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Pattern Recognition For Printed Material

A Mini Project Report submitted to Manipal Institute of Technology in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY
IN
MECHATRONICS

Submitted by

Tejal V Shetty - 190929006
Shreyas Rao - 190929004
Saurabh Patel - 190929138
Chirag Shetty - 190929210

Under the guidance of

Dr. Umesh Kumar Sahu
Assistant Professor

DEPARTMENT OF MECHATRONICS
MANIPAL INSTITUTE OF TECHNOLOGY
(A Constituent of Manipal Academy of Higher Education)
MANIPAL - 576104, KARNATAKA, INDIA

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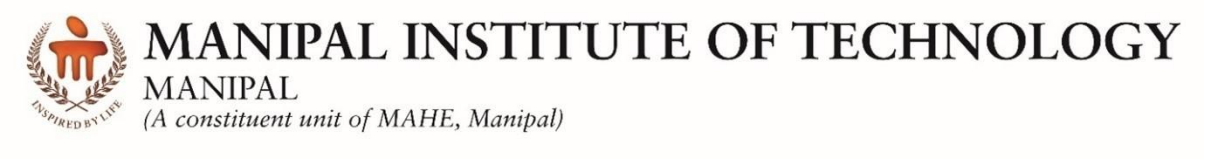

DEPARTMENT OF MECHATRONICS

Manipal
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CERTIFICATE

This is to certify that the mini project / software titled Title is a record of work done by **Tejal V Shetty** (190929006), **Shreyas Rao** (190929004), **Saurabh Patel** (190929138), and **Chirag Shetty** (190929210) submitted for Machine Vision and Image Processing (PE-V), MTE 4075 during the academic year 2022-2023.

Dr. Umesh Kumar Sahu
Assistant Professor
Dept. of Mechatronics
MIT Manipal

ABSTRACT

The problem of pattern recognition is a prevalent one, not just in the field of textiles and printing, but in all major fields that require the classification, identification, or use of patterns on a day to day basis. Printed patterns are a staple of most cultures, and date back to being used by humans in prehistoric times, along with being found in nature on animal pelts and fur for as long as life has existed on earth.

There exists a need to classify and recognize these patterns, as it is impossible for a human to memorize and recognize them with a high degree of accuracy if one is not trained in that matter. A global database of patterns would help alleviate this issue, and would also help anyone who wishes to use patterns for any application.

The development of an algorithm that would instantly recognize patterns, would therefore be extremely useful to anyone who works in an industry that involves a high degree of usage of patterns.

The research papers that proved as the inspiration for this include several advanced methods for achieving similar results, however, they use only one method each, of the two used in our algorithm. They also involve substantially larger datasets, with multiple image references for each pattern, and involve superior technology, such as multispectral cameras. Therefore, they are out of the scope of this simpler algorithm, but the algorithm was able to replicate the simpler methods flawlessly.

Although more images for the same pattern would mean better data, using a single image for detection would be more efficient for daily applications, and would be user-friendly, while also maintaining a substantial degree of accuracy.

LIST OF FIGURES

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CHAPTER 1

Introduction

This project deals with the recognition of patterns on printed cloth, an important requirement for the classification, sorting and searching of the required patterns in large textile industries.

The problem statement involves being able to detect and categorize the printed patterns found on a piece of cloth or paper, based on the pattern set that is available beforehand.

It requires algorithms to differentiate between different colours of the same pattern, and minute details that are hard to detect for the untrained eye. The applications include categorizing and sorting of the printed materials from a collection of a many items. Despite this, it could also be used to categorize animals based on their patterns (a hypothetical application that isn't implemented here).

1.1 Motivation

The classification of patterns and management of a dataset is a major requirement in several industries, not just the fabric-related ones. A software such as this one would allow for easy maintenance and categorization of a large set of information, and also allow easy access for anyone who wishes to access the data.

1.2 Objective

• The primary objective is to detect and categorize (by means of naming) the patterns that have been fed to the program, by means of comparison with an on-hand dataset that serves as a reference of all the possibilities

• The patterns are detected using various methods, based on the type of pattern, i.e. patterns with curves, patterns with straight edges, coloured patterns, patterns with discernible points, etc.

1.3 Challenges

The challenges would involve detecting the points/regions of interest that would help us discern, differentiate and identify the pattern from the ones available in the dataset.

The algorithm must also be efficient and computationally cheap, considering the large size of the dataset that is used, and the fact that the computations would only increase as the size of the dataset increases.

1.4 Scope of Work

The project aims to provide a simple to use, user friendly program that allows the user to give an input image that contains a well captured pattern and finds the corresponding classification and tag of that pattern, based on the templates available in the dataset.

1.5 Report Organization

This Report is organized in six chapters mainly including introduction, literature review, methodology, result and discussion, conclusion and future scope and contribution of each team member. Each chapter is supported with relevant subtopics.

- Chapter 1: Includes the overview of the report. The objectives along with a problem statement, hypothesis, and scope of research are stated in this chapter. It tries to focus the need for research and methodology used for problem analysis.

- Chapter 2: Literature reviews of methods are discussed. A brief review of problem statement is taken into consideration. A summary is presented that highlight the research gap.

- Chapter 3: Addresses the methodology used in this report. Presents the flow diagram of the proposed method. Details of dataset used is presented in this chapter. Justifies the method utilized for the getting solution to the problem. Detailed description of the method of work is presented.

- Chapter 5: Discuss the result and their detailed discussion that are obtained by applying proposed methodology from the data analysis and simulation.

- Chapter 6: Presents the conclusion and scope of future work.

CHAPTER 2
Literature Review

2.1 Review of Literature

The 2 base papers referenced in the report employ 2 different methods of processing and also have 2 different outcomes. However, they act as suitable references for our algorithm as they employ methods similar to the ones used here.

The first paper performs colour recognition on multispectral images. The data density in this application is quite large, and the image type also brings along greater computational intensity, however, the algorithm successfully computes the distribution of colour in a 3-dimensional space, whereas out application only does a 2-dimensional histogram based colour sampling.

The second paper defines an approach to determine weave patterns based on 4-sided lighting of the same image, hence working with a larger dataset. It involves a complicated algorithm and has several image processing steps to achieve the desired output. Though all the techniques have not been employed here, several of the basic steps have served as inspiration for our algorithm.

2.2 Summary

The base papers employ techniques that are computationally and mathematically advanced, however they use smaller datasets compared to the application implemented in this report. Due to this, even though the accuracy for each individual image seems less than that of the images considered in the papers, when the overall accuracy is taken, our algorithm provides a high level of accuracy considering the fact that only a single image is used per pattern(unlike the multiple images used per pattern in the reference patterns), by combining the results achieved using both the histogram matching, and point matching methods, to get the best result.

CHAPTER 3
Methodology

3.1 Theoretical Background

The dataset includes a collection of all the patterns that are known, along with their corresponding name/category. It must be contained in a folder that allows us to add more pattern samples if needed. The samples must have been recorded under ideal conditions (parallel lighting, high resolution, minimum noise, etc.)

3.2 Experiment and Implementation

The primary method would be the detection of the important factors that define the shape of the pattern. The first level would include a basic histogram comparison, which would allow us to detect abstract patterns, as well as coloured patterns. Then, it would move on to point detection and comparison with the same features extracted from the samples.

The implementation is done using functions present in the OpenCV library.

The first set includes the histogram related functions. The calculation of the histogram is handled by the function, and mathematical operations are performed on this data so as to get the closeness to a predefined dataset.

The second set of functions includes the orb feature matching functions, which perform a type of dense feature matching to find features that are similar in both images. This is computationally intensive and done only to narrow down the choices presented after histogram matching, or when no matches are found in the aforementioned step.

3.3 Summary

The program identifies the pattern and names it based on the tags in the dataset. The dataset present on the host system is the basis for all our comparisons. The classification of the pattern is based on the best match obtained using both the histogram, and point matching methods.

CHAPTER 4
Results and Discussion

4.1 Results

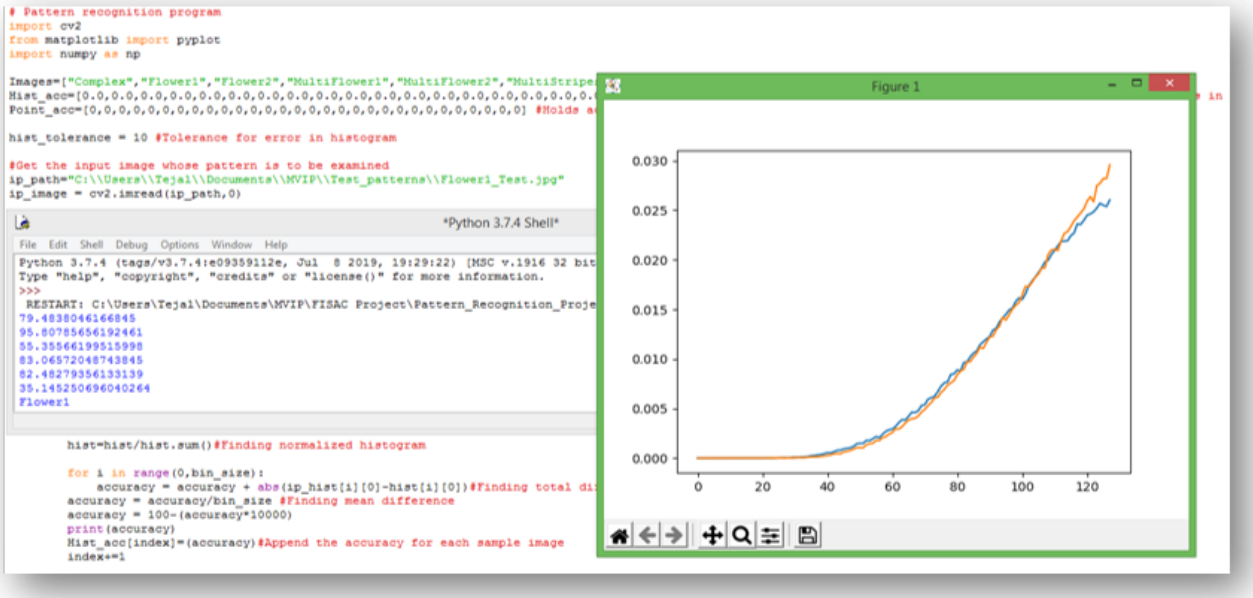

Fig. 1.1: Histogram matching providing the correct match

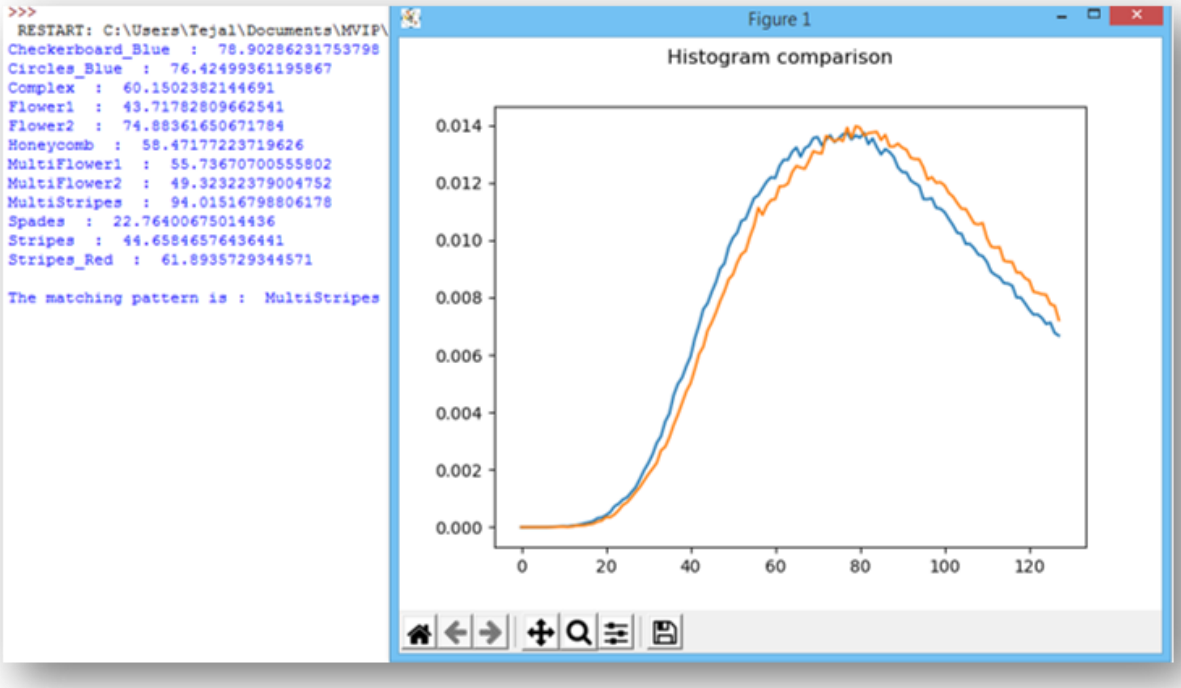

Fig. 1.2: Histogram matching providing the correct match for another image

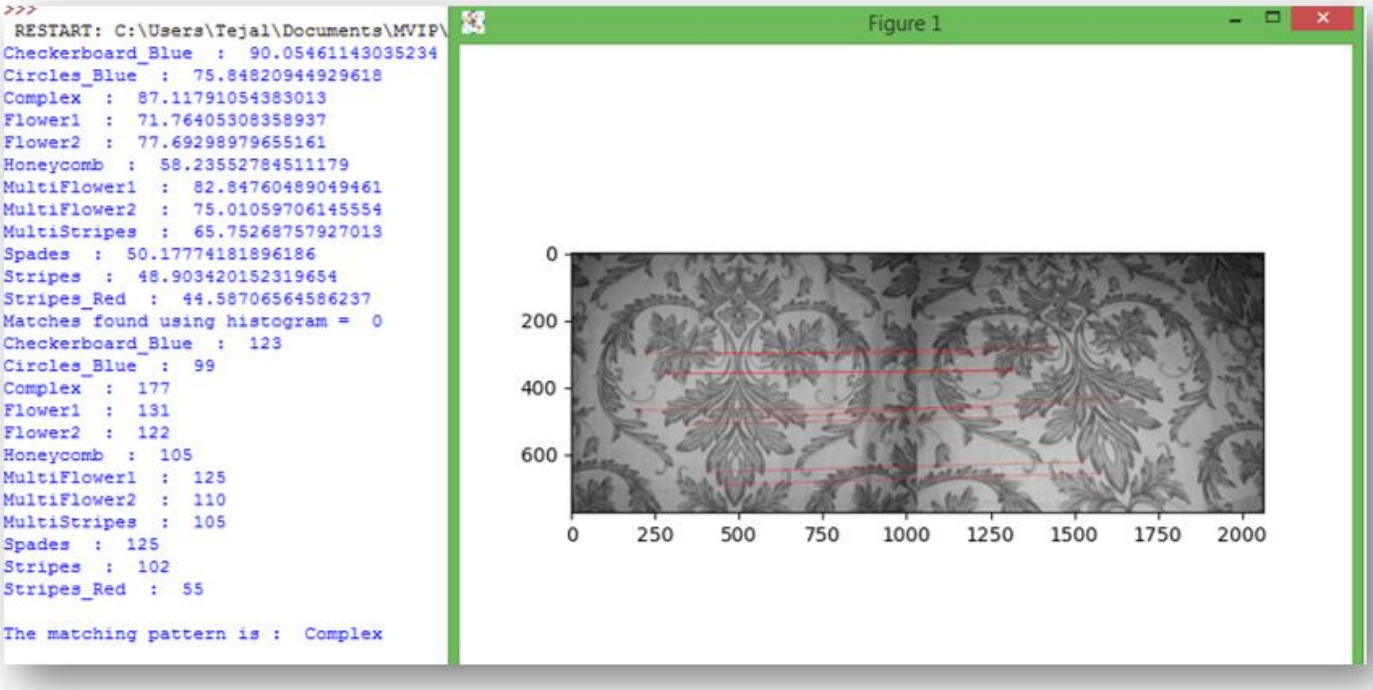

Fig. 1.3: Feature matching providing the correct match

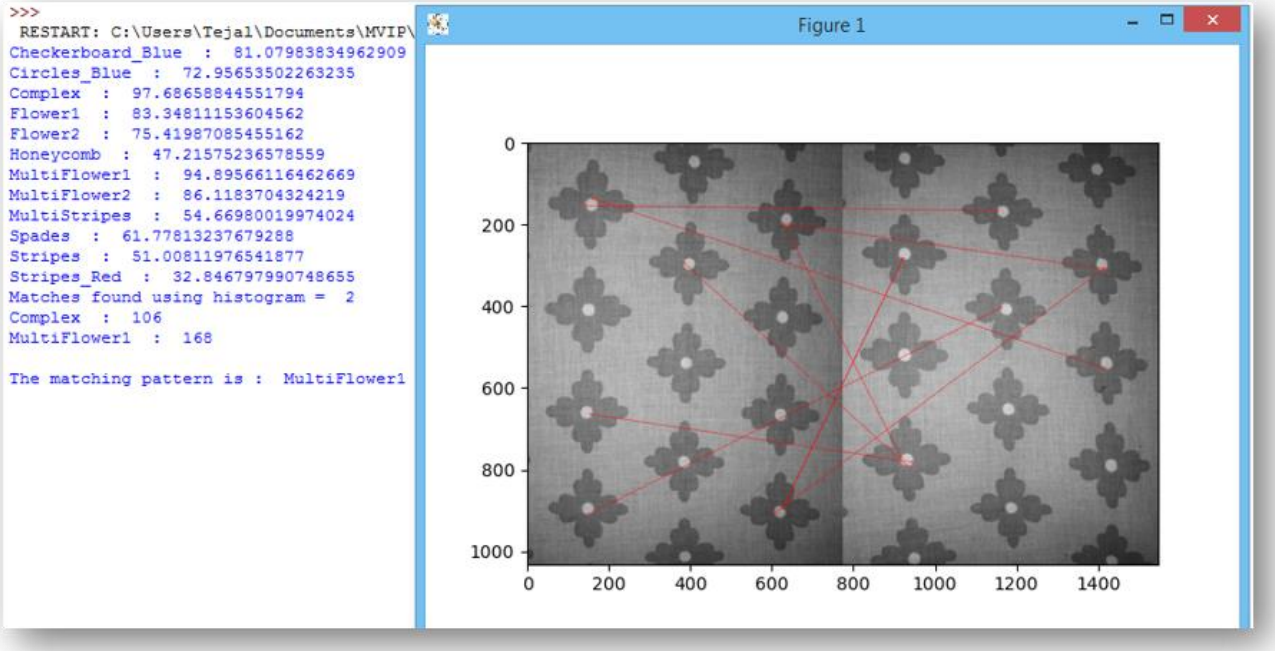

Fig. 1.4: Feature matching providing the correct match for an image with a repeated pattern

4.2 Discussion

The patterns are recognized in the correct manner, and the results also show the closeness of the patterns to the templates in the dataset. 10 matches are also shown for the point-based feature matching method. These allow us to visualize the results that the system bases its decision on.

The results are based on simple mathematical formulas, for the sake of preserving computer resources, but can also be modified if the need arises. Therefore, the basic steps can be modified in the future to accommodate any other needs, and also to improve the accuracy of both models using methods that would be even faster and efficient.

CHAPTER 5
Conclusion and Future Scope

5.1 Conclusion

Patterns are recognized based on either the colours or the features present in a short period of time, and this is useful for daily use, and in working scenarios where professionals would need to refer to a directory of patterns in a hurry.

The algorithm is not perfect due to the limited dataset (only one image per pattern), and due to its simplicity

5.2 Scope for Future Work

- A larger dataset with more computational power would lead to better matches.

- Can be applied to recognize animal pelt patterns, leaf patterns, etc., that can aid in the classification and recognition of endangered species/rare variants

- Can be applied for recognition of architectural patterns, ancient painting styles in different cultures, etc.

CHAPTER 6
Contribution of Each Team Member

Tejal V Shetty - 190929006

Contributions

Research, Algorithm, Coding

Analysis

The primary part of the research and the code required work put in to start the basic framework, because that was what led to the fine-tuning and correction of the program later on. The code has to implement the basic functions decided according to the algorithm and research performed, and must run efficiently, using the least computational power needed.

Shreyas Rao - 190929004

Contributions

Documentation, Dataset generation, Algorithm

Analysis

The dataset generation was necessary for the generation of a stable and comprehensive list of patterns that could be used and documentation was necessary to maintain a detailed report of the code and the algorithm.

Saurabh Patel - 190929138

Contributions

Coding, Documentation, Dataset Processing

Analysis

The processing of the dataset was necessary to ensure that all the images were of the same format, size and metadata characteristics, which is necessary for the proper development of the algorithm.

Chirag Shetty - 190929210

Contributions

Research, Dataset processing, Coding

Analysis

The processing of the test patterns, as well as the dataset templates is necessary for fine tuning the algorithm, along with improving upon the code, so as to improve the accuracy, and reduce the computational load.

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