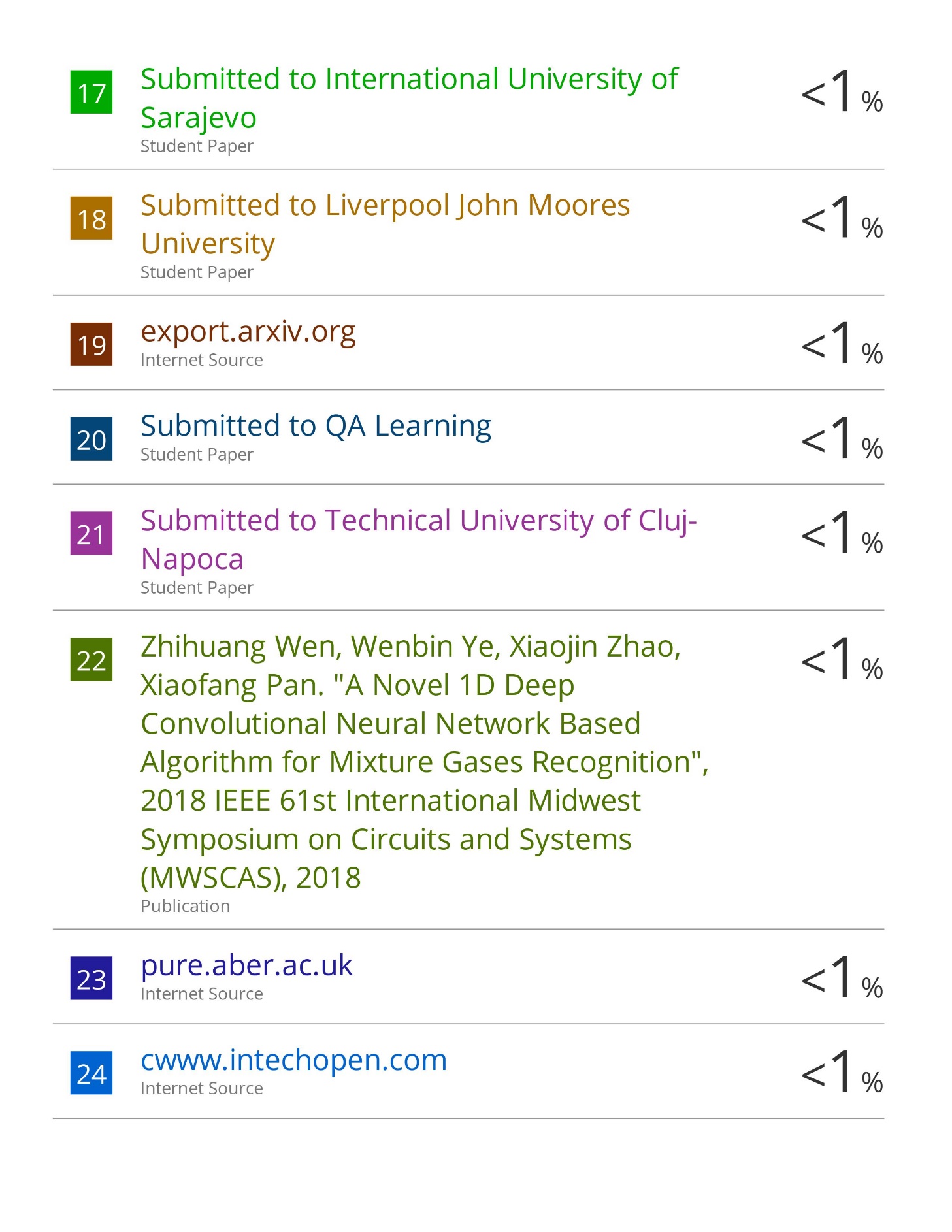
**5.2 Future Work**

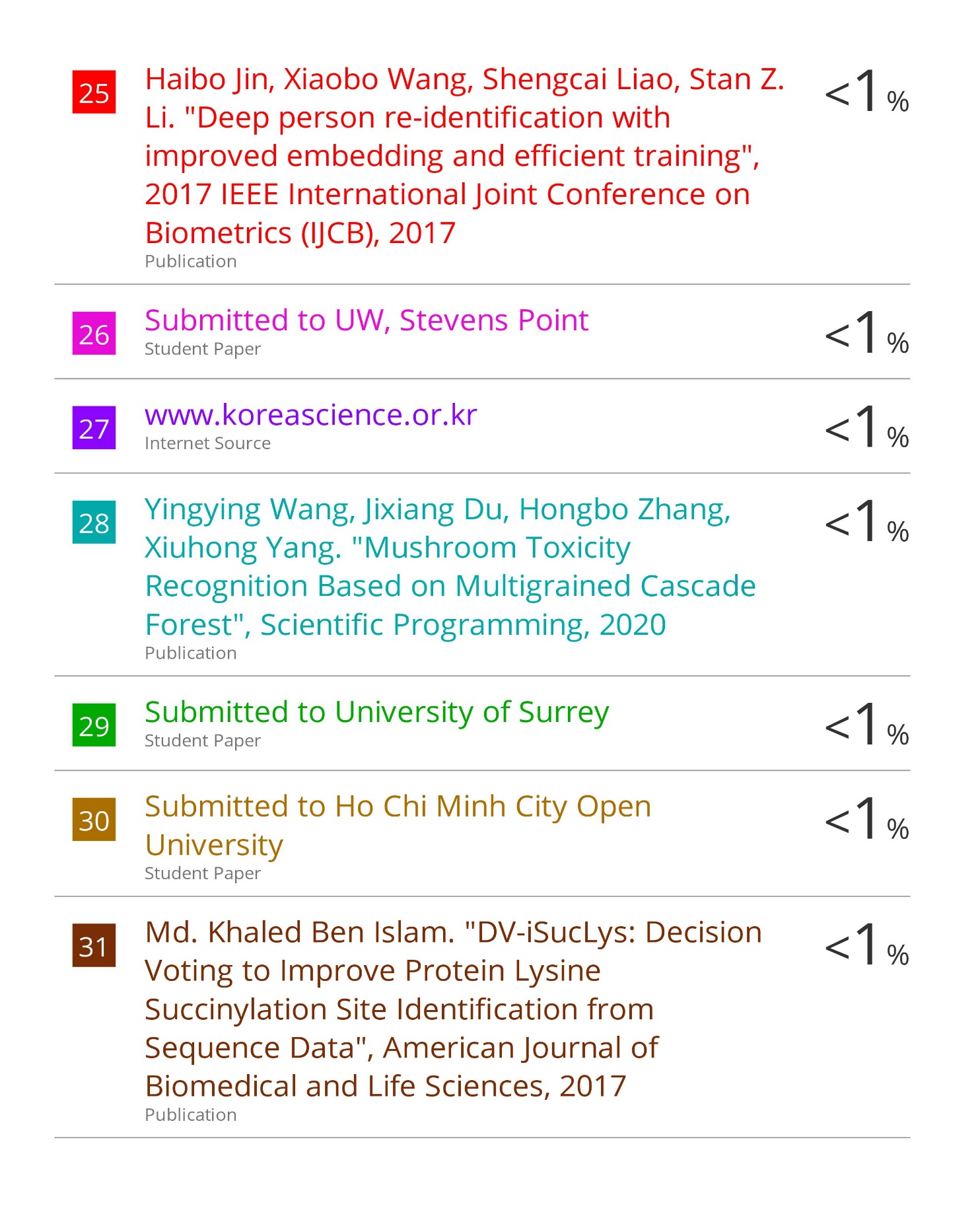
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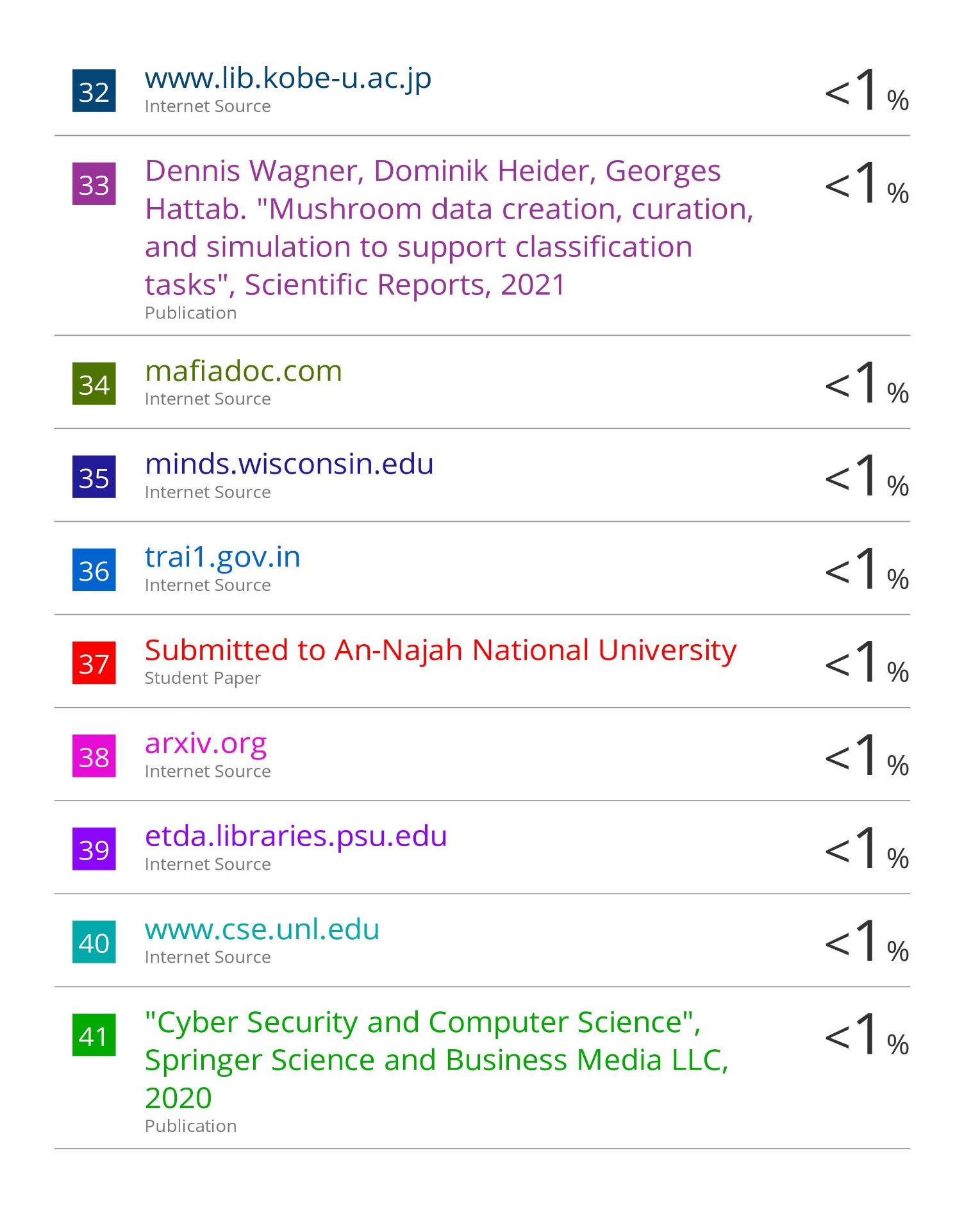
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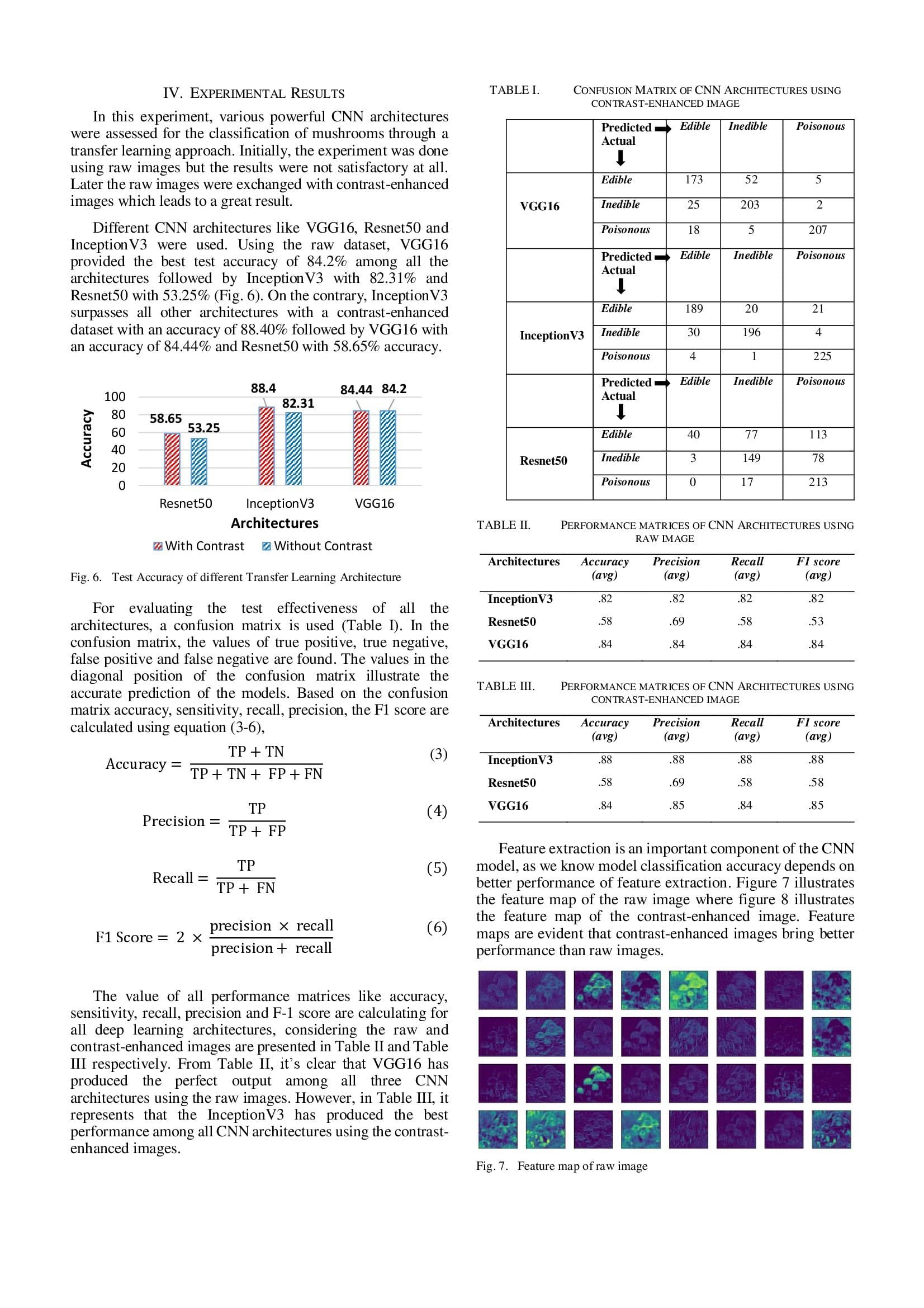
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