MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR

(A Govt. Aided UGC Autonomous & NAAC Accredited Institute Affiliated to RGPV, Bhopal)

Project Report

on

Pratibimb: An art that reflects your emotions

A project report submitted in partial fulfilment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

in

COMPUTER SCIENCE AND ENGINEERING

Submitted by:

Sahaj Jain

0901CS191103

Faculty Mentor:

Mr. Mir Shahnawaz Ahmad

Assistant Professor, Computer Science And Engineering

Dr. Shubhi Kansal

Assistant Professor, Electronics Engineering

Submitted to:

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE

GWALIOR - 474005 (MP) est. 1957

MAY-JUNE 2022

MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR

(A Govt. Aided UGC Autonomous & NAAC Accredited Institute Affiliated to RGPV, Bhopal)

CERTIFICATE

This is certified that **Sahaj Jain** (0901CS191103) has submitted the project report titled **Pratibimb: Art that reflects your Emotions** under the mentorship of **Mir Shahnawaz Ahmad, Asst. Professor, MITS, Dr. Shubhi Kansal, Asst. Professor, Electronics Engineering,** in partial fulfilment of the requirement for the award of degree of Bachelor of Technology in Computer Science and Engineering from Madhav Institute of Technology and Science, Gwalior.

09/05/22

Mr. Mir Shahnawaz Ahmad
Faculty Mentor
Assistant Professor
Computer Science and Engineering

Shubhi
9/5/22

Dr. Shubhi Kansal
Faculty Mentor
Assistant Professor
Electronics Engineering

09/05/2022

Dr. Manish Dixit
Professor and Head,
Computer Science and Engineering

Dr. Manish Dixit
Professor & HOD
Department of
M.I.T.S. Gwa

MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR

(A Govt. Aided UGC Autonomous & NAAC Accredited Institute Affiliated to RGPV, Bhopal)

DECLARATION

We hereby declare that the work being presented in this project report, for the partial fulfilment of requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering at Madhav Institute of Technology & Science, Gwalior is an authenticated and original record of my work under the mentorship of **Mir Shahnawaz Ahmad, Asst. Professor, Computer Science and Engineering Department, Dr. Shubhi Kansal, Asst. Professor, Electronics Engineering.**

We declare that we have not submitted the matter embodied in this report for the award of any degree or diploma anywhere else.

09/05/22

Sahaj Jain
(0901CS191103)
3rd Year
Computer Science and Engineering

MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR

(A Govt. Aided UGC Autonomous & NAAC Accredited Institute Affiliated to RGPV, Bhopal)

ACKNOWLEDGEMENT

The full semester project has proved to be pivotal to my career. we are thankful to my institute, **Madhav Institute of Technology and Science** to allow us to continue my disciplinary/interdisciplinary project as a curriculum requirement, under the provisions of the Flexible Curriculum Scheme (based on the AICTE Model Curriculum 2018), approved by the Academic Council of the institute. We extend our gratitude to the Director of the institute, **Dr. R. K. Pandit** and Dean Academics, **Dr. Manjaree Pandit** for this.

We would sincerely like to thank our department, **Department of Computer Science and Engineering, for allowing** me to explore this project. we humbly thank **Dr. Manish Dixit**, Professor and Head, Department of Computer Science and Engineering, for his continued support during the course of this engagement, which eased the process and formalities involved.

We are sincerely thankful to our faculty mentor. We are grateful to the guidance of **Mir Shahnawaz Ahmad**, Assistant Professor, CSE Department, **Dr. Shubhi Kansal**, Asst. Professor, Electronics Engineering, for their continued support and guidance throughout the project. We are also very thankful to the faculty and staff of the department.

09/05/22

Sahaj Jain
(0901CS191103)
3rd Year
Computer Science and Engineering

ABSTRACT

There is a long-standing and fundamental debate regarding how emotion can be expressed by fine art. With advancement of tech, there has been exponential development in Generative art, a system that operates autonomously, or semi-autonomously, rather than directly by the artist. The artist creates the system and establishes parameters that affect the outcome, but the outcome itself emerges from the system rather than from the artist. In the past decade there has been increased interest in research on colour and psychological functioning as well. The human facial expressions convey a lot of emotional information visually rather than articulately. Facial expression recognition plays a crucial role in the area of human-machine interaction. In this project we have applied various technologies to create an artwork that the viewer can interact with, and it can respond to their emotions and expressions such as anger, disgust, fear, happiness, sadness, surprise and neutrality. It is something the viewer will emotionally be able to connect to.

- **Keywords:** Emotions, Generative art, Facial Expression, Feature Extraction, colour psychology.

सार:

कला द्वारा भावनाओं को कैसे व्यक्त किया जा सकता है, इस बारे में एक लंबी और मौलिक बहस है। तकनीक की प्रगति के साथ, जनरेटिव आर्ट में घातीय विकास हुआ है, एक ऐसी प्रणाली जो सीधे कलाकार के बजाय स्वायत्त या अर्ध-स्वायत्त रूप से संचालित होती है। कलाकार सिस्टम बनाता है और ऐसे पैरामीटर स्थापित करता है जो परिणाम को प्रभावित करते हैं, लेकिन परिणाम स्वयं कलाकार के बजाय सिस्टम से निकलता है। पिछले एक दशक में रंग और मनोवैज्ञानिक कार्यप्रणाली पर भी शोध में रुचि बढ़ी है। मानवीय चेहरे के भाव कलात्मक रूप से ही नहीं बल्कि नेत्रहीन रूप से बहुत सारी भावनात्मक जानकारी व्यक्त करते हैं। मानव-मशीन संपर्क के क्षेत्र में चेहरे की अभिव्यक्ति की पहचान एक महत्वपूर्ण भूमिका निभाती है। इस परियोजना में हमने एक कलाकृति बनाने के लिए विभिन्न तकनीकों को लागू किया है जिसके साथ दर्शक बातचीत कर सकता है, और यह उनकी भावनाओं और भावों जैसे क्रोध, घृणा, भय, खुशी, उदासी, आश्चर्य और तटस्थता का जवाब दे सकता है। यह एक ऐसी चीज है जिससे दर्शक भावनात्मक रूप से जुड़ पाएगा।

कीवर्ड: इमोशन्स, जनरेटिव आर्ट, फेशियल एक्सप्रेशन, फ़ीचर एक्सट्रैक्शन, कलर साइकोलॉजी।

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1 INTRODUCTION:

1.1 PROJECT OVERVIEW:

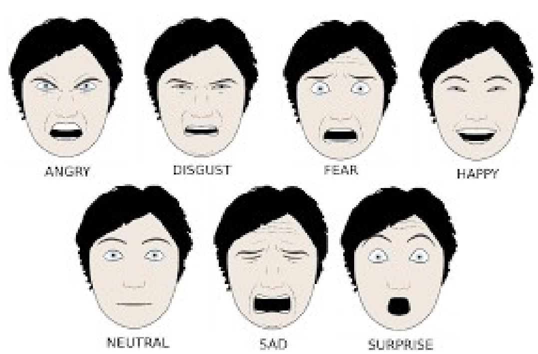
With the advent of modern technology our desires went high and it binds no bounds. In the present era a huge research work is going on in the field of digital image processing and generative AI. The way of progression has been exponential and it is ever increasing.

Generative art refers to art that in whole or in part has been created with the use of an autonomous system. An autonomous system in this context is generally one that is non-human and can independently determine features of an artwork that would otherwise require decisions made directly by the artist. "Generative art" often refers to algorithmic art (algorithmically determined computer generated artwork).

Image processing is the field of signal processing where both the input and output signals are images. One of the most important application of Image processing is Facial expression recognition. Our emotion is revealed by the expressions in our face. Facial Expressions plays an important role in interpersonal communication. Facial expression is a nonverbal scientific gesture which gets expressed in our face as per our emotions.

The objective of this project is to develop Generative Artwork that responds to viewer's Facial Expression, which can take human facial images containing some expression as input and recognize and classify and respond to seven different expression class such as:

I. Neutral
II. Angry
III. Disgust
IV. Fear
V. Happy
VI. Sadness
VII. Surprise



1.1(Seven Expressions)

1.2 Objectives and Scope:

The objective of emotion responsive generative art is identifying emotions of the viewer and respond in the form of art. The emotion can be captured either from face or from verbal communication. In this work we focus on identifying human emotion from facial expressions. Facial emotion recognition is one of the useful task and can be used as a base for many real-time applications. We humans can easily identify the emotion of other humans without any effort. With this we try to achieve a medium through which the viewers' can get a better understanding of their perspective of emotions and of themselves.

1.3 Project Features:

In our project the input for expression detection is taken through the webcam of the system on which the project is running in video format and then it's given to a pre-trained deep learning model via an API request to get output from our given list of expressions. The returned output will be displayed and transferred to the generative algorithm that will modify the art.

1.4 Feasibility:

Before starting the project, a feasibility study is carried out to measure the viability of the system. Feasibility study is necessary to determine if creating a new or improved system is friendly with the cost, benefits, operation, technology and time. Following feasibility study is given as below:

1.4.1 Technical Feasibility : Technical feasibility is one of the first studies that must be conducted after the project has been identified. Technical feasibility study includes the hardware and software devices. The required technologies (JavaScript and VSCode) existed.

1.4.2 Operational Feasibility : Operational Feasibility is a measure of how well a proposed system solves the problem and takes advantage of the opportunities identified during scope definition. The following points were considered for the project's technical feasibility: The system will detect and capture the image of face. The captured image is then (identified which category)

1.4.3 Economic Feasibility : The purpose of economic feasibility is to determine the positive economic benefits that include quantification and identification. The system is economically feasible due to availability of all requirements such as pre trained model API.

1.4.4 Schedule Feasibility : Schedule feasibility is a measure of how reasonable the project timetable is. The system is found to be schedule feasible because the system is designed in such a way that it will finish prescribed time.

1.5 System Requirements:

> Fluently working laptop

> Web Camera

> 4 GB RAM

1.6 Technologies Used:

1.6.1 Processing :
Processing is a simple programming environment that was created to make it easier to develop visually oriented applications with an emphasis on animation and providing users with instant feedback through interaction. The developers wanted a means to “sketch” ideas in code.

1.6.2 P5.js :
p5.js is a JavaScript library for creative coding, with a focus on making coding accessible and inclusive for artists, designers and anyone else! It is based on Processing framework.

1.6.3 OpenCV :
OpenCV is a cross-platform library using which we can develop real-time computer vision applications. It mainly focuses on image processing, video capture and analysis including features like face detection and object detection.

1.6.4 Danfo.js :
Danfo.js is a javascript package that provides fast, flexible, and expressive data structures designed to make working with "relational" or "labelled" data both easy and intuitive. It is heavily inspired by Pandas library, and provides a similar API.

1.6.5 TensorFlow :
TensorFlow is an open-source library developed by Google primarily for deep learning applications. It also supports traditional machine learning. TensorFlow accepts data in the form of multi-dimensional arrays of higher dimensions called tensors.

1.6.6 ML5.js :
ml5.js is an open source, friendly high level interface to TensorFlow.js, a library for handling GPU-accelerated mathematical operations and memory management for machine learning algorithms.

1.6.7 FaceAPI :
It is a JavaScript API for face detection and face recognition in the browser. It is implemented on top of the tensorflow.js core API.

1.6.8 Visual Studio Code :
It is a source-code editor made by Microsoft for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.

1.6.9 Git :
Git is a software for tracking changes in any set of files, usually used for coordinating work among programmers collaboratively developing source code during software development

1.6.10 HTML :
HTML is the standard markup language for documents designed to be displayed in a web browser. It can be assisted by technologies such as Cascading Style Sheets and scripting languages such as JavaScript.

1.6.11 CSS :
Cascading Style Sheets is a style sheet language used for describing the presentation of a document written in a markup language such as HTML. CSS is a cornerstone technology of the World Wide Web, alongside HTML and JavaScript.

1.7 API Models Used :
FaceAPI provides various models for face detection and face recognition through API request, from which the we have used:

1.7.1 Face Recognition Model :
For face recognition, a ResNet-34 like architecture is implemented to compute a face descriptor (a feature vector with 128 values) from any given face image, which is used to describe the characteristics of a person's face. The model is not limited to the set of faces used for training, meaning you can use it for face recognition of any person, for example yourself. You can determine the similarity of two arbitrary faces by comparing their face descriptors, for example by computing the euclidean distance or using any other classifier of your choice.

1.7.2 68 Point Face Landmark Detection Model :
This package implements a very lightweight and fast, yet accurate 68 point face landmark detector. The default model has a size of only 350kb. The model employs the ideas of depthwise separable convolutions as well as densely connected blocks. The models have been trained on a dataset of ~35k face images labelled with 68 face landmark points.

1.7.3 Face Expression Recognition Model :
The face expression recognition model is lightweight, fast and provides reasonable accuracy. The model has a size of roughly 310kb and it employs depthwise separable convolutions and densely connected blocks. It has been trained on a variety of images from publicly available datasets as well as images scraped from the web. Note, that wearing glasses might decrease the accuracy of the prediction results.

1.8 Problem Statement :
Human emotions and intentions are expressed through facial expressions and deriving an efficient and effective feature is the fundamental component of facial expression system. Face recognition is important for the interpretation of facial expressions in applications such as intelligent, man-machine interface and communication, intelligent visual surveillance, teleconference and real-time animation from live motion images.

Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art. Although Generative Art is almost always abstract in nature, it can't be defined by the style of the work. The common factor of generative artworks is the methodology of its production, not the style of the end result.

CHAPTER 2: LITERATURE REVIEW

Artificial intelligence art, or AI art, is any artwork created with the assistance of AI. It can be created autonomously by AI systems or created in collaboration with humans and an AI system. In 2018, British auction house Christie's sold its first piece of computer-generated art, titled "Portrait of Edmond Belamy", made by a French art collective named Obvious, sold for a whopping $ 432,500, about 45 times more than its estimated worth.

ImageProcessing

Research in the fields of face detection and tracking has been very active and there is exhaustive literature available on the same. The major challenge that the researchers face is the non-availability of spontaneous expression data. Capturing spontaneous expressions on images and video is one of the biggest challenges ahead. Many attempts have been made to recognize facial expressions. Zhang et al investigated two types of features, the geometry-based features and Gabor wavelets based features, for facial expression recognition.

Appearance based methods, feature invariant methods, knowledge based methods, Template based methods are the face detection strategies whereas Local Binary Pattern phase correlation, Haar classifier, AdaBoost, Gabor Wavelet are the expression detection strategies in related field [3]. Face reader is the premier for automatic analysis of facial expression recognition and Emotient, Affectiva, Karios etc are some of the API's for expression recognition. Automatic facial expression recognition includes two vital aspects: facial feature representation and classifier problem [2].

For classifier problem we use algorithms like Machine learning, Neural Network, Support Vector Machine, Deep learning, Naive Bayes. The formation of histogram by using any of facial feature representation will use Support Vector Machine (SVM) for expression recognition. SVM builds a hyperplane to separate the high dimensional space. An ideal separation is achieved when the distance between the hyper plane and the training data of any class is the largest [4].

Generative Art

Generative art has a history measured in decades, not long compared to other arts, which is probably why it's still on the periphery of the art world. Art colleges across the globe are churning out tens of thousands of painters, potters, fashion designers, and graphic designers every year, but the number of practicing generative artists in the world at present could probably fit comfortably onto a single Caribbean cruise liner (which would be a lovely idea if anyone fancies arranging it). This demographic is changing fast, though.

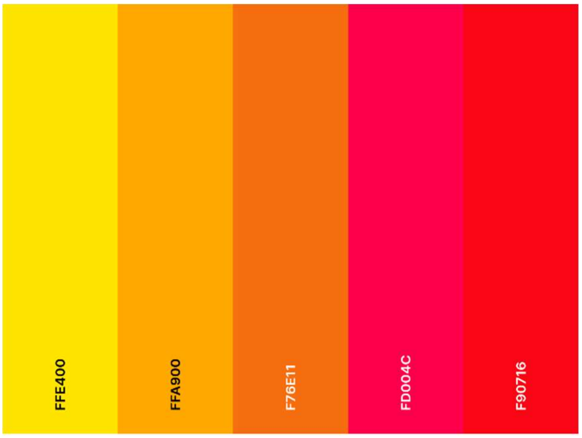
The term generative art has only been in general use since the 1960s, but the concept has been with us much longer. Generative forms of music, for example, have been around since Mozart. His Musikalisches Würfelspiel (Musical Dice Game) was an early example of a generative artistic system.

It may be early days for the digital toolset, but these technological marvels award us some novel powers of expression. At the same time, they have a huge bearing on the type of work we produce with them.

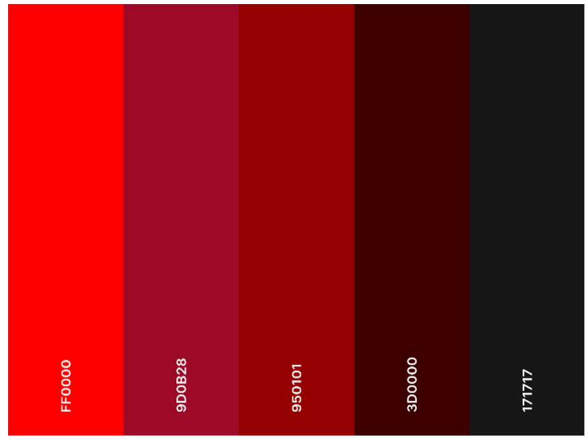
The art of using colour symbolism

Colour is a powerful communication tool and can be used to signal action, influence mood, and even influence physiological reactions. Certain colours have been associated with increased blood pressure, increased metabolism, and eyestrain. Millions of years of biological conditioning have created certain associations between colours and objects or emotions, while some associations may be more recent. Understanding these associations will give you a shortcut to people's hearts, provoking a specific emotion and maybe even a behaviour.

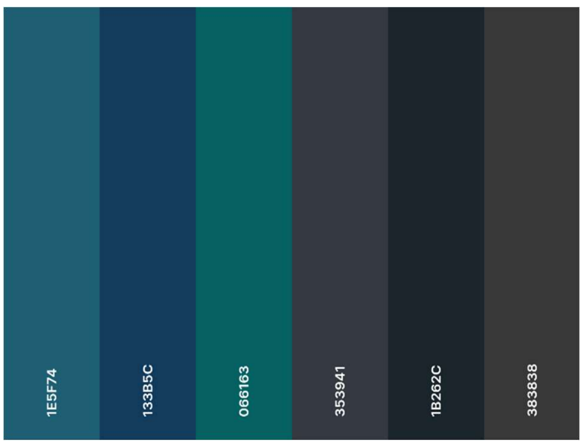
Colour meanings stem from psychological effects, biological conditioning and cultural developments. The 2015 Pixar movie Inside Out is about a girl who has five "basic" emotions living in her head. Each one is coloured uniquely (e.g., anger is "red", fear is "purple", and disgust is "green"). The idea represented in the movie is that colour—just like a set of behaviours, facial expressions, and/or vocalizations—distinguishes one emotion from another.



Happiness

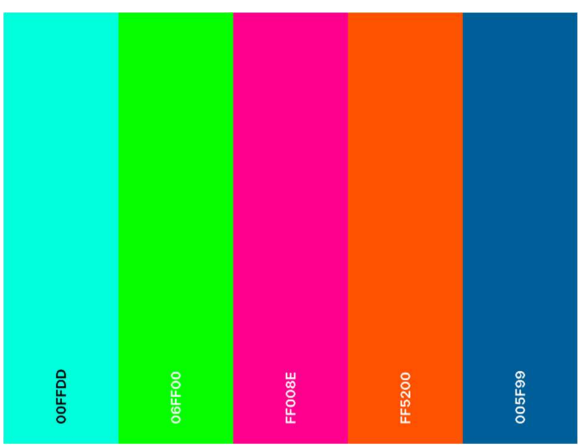


Anger



Sad

Disgusted



Surprised

Fearful

2.1: Colour psychology and Emotions

CHAPTER 3: DETAILED DESIGN

3.1 Algorithm :

- **Step 1** - Creating Canvas for video input.
- **Step 2** - Setting up ml5.js and faceAPI request for detection of face from video input.
- **Step 3** - Receiving face and expression results from the request.
- **Step 4** – Ensuring the request is processed else error is handled.
- **Step 6** – Danfojs receives the data of face landmarks and expressions.
- **Step 7** – Data is processed and sent to Generative Algorithm.
- **Step 8** – Generative Algorithm maintains a particle system with variable vectors.
- **Step 9** – System manipulates attributes like shader and attraction according to face data.
- **Step 10** – Algorithm checks the expression and system attributes after predefined interval.

3.2 Detailed Description :

A Facial expression is the visible manifestation of the affective state, cognitive activity, intention, personality and psychopathology of a person and plays a communicative role in interpersonal relations. It has been studied for a long period of time and obtained progress in recent decades. Though much progress has been made, recognizing facial expressions with a high accuracy remains to be difficult due to the complexity and varieties of facial expressions [2].

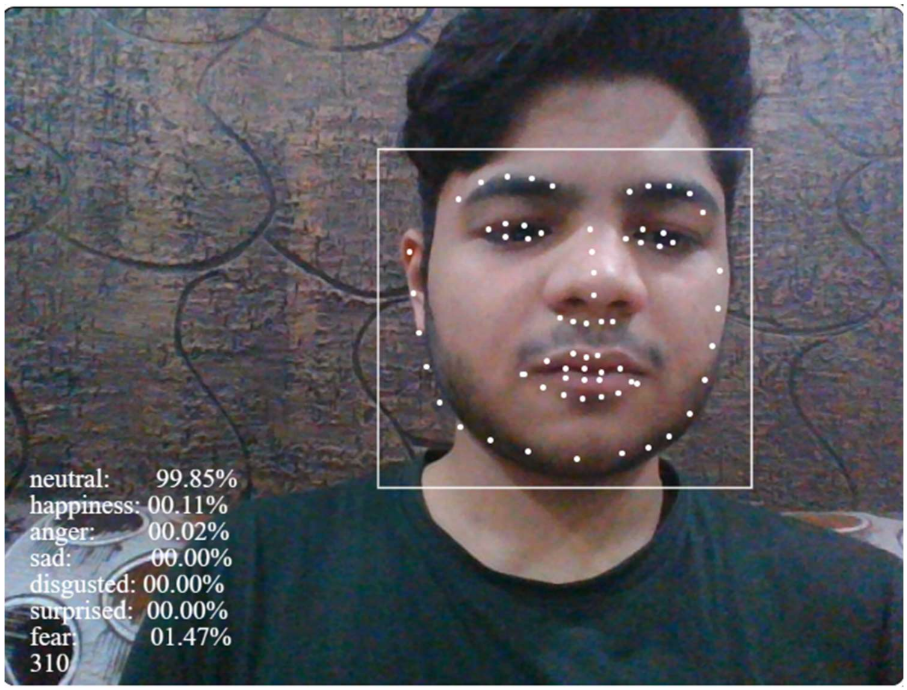
Generally human beings can convey intentions and emotions through nonverbal ways such as gestures, facial expressions and involuntary languages. This system can be significantly useful, nonverbal way for people to communicate with each other. The important thing is how fluently the system detects or extracts the facial expression from the image. The system is growing attention because this could be widely used in many fields like lie detection, medical assessment and human computer interface. On day-to-day basics humans commonly recognize emotions by characteristic features, displayed as a part of a facial expression. For instance happiness is undeniably associated with a smile or an upward movement of the corners of the lips. Similarly other emotions are characterized by other deformations typical to a particular expression.

Generative art refers to art that in whole or in part has been created with the use of an autonomous system. An autonomous system in this context is generally one that is non-human and can independently determine features of an artwork that would otherwise require decisions made directly by the artist. In some cases the human creator may claim that the generative system represents their own artistic idea, and in others that the system takes on the role of the creator.

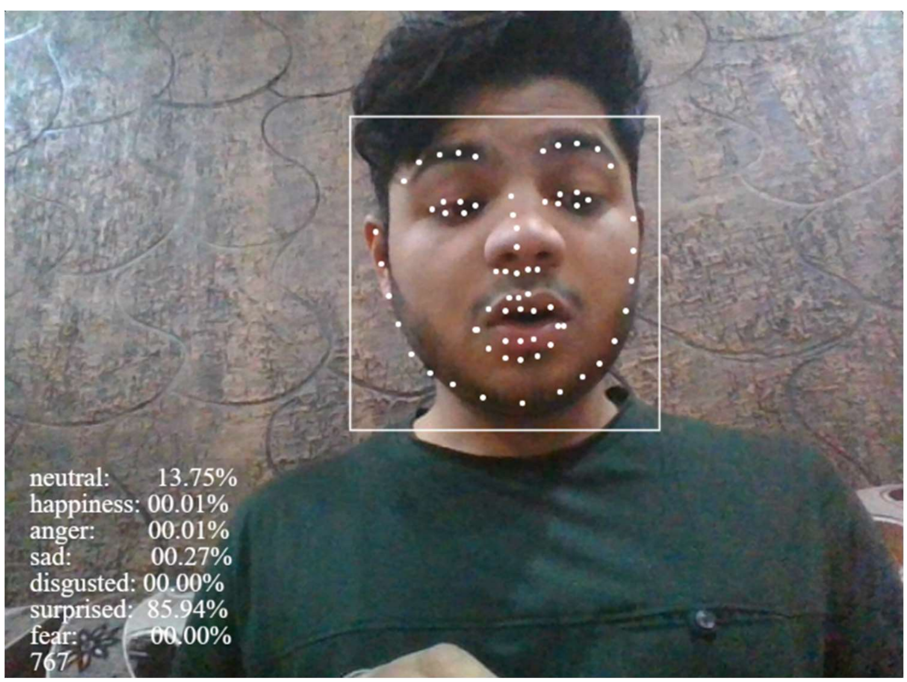
"Generative art" often refers to algorithmic art (algorithmically determined computer generated artwork) and synthetic media (general term for any algorithmically-generated media), but artists can also make it using systems of chemistry, biology, mechanics and robotics, smart materials, manual randomization, mathematics, data mapping, symmetry, tiling, and more.

CHAPTER 4: FINAL RESULT

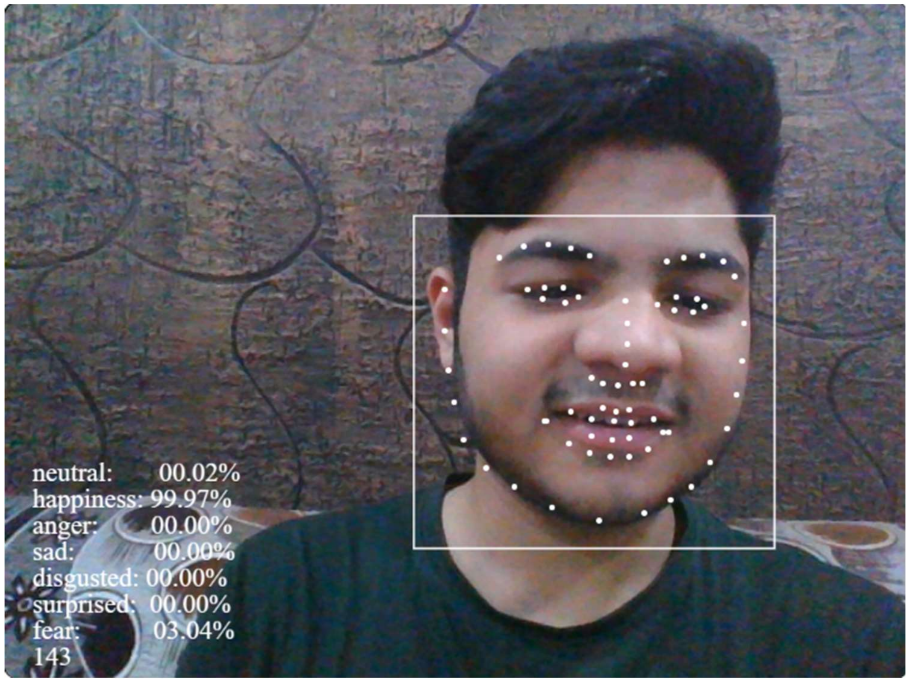
4.1 Result:



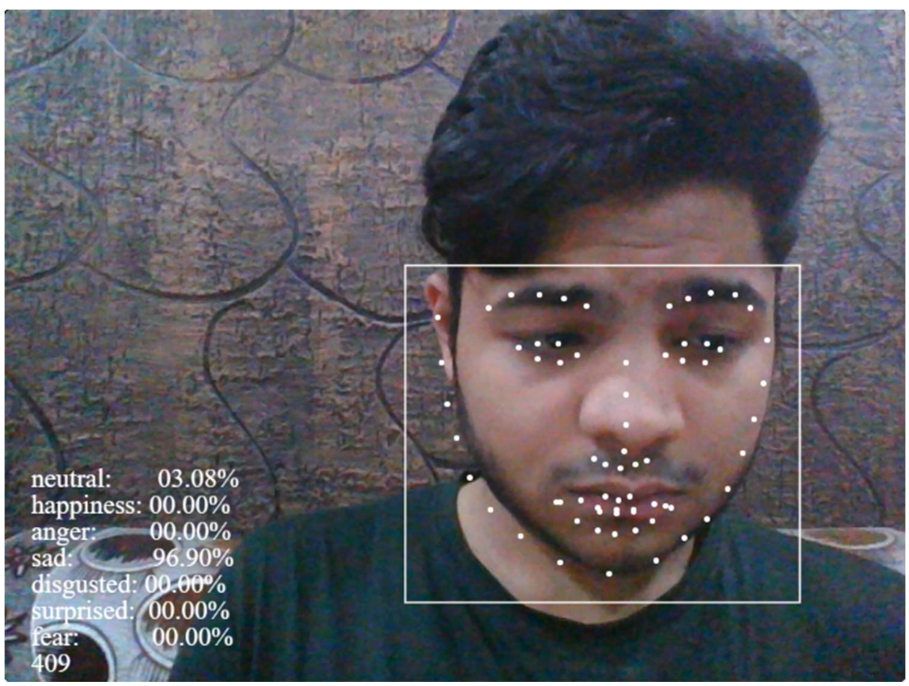
Neutral



Surprise



Happy



Sad

Fig 4.1: Facial Expression Recognition

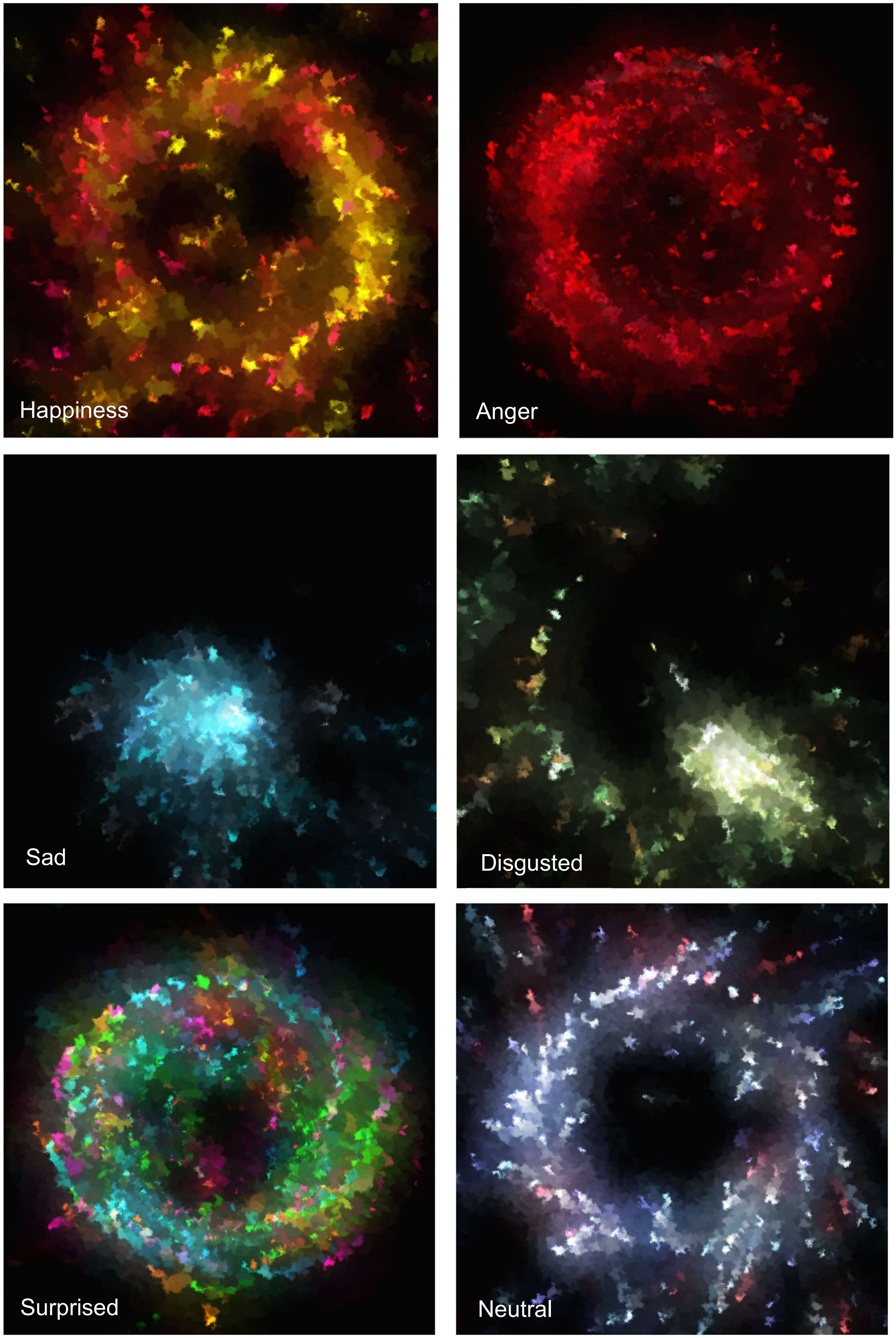


Fig 4.2: Generative Art and Emotions

4.2 Applications:

Aesthetic art such as this, helps one to have emotional awareness. Emotional awareness helps us know what we need and want (or don't want!). It helps us build better relationships. That's because being aware of our emotions can help us talk about feelings more clearly, avoid or resolve conflicts better, and move past difficult feelings more easily.

One of the most important aspect of this project is that more than artwork, it is a software that provides user (viewer, here) output specific to his emotions. Hence this can be used in areas where service provided depends upon the emotions or mood of the user such as mood boosting light therapy.

Also Useful in Chromotherapy. Colour therapy, also known as chromotherapy, is a form of therapy that uses colour and light to treat certain mental and physical health conditions.

Generative Art opens up a whole new domain in the field of Art. Generative tools are not just being used to create art, architecture and music. They're also being used to design physical products, video games, and other objects meant to be used in everyday life.

CHAPTER 5: CONCLUSION:

Purpose of this project was to create a real time, semi-autonomous generative art algorithm that is interactive and uses computer vision and AI face detection models from faceAPI and ml5.js to develop an artwork which is responsive to viewers emotions through face expression recognition by classifying expressions into happiness, anger, sad, disgust, surprise, and fear. By classifying the expressions, we can generate values for predefined attributes which updates the underlying particle system. Each expression has been expressed through some colour and particle motion with respect to the concepts of colour psychology, which gives it a notion of emotion. The art is itself able to appeal to the viewer giving it a sense of aesthetics, something the viewer will emotionally be able to connect to.

REFERENCE :

1. Bettadapura, V. (2012). Face expression recognition and analysis: the state of the art. *arXiv preprint arXiv:1203.6722*.
2. Shan, C., Gong, S., & McOwan, P. W. (2005, September). Robust facial expression recognition using local binary patterns. In *Image Processing, 2005. ICIP 2005. IEEE International Conference on* (Vol. 2, pp. II-370). IEEE.
3. Bhatt, M., Drashti, H., Rathod, M., Kirit, R., Agravat, M., & Shardul, J. (2014). A Studyof Local Binary Pattern Method for Facial Expression Detection. *arXiv preprint arXiv:1405.6130*.
4. Chen, J., Chen, Z., Chi, Z., & Fu, H. (2014, August). Facial expression recognition based on facial components detection and hog features. In *International Workshops on Electrical and Computer Engineering Subfields* (pp. 884-888).
5. *Boden, Margaret; Edmonds, Ernest (2009). "What is Generative Art?". Digital Creativity.* ***20*** *(1/2): 21–46. doi:10.1080/14626260902867915. S2CID 28266287.*
6. ^ *Nake, Frieder. "Georg Nees: Generative Computergrafik". University of Bremen. Retrieved 19 August 2012.*
7. ^ Ness, Georg; Bense, Max: *computer-grafik*; Edition Rot 19; Stuttgart, 1965.
8. ^ Osborne, Harold, ed. *The Oxford Companion to Twentieth-Century Art*, Oxford; New York: Oxford University Press
9. ^ Walker, J. A. *Glossary of art, architecture, and design since 1945 (3rd ed.)*, London; Boston: Library Association Publishing; G.K. Hall.
10. *"CHARACTER COSTUME DESIGN CREATION", Character Costume Figure Drawing, Routledge, pp. 169–183, 2013-03-20, ISBN 978-0-08-095407-3, retrieved 2022-05-04*
11. ^ Jump up to:[a] [b] *Roohi S, Forouzandeh A (May 2019). "Regarding color psychology principles in adventure games to enhance the sense of immersion". Entertainment Computing.* ***30****: 100298. doi:10.1016/j.entcom.2019.100298. ISSN 1875-9521. S2CID 133023544.*
12. ^ Jump up to:[a] [b] [c] *de Craen AJ, Roos PJ, de Vries AL, Kleijnen J (1996). "Effect of colour of drugs: systematic review of perceived effect of drugs and of their effectiveness". BMJ.* ***313*** *(7072): 1624–1626. doi:10.1136/bmj.313.7072.1624. PMC 2359128. PMID 8991013.*
13. ^ Jump up to:[a] [b] *Alter A (March 21, 2013). "I See Red". Slate.*
14. ^ Jump up to:[a] [b] *Birren F (1961). Colour Psychology & Colour Therapy. Secaucus, N. J: The Citadel Press. p. 198. ISBN 0806506539.*