

Summer Training Report
on
PEN AND PAINT
(using Python and OpenCV)

**A Project Report submitted in partial fulfilment of the requirements for
the award of**

Bachelor of Engineering
IN
COMPUTER SCIENCE AND ENGINEERING

Submitted by

Kriti Aggarwal
(Roll no: CO19335)

Under the supervision of
Dr. Gulshan Goyal



CHANDIGARH COLLEGE OF ENGINEERING AND TECHNOLOGY
(DEGREE WING)

Government Institute under Chandigarh (UT) Administration, Affiliated to Panjab
University, Chandigarh

Sector-26, Chandigarh. PIN-160019

AUGUST, 2020



CHANDIGARH COLLEGE OF ENGINEERING AND TECHNOLOGY (DEGREE WING)

Government Institute under Chandigarh (UT) Administration | Affiliated to Panjab University, Chandigarh

Sector-26, Chandigarh. PIN-160019 | Tel. No. 0172-2750947, 2750943

Website: www.ccet.ac.in | Email: principal@ccet.ac.in | Fax. No. :0172-2750872



Department of Computer Sc. & Technology

CANDIDATE'S DECLARATION

I hereby declare that the work presented in this report entitled "PEN AND PAINT (using Python and OpenCV)", in fulfilment of the requirement for the award of the degree Bachelor of Engineering in Computer Science & Engineering, submitted in CSE Department, Chandigarh College of Engineering & Technology (Degree wing) affiliated to Punjab University, Chandigarh, is an authentic record of my own work carried out during my degree under the guidance of **Dr. Gulshan Goyal**. The work reported in this has not been submitted by me for award of any other degree or diploma.

Date : 02-08-20

Kriti Aggarwal

Place: Chandigarh

CO19335



CHANDIGARH COLLEGE OF ENGINEERING AND TECHNOLOGY (DEGREE WING)

Government Institute under Chandigarh (UT) Administration | Affiliated to Panjab University, Chandigarh

Sector-26, Chandigarh. PIN-160019 | Tel. No. 0172-2750947, 2750943

Website: www.ccet.ac.in | Email: principal@ccet.ac.in | Fax. No. :0172-2750872



Department of Computer Sc. & Technology

CERTIFICATE

This is to certify that the Project work entitled “PEN AND PAINT (using Python and OpenCV)” submitted by KRITI AGGARWAL, CO19335 in fulfilment for the requirements of the award of Bachelor of Engineering Degree in Computer Science & Engineering at Chandigarh College of Engineering and Technology (Degree Wing), Chandigarh is an authentic work carried out by him/her under my supervision and guidance.

To the best of my knowledge, the matter embodied in the project has not been submitted to any other University / Institute for the award of any Degree.

Date : 02-08-20

Place : Chandigarh

Dr. Gulshan Goyal

Dept. of CSE

CCET(Degree Wing)

Chandigarh

Department of Computer Sc. & Technology





CHANDIGARH COLLEGE OF ENGINEERING AND TECHNOLOGY (DEGREE WING)

Government Institute under Chandigarh (UT) Administration | Affiliated to Panjab University, Chandigarh

Sector-26, Chandigarh. PIN-160019 | Tel. No. 0172-2750947, 2750943

Website: www.ccet.ac.in | Email: principal@ccet.ac.in | Fax. No. :0172-2750872



Department of Computer Sc. & Technology

ACKNOWLEDGEMENT

It is a great pleasure and honour to represent this Summer Training Report on “PEN AND PAINT (using Python and OpenCV)”. I have taken sincere efforts in this Project. However, it would not have been possible without the invaluable help and support of my mentor Dr. Gulshan Goyal and my course instructors and fellow mates on Coursera Portal.

I am highly indebted to Chandigarh College of Engineering & Technology (Degree Wing) for their guidance and constant supervision as well as for providing all the necessary information. My instructor on Coursera taught me all the basics required to get started with python and gave me enough confidence to explore the various libraries of python without any hesitation. I would like to express my special gratitude and thanks to my mentor for encouraging me to do something different and new and for also addressing my queries throughout the project. I would also like to thank Punjab University for including IPD as a part of my curriculum.

Kriti Aggarwal
CO19335
(2nd Semester)
Dept. of CSE



CHANDIGARH COLLEGE OF ENGINEERING AND TECHNOLOGY (DEGREE WING)

Government Institute under Chandigarh (UT) Administration | Affiliated to Panjab University, Chandigarh

Sector-26, Chandigarh. PIN-160019 | Tel. No. 0172-2750947, 2750943

Website: www.ccet.ac.in | Email: principal@ccet.ac.in | Fax. No. :0172-2750872



Department of Computer Sc. & Technology

ABSTRACT

Python is an interpreted, high-level, general purpose programming language. It has easy to read syntax and huge collection of advanced libraries. I have made a program called Pen and Paint which uses python as the main programming language and takes advantage of its advanced libraries like OpenCV, NumPy and printy. It allows the user to write over an image or a white screen by moving a blue colour cap in air. It also has features that allow user to save and erase the work. This is possible with the help of OpenCV, cross-platform library, that focuses on real time computer vision applications like image processing, video capture and analysis.

Table of Contents

Submitted by	1
CHAPTER 1: Introduction	10
1.1. About the course	10
1.1.1. Course Introduction.....	10
1.1.2. About the course instructor	10
1.1.3. Course objectives	10
1.1.4. Features	11
1.1.5. Skills.....	11
1.2. Getting started with Python	11
1.2.1. coding interfaces.....	12
1.3. Using visual studio code	13
1.3.1. Features.....	13
1.3.2. Working with VS Code.....	14
CHAPTER 2: programming for everybody	15
2.1. Computer Programming	15
1.2.1. The building blocks of a program.....	15
1.2.2. Interpreter and Compiler.....	15
1.2.3. General errors while programming.....	16
1.2.4. Debugging.....	16
2.1. Introduction to python	16
2.2. History	17
2.3. Features of Python.....	17
2.4. Applications	19
2.5. Python Basics.....	22
2.2.1. Variables	22
2.2.2. Data Types	22
2.2.4. Conditional execution	24
2.2.4. Control statement.....	25
2.2.5. Functions.....	26
2.2.5. File Handling.....	27
2.6. Glossary	28
2.7. Conclusion	28
3.1. Introduction.....	29
3.2. Project Analysis.....	29
3.2.1. Existing Systems.....	29
3.2.2. Proposed system.....	29
3.2.3. Competitive Edge.....	30
3.2.4. GAP Analysis.....	30
3.3. Features and Functions	31
3.4. Python libraries	32
3.4.1 OpenCV.....	32
3.4.2. NumPy.....	32
3.4.3. Printy.....	33

3.5. Methodology	33
3.5.1. Program design.....	33
3.5.2. Working.....	34
3.6. Results	36
3.6.1. Welcome	36
3.6.2. Web cam frame	36
3.6.3. Paint window.....	37
3.6.4. Draw and save image	38
References:	40

Table of Figures

Figure 1.....	12
Figure 2.....	12
Figure 3.....	13
Figure 4.....	14
Figure 5.....	36
Figure 6.....	36
Figure 7.....	37
Figure 8.....	37
Figure 9.....	38
Figure 10.....	38
Figure 11.....	39

CHAPTER 1: Introduction

1.1. About the course

1.1.1. Course Introduction

The first two courses in the specialization python for everybody teaches us about the basic knowledge of computer programming and python. It covers everything that we need to know in order to start exploring python libraries and learn any other python application.

1. Course 1: programming for everybody

This course aims to teach everyone the basics of programming computers using Python. We cover the basics of how one constructs a program from a series of simple instructions in Python.

2. Course 2: python Data Structures

This course will introduce the core data structures of the Python programming language. We move past the basics of procedural programming and explore how we can use the Python built-in data structures such as lists, dictionaries, and tuples to perform increasingly complex data analysis.

1.1.2. About the course instructor

Charles Severance (a.k.a. Dr. Chuck) is a Clinical Associate Professor at the University of Michigan School of Information, where he teaches various technology-oriented courses including programming, database design, and Web development. Chuck has written a number of books including Using Google App Engine, and Python for Informatics. His research field is in the building of learning management systems such as Sakai, Moodle, Blackboard, ANGEL, and others. He was the chief architect for the Sakai Project, a learning management system used at about 300 schools worldwide and wrote the book Sakai: Free as in Freedom, that describes his experiences as one of the leaders of the project. In the mid-1990s he was the host of Internet : TCI, a national television talk show about the Internet that ran for several years on the TCI cable system. He was long-time a columnist for the IEEE Computer Magazine writing a monthly column called "Computing Conversations" that features video interviews with famous technology leaders and innovators.

1.1.3. Course objectives

To learn the following aspects of python:

- Using variables in programs
- Conditional execution (if statements)
- Repeated execution / looping (for statements)
- Functions and code reuse
- How to open a file and read data from a file
- How to create a list in Python
- How to create a dictionary
- Sorting data
- How to use the tuple structure in Python

1.1.4.Features

- The various exercises and quizzes designed to test our knowledge and understanding. This concept helps us to grasp this new language faster and more easily.
- The instructor gives clear and easy instructions.
- The certification keeps us motivated to complete the course.
- The peer grading system allows us to get reviews from others.
- The course is self - paced and easy to follow.

1.1.5.Skills

- Python programming
- Python syntax and semantics
- Basic programming language
- Computer programming
- Data structures
- Tuples

1.2. Getting started with Python

Python is a high level, general purpose programming language .

To download the latest, stable version of python go to : <https://www.python.org/downloads/> .

The project is made using python 3.8.3 released on may, 2020.

1.2.1. coding interfaces

Python has three inbuilt ways of executing the code:

- **Python Terminal :** you can write commands or run the python files directly through the python terminal

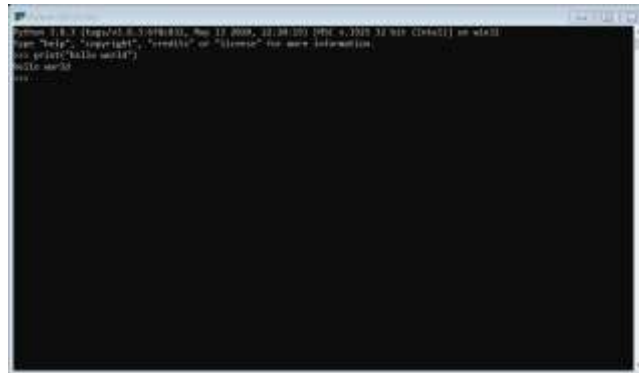


Figure 1

- **Python IDLE:** python comes with a pre-installed IDLE where you can write the program



Figure 2

- **Command prompt :** you can run python files and access python shell through command prompt .

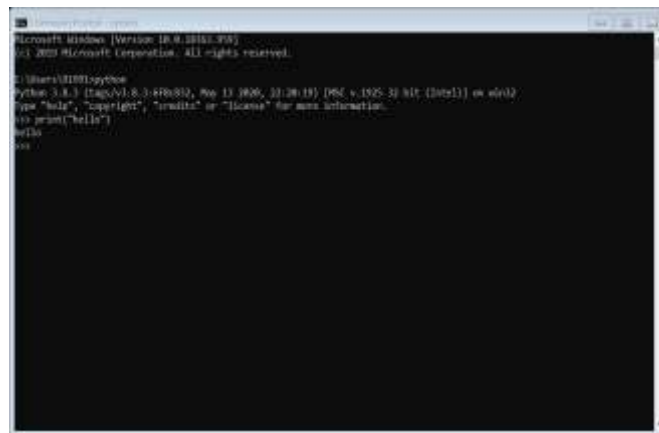


Figure 3

1.3. Using visual studio code

Visual Studio Code is a code editor redefined and optimized for building and debugging modern web and cloud applications.

To download latest version of visual studio code go to :

<https://code.visualstudio.com/Download>.

1.3.1. Features

IntelliSense: IntelliSense provides smart completions based on variable types, function definitions, and imported modules.

Run and Debug : Debug code right from the editor. Launch or attach to you running apps and debug with break points, call stack ,and an interactive console.

Git command Built -in :Work with Git and other SCM providers. Review diffs, stage files, and make commits right from the editor. Push and pull from any hosted SCM service.

Extensible and Customizable: Install extensions to add new languages, themes ,debugger and to connect to additional services. Extensions run in separate processes and does not slow down the editor.

Easy deploy :With Microsoft Azure you can deploy and host your Python sites, store and query relational and document based data, and scale with serverless computing, all with ease, all from within VS Code.

1.3.2. Working with VS Code

Launch visual studio code , it will reload the last opened projects itself and to create open a new file, click on file > new file. You can open new window by clicking on file > new window. You can open the power shell by clicking on terminal>open new terminal.

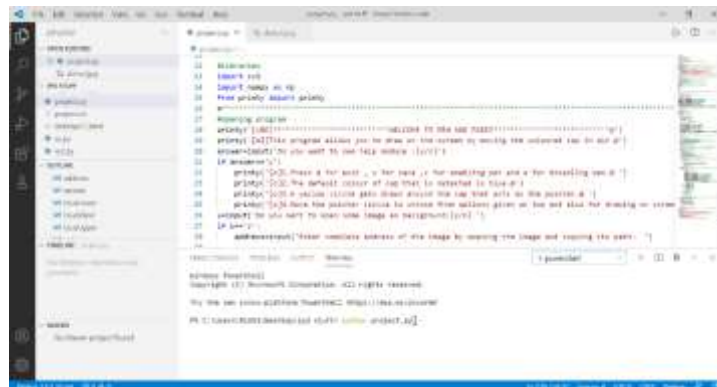


Figure 4

CHAPTER 2: programming for everybody

2.1. Computer Programming

Computer programming is the process of designing and building an executable computer program in languages like python in order to perform a specific task .

1.2.1. The building blocks of a program

- **Input** : Get data from the “outside world”. It includes taking data from the user, reading data from a file, or even some kind of sensor like a microphone or GPS.
- **Output** :Display the results of the program on a screen or store them in a file or perhaps write them to a device like a speaker to play music or speak text.
- **Sequential execution** : Perform statements one after another in the order they are encountered in the script.
- **Conditional execution**: Check for certain conditions and then execute or skip a sequence of statements.
- **Repeated execution** :Perform some set of statements repeatedly, usually with some variation. **Reuse**: Write a set of instructions once and give them a name and then reuse those instructions as needed throughout your program.

1.2.2. Interpreter and Compiler

A **compiler** is a computer program that transforms code written in a high-level programming language into the machine code. It is a program which translates the human-readable code to a language a computer processor understands (binary 1 and 0 bits). The computer processes the machine code to perform the corresponding tasks. A compiler should comply with the syntax rule of that programming language in which it is written. However, the compiler is only a program and cannot fix errors found in that program. So, if you make a mistake, you need to make changes in the syntax of your program.

An **interpreter** is a computer program, which coverts each high-level program statement into the machine code. This includes source code, pre-compiled code, and scripts. Both compiler and interpreters do the same job which is converting higher level programming language to

machine code. However, a compiler will convert the code into machine code (create an exe) before program run. Interpreters convert code into machine code when the program is run.

1.2.3. General errors while programming

- **Syntax errors** :These are the first errors you will make and the easiest to fix. A syntax error means that you have violated the “grammar” rules of the language. Programming languages have a specific syntax that needs to be followed. This sort of errors should be fixed in order for program to compile.
- **Logic errors** :A logic error is when your program has good syntax but there is a mistake in the order of the statements or perhaps a mistake in how the statements relate to one another .
- **Semantic errors**: A semantic error is when your description of the steps to take is syntactically perfect and in the right order, but there is simply a mistake in the program. The program is perfectly correct but it does not do what you intended for it to do.

1.2.4. Debugging

Debugging comes to use when the program encounters error or even when it gives you a result that is different from what you had intended. Debugging is the process of finding the cause of the error in your code. When you are debugging a program, and especially if you are working on a hard bug, there are four things to try: reading Examine your code, read it back to yourself, and check that it says what you meant to say. running Experiment by making changes and running different versions. You need to identify the type of error either based on error messages shown by compiler or by reading through the code . At some point, the best thing to do is back off, undoing recent changes, until you get back to a program that works and that you understand. Then you can start rebuilding

2.1. Introduction to python

Python is an interpreted, general purpose ,high level programming language created by Guido van Rossum and first released in 1991. Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.

Python Programming language uses a simple object-oriented programming approach and very efficient high-level data structures. It also uses very simple and concise syntax and dynamic typing.

One of the key benefits of Python Programming is its interpretive nature. The Python interpreter and standard library are available in binary or source form from the Python website, and can run seamlessly on all major operating systems. Python Programming language is also freely-distributable, and the same site even has tips and other third-party tools, programs, modules and more documentation.

This language is easy to learn since it uses English keywords rather than punctuation, and it has fewer syntax constructions than other programming languages.

2.2. History

- Python laid its foundation in the late 1980s.
- The implementation of Python was started in December 1989 by **Guido Van Rossum** at CWI in Netherland.
- In February 1991, **Guido Van Rossum** published the code (labelled version 0.9.0) to alt.sources.
- In 1994, Python 1.0 was released with new features like lambda, map, filter, and reduce.
- Python 2.0 added new features such as list comprehensions, garbage collection systems.
- On December 3, 2008, Python 3.0 (also called "Py3K") was released. It was designed to rectify the fundamental flaw of the language.
- ABC programming language is said to be the predecessor of Python language, which was capable of Exception Handling and interfacing with the Amoeba Operating System.
- The following programming languages influence Python:
 - ABC language.
 - Modula-3

2.3. Features of Python

Python provides many useful features which make it popular and valuable from the other programming languages. It supports object-oriented programming, procedural programming

approaches and provides dynamic memory allocation. We have listed below a few essential features.

1) Easy to Learn and Use

Python is easy to learn as compared to other programming languages. Its syntax is straightforward and much the same as the English language. There is no use of the semicolon or curly-bracket, the indentation defines the code block. It is the recommended programming language for beginners.

2) Expressive Language

Python can perform complex tasks using a few lines of code. A simple example, the hello world program you simply type `print("Hello World")`. It will take only one line to execute, while Java or C takes multiple lines.

3) Interpreted Language

Python is an interpreted language; it means the Python program is executed one line at a time. The advantage of being interpreted language, it makes debugging easy and portable.

4) Cross-platform Language

Python can run equally on different platforms such as Windows, Linux, UNIX, and Macintosh, etc. So, we can say that Python is a portable language. It enables programmers to develop the software for several competing platforms by writing a program only once.

5) Free and Open Source

Python is freely available for everyone. It is freely available on its official website www.python.org. It has a large community across the world that is dedicatedly working towards make new python modules and functions. Anyone can contribute to the Python community. The open-source means, "Anyone can download its source code without paying any penny."

6) Object-Oriented Language

Python supports object-oriented language and concepts of classes and objects come into existence. It supports inheritance, polymorphism, and encapsulation, etc. The object-oriented procedure helps to programmer to write reusable code and develop applications in less code.

7) Extensible

It implies that other languages such as C/C++ can be used to compile the code and thus it can be used further in our Python code. It converts the program into byte code, and any platform can use that byte code.

8) Large Standard Library

It provides a vast range of libraries for the various fields such as machine learning, web developer, and also for the scripting. There are various machine learning libraries, such as Tensor flow, Pandas, Numpy, Keras, and Pytorch, etc. Django, flask, pyramids are the popular framework for Python web development.

9) GUI Programming Support

Graphical User Interface is used for the developing Desktop application. PyQt5, Tkinter, Kivy are the libraries which are used for developing the web application.

10) Integrated

It can be easily integrated with languages like C, C++, and JAVA, etc. Python runs code line by line like C, C++ Java. It makes easy to debug the code.

11. Embeddable

The code of the other programming language can use in the Python source code. We can use Python source code in another programming language as well. It can embed other language into our code.

12. Dynamic Memory Allocation

In Python, we don't need to specify the data-type of the variable. When we assign some value to the variable, it automatically allocates the memory to the variable at run time. Suppose we are assigned integer value 15 to **x**, then we don't need to write **int x = 15**. Just write **x = 15**.

2.4. Applications

1) Web Applications

We can use Python to develop web applications. It provides libraries to handle internet protocols such as HTML and XML, JSON, Email processing, request, BeautifulSoup, Feedparser, etc. One of Python web-framework named Django is used on Instagram. Python provides many useful frameworks, and these are given below:

- Django and Pyramid framework(Use for heavy applications)
- Flask and Bottle (Micro-framework)
- Plone and Django CMS (Advance Content management)

2) Desktop GUI Applications

The GUI stands for the Graphical User Interface, which provides a smooth interaction to any application. Python provides a Tk GUI library to develop a user interface. Some popular GUI libraries are given below.

- Tkinter or Tk

- wxWidgetM
- Kivy (used for writing multitouch applications)
- PyQt or Pyside

3) **Console-based Application**

Console-based applications run from the command-line or shell. These applications are computer programs which are used to execute commands. This kind of application was more popular in the old generation of computers. Python can develop this kind of application very effectively. It is famous for having REPL, which means the Read-Eval-Print Loop that makes it the most suitable language for the command-line applications.

Python provides many free libraries or modules which help to build the command-line apps. The necessary IO libraries are used to read and write. It helps to parse arguments and create console help text out-of-the-box. There are also advanced libraries that can develop independent console apps.

4) **Software Development**

Python is useful for the software development process. It works as a support language and can be used to build control and management, testing, etc.

5) **Scientific and Numeric**

This is the era of Artificial intelligence where the machine can perform the task the same as the human. Python language is the most suitable language for Artificial intelligence or machine learning. It consists of many scientific and mathematical libraries, which makes it easy to solve complex calculations.

Implementing machine learning algorithms requires complex mathematical calculation. Python has many libraries for scientific and numeric such as Numpy, Pandas, Scipy, Scikit-learn, etc. If you have some basic knowledge of Python, you need to import libraries on the top of the code. Few popular frameworks of machine libraries are given below.

- SciPy
- Scikit-learn
- NumPy
- Pandas
- Matplotlib

6) **Business Applications**

Business Applications differ from standard applications. E-commerce and ERP are an example of a business application. This kind of application requires extensively, scalability and readability, and Python provides all these features.

Oddo is an example of the all-in-one Python-based application which offers a range of business applications. Python provides a Tryton platform which is used to develop the business application.

7) Audio or Video-based Applications

Python is flexible to perform multiple tasks and can be used to create multimedia applications. Some multimedia applications which are made by using Python are TimPlayer, cplay, etc. The few multimedia libraries are given below.

- Gstreamer
- Pyglet
- QT Phonon

8) 3D CAD Applications

The CAD (Computer-aided design) is used to design engineering related architecture. It is used to develop the 3D representation of a part of a system. Python can create a 3D CAD application by using the following functionalities.

- Fandango (Popular)
- CAMVOX
- HeeksCNC
- AnyCAD
- RCAM

9) Enterprise Applications

Python can be used to create applications that can be used within an Enterprise or an Organization. Some real-time applications are OpenERP, Tryton, Picalo, etc.

10) Image Processing Application

Python contains many libraries that are used to work with the image. The image can be manipulated according to our requirements. Some libraries of image processing are given below.

- OpenCV
- Pillow
- SimpleITK

In this topic, we have described all types of applications where Python plays an essential role in the development of these applications. In the next tutorial, we will learn more concepts about Python.

2.5. Python Basics

2.2.1. Variables

Python variables do not need explicit declaration to reserve memory space. The declaration happens automatically when you assign a value to a variable. The equal sign (=) is used to assign values to variables.

2.2.2. Data Types

Python has five standard data types –

- **Numbers** : Number data types store numeric values. Number objects are created when you assign a value to them.
- **String**: Strings in Python are identified as a contiguous set of characters represented in the quotation marks. Python allows for either pairs of single or double quotes. Subsets of strings can be taken using the slice operator ([] and [:]) with indexes starting at 0 in the beginning of the string and working their way from -1 at the end.

```
# Creating a String
String1 = 'Welcome to the Geeks World'
print("String with the use of Single Quotes: ")
print(String1)
```

- **List**: Lists are the most versatile of Python's compound data types. A list contains items separated by commas and enclosed within square brackets ([]). To some extent, lists are similar to arrays in C. One difference between them is that all the items belonging to a list can be of different data type.

```
# Declaring a list
L = [1, "a" , "string" , 1+2]
print L
```

```
L.append(6)
print L
L.pop()
print L
print L[1]
```

- **Tuple:** A tuple consists of a number of values separated by commas. Tuples are enclosed within parentheses.

The main differences between lists and tuples are: Lists are enclosed in brackets ([]) and their elements and size can be changed, while tuples are enclosed in parentheses (()) and cannot be updated

```
tup = (1, "a", "string", 1+2)
print tup
print tup[1]
```

- **Dictionary:** Python's dictionaries are kind of hash table type. They work like associative arrays or hashes found in Perl and consist of key-value pairs. Values, on the other hand, can be any arbitrary Python object.

Dictionaries are enclosed by curly braces ({ }) and values can be assigned and accessed using square braces ([])

Creating an empty Dictionary

```
Dict = { }
print("Empty Dictionary: ")
print(Dict)
```

Creating a Dictionary

with dict() method

```
Dict = dict({1: 'Geeks', 2: 'For', 3: 'Geeks'})
print("\nDictionary with the use of dict(): ")
print(Dict)
```

Creating a Dictionary

with each item as a Pair

```
Dict = dict([(1, 'Geeks'), (2, 'For')])
```

```
print("\nDictionary with each item as a pair: ")
print(Dict)
```

2.2.4. Conditional execution

Conditional execution gives us the ability to check conditions and change the behaviour of the program accordingly. There are four type of conditional execution statement in python:

- **If :** An if statement consists of a Boolean expression followed by one or more statements.

```
if condition:
    statement1
statement2
# Here if the condition is true, if block
# will consider only statement1 to be inside its block
```

- **If-else:** An if statement can be followed by an optional else statement, which executes when the Boolean expression is FALSE

```
if (condition):
    # Executes this block if
    # condition is true
else:
    # Executes this block if
    # condition is false
```

- **Nested if :** we can use one if or else if statement inside another if or else if statement(s)

```
if (condition1):
    # Executes when condition1 is true
    if (condition2):
        # Executes when condition2 is true
    # if Block is end here
# if Block is end here
```


- **if-elif-else ladder:** a user can decide among multiple options. The if statements are executed from the top down. As soon as one of the conditions controlling the if is true, the statement associated with that if is executed, and the rest of the ladder is bypassed. If none of the conditions is true, then the final else statement will be executed.

```
if (condition):
    statement
elif (condition):
    statement
.
.
else:
    statement
```

2.2.4. Control statement

Control statements are responsible for managing the flow in which loops get executed. The order in which the specified set of statements need to be executed can be effectively governed using these control statements.

- **for :**for is used for passing through a ordered set of programming statements. the execution of the loop happens until the last necessary element is executed in the specified range or the mentioned condition is satisfied.

```
for var in iterable:
    # statements
```

- **While:** while loop is used when the well-organized set of programming statements need to be executed until the condition is satisfied. After the condition is satisfied the next statement call happens.

```
while expression:
    statement(s)
```

- **Continue :**Terminates the loop and passes the control to the statement after the loop.

```
# Prints all letters except 'e' and 's'
```

```

for letter in 'hello, see you soon':
    if letter == 'e' or letter == 's':
        continue
    print('Current Letter :', letter)
    var = 10

```

- **Break** :If a break statement is mentioned within a nested looping then the control will be pulled out of the most inner loop in the nesting.

```

for letter in 'hello ,see you soon':
    # break the loop as soon it sees 'e'
    # or 's'
    if letter == 'e' or letter == 's':
        break
    print('Current Letter :', letter)

```

2.2.5. Functions

The ‘def’ keyword is used to declare functions. Optional arguments can be set in the function declaration after mandatory arguments, by assigning them default values. In case of named arguments, the argument name is assigned a value. Functions can return a tuple. Parameters are passed through reference, but tuples, int, strings and other immutable types are unchangeable because only the memory location of the item is passed. Binding another object to the variable removed the older one and replaces immutable types

```

# A simple Python function to check
# whether x is even or odd
def evenOdd( x ):
    if (x % 2 == 0):
        print "even"
    else:
        print "odd"
# Driver code
evenOdd(2)
evenOdd(3)

```

2.2.5. File Handling

Python too supports file handling and allows users to handle files i.e., to read and write files, along with many other file handling options, to operate on files. Each file ends with an EOF indicator to tell the interpreter that the file has ended. There are four features of File handling in Python:

- Open

There are four different types of opening modes,

- “r” READ: READ mode has a default value. Opens a file for any errors in the file does not exist.
- “a” APPEND: APPEND mode opens a file for appending, creates the file if it does not exist.
- “w” WRITE: WRITE mode opens a file for writing, creates the file if it does not exist.
- “x” CREATE: CREATE mode creates the specified file returns an error if the file with the same name exists

```
# file opening example in Python
```

```
f = open("filename", "mode")
```

- Read

```
# read the entire file as one string
```

```
with open('filename.txt') as f:
```

```
data = f.read()
```

- Write/Create

Writing and creating this mode used when we would like to add to the file or create a new file. To write to an existing file, you must add a parameter to the open() function.

- a-Append: will append to the end of the file.
- w-Write: will overwrite any existing content

```
# Write text data to a file
```

```
f.write('hi there, this is a first line of file.\n')
```

```
f.write('and another line.\n')
```

- Delete

When we want to import an OS module we have to delete the file. Before deleting a file we must have to close that file. For closing a file we should use the close() function.

```
f.close();
```

File processing takes place in the following order :

- Open a file that returns a file handle:
- Use the handle to perform read or write action.
- Close the file handle .

2.6. Glossary

Complete glossary for python 3.8.3 can be referred here:

<https://docs.python.org/release/3.8.3/glossary.html>

2.7. Conclusion

Both these courses were helpful in further exploration of python and python libraries .

Python is an easy to learn ,high level language with vast application with help of different libraries.

The python code is easy to read and understand even for people with no programming background .

The python data structures allows us to easily sort and retrieve our data. It is known for solving histogram related problems.

Python files help us to get data from computer memory and store data to it.

CHAPTER 3: Project - PEN AND PAINT

3.1. Introduction

The aim of the project is to build a program that enables user to write on the screen with moving a blue pen cap in air. The program is unique ,easy to read and fast.it has an easy to understand interface.

It uses computer vision to track the position of blue colour cap and draw according to it. It has various different options which make it unique and attractive. It is fun to use and has no additional costs unlike other writing options like stylus pens that need both money and additional resources.

This program is targeted for all age groups .

this program will provide a fun experience for kids ,and easy experience for adults who just want to paint rather than learn complex painting software or by expensive equipment.

Even for the beginner artists ,its is an free of cost solution that will help then practice drawing without worrying about committing mistakes and ruining resources and will help them to save their achievements in desired picture format to share with friends and family afterword

3.2. Project Analysis

3.2.1. Existing Systems

The traditional paint on laptop can be used with the help of mouse but it does not uses any sorts of computer vision techniques .

One can buy paints and canvases from market but at times it is not possible to go to the market or to spend money buying stuff again and again.

Even though you many find some OpenCV code snippets that will help you with object identification but there is not particular program the has so many features combined together and in ready to use format. They all need some sort of knowledge of OpenCV and a programming background to use them .they use multiple libraries to only achieve a simple feature which makes them undesirable as compared to pen and paint .

3.2.2. Proposed system

‘Pen and Paint’ is a multi-featured program that allows user to not only draw but save erase and clear image as well .

Scope of the project :

- To allow user to write with blue colour cap without actually touching mouse or screen.
- To allow user to choose between screens
- To allow user to work on a paint like interface which gives them a nostalgic yet a blissful feeling.
- To be able to save the work in desired picture format.

3.2.3. Competitive Edge

The three main reasons which make 'pen and paint' unique and a strong competition are:

- **Multiple features** :it has many features integrated into a single program while preserving the traditional, easy going of the computer paint and also giving the taste of the high cost touchless solutions like stylus and touchpad laptops.
- **No additional expenditure**: the program does not have any additional requirements and libraries and software used in making of the program is available for free anywhere on the internet.
- **Easy to understand and use** : both the code and program interface is made in such a way that it keeps the program complexities to minimum .
 - The code is written while keeping the non -programming users in mind .
 - Proper commenting is done at every point in the code so that on giving a single glance you can understand what is going on in the program.
 - There is an option available at time of running the program that allows you to see the program instructions.
 - The instructions are simple and easy to follow.

3.2.4. GAP Analysis

- The program is at a basic stage where user needs to physically download python and its libraries on the computer : the users who have a very limited knowledge of internet and small children can find it difficult and tiresome to go download python correctly
- It has a limited colour palate as compared to computer paint which has a huge variety of colour options.:

If we look at the variety of colours available in the market and on the online painting applications that work with help of mouse . the more matured users would want a wider selection range so they can take their work to next level.

- The program is still vulnerable to the user input , wrong input can lead to abrupt termination of the program : it does not have a feature to detect errors made by user in pressing the key and will close the program if such situation arises
- Even though the program works on contour detection and blue colour is hardest to detect the program can cause errors if you are sitting in a blue background:

3.3. Features and Functions

PEN AND PAINT has following features that make it unique and different :

- **A colourful terminal interface:** the printy library is used to add life to the usual plane and boring white and black terminal by adding colours to the print statements .
- **Option to open image as background :** You can choose to open any image lying on your computer by giving its path to the program and draw upon it.
- **A white background :** the default background if you choose not to open the image is white.
- **Four different colours:** you can switch between four different colours (red, blue, green and yellow) while working on the program as per your convenience.
- **An eraser :** There is an eraser present just like in traditional paint app ,so you do not need to worry about making mistakes.
- **Save paint window:** you save your paint window at any point of time by pressing s key and then specifying the name of that you want to save the image with. Thus it allows you to save that image in png, jpg formats.
- **Three different brush sizes :** you can change your brush width from between three different sizes anytime in the program .this allows you to change both the size of your eraser and that of your paint.
- **Option to turn pen on and off by a simple key press :** you can turn on the pen by pressing ‘c’ and turn it off by pressing ‘w’. This allows you add space between to lines and also allows you to leave your program unattended while you go to get yourself a glass of water.

3.4. Python libraries

3.4.1 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.

Features:

- Open-source
- Fast speed
- Easy to integrate
- Ease of coding
- Fast prototyping

For this project OpenCV is used along with python language.

To install through pip :

```
pip install opencv-python
```

or

```
pip install opencv-contrib-python
```

Once you install opencv you get numpy automatically installed to be used within your code .

To import opencv :

```
import cv2
```

Official website: <https://opencv.org/>

OpenCV 4.4.0 has been used at the time of writing the code.

3.4.2. NumPy

NumPy is a Python package. It stands for 'Numerical Python'. It is a library consisting of multidimensional array objects and a collection of routines for processing of array.

Features :

- It is fast and versatile.
- Using NumPy, a developer can perform the following operations –
 1. Mathematical and logical operations on arrays.
 2. Fourier transforms and routines for shape manipulation.
 3. Operations related to linear algebra. NumPy has in-built functions for linear algebra and random number generation.

- NumPy supports a wide range of hardware and computing platforms, and plays well with distributed, GPU, and sparse array libraries.
- The core of NumPy is well-optimized C code.
- We can enjoy the flexibility of Python with the speed of compiled code.
- NumPy's high level syntax makes it accessible and productive for programmers from any background or experience level.
- Distributed under a liberal BSD license, NumPy is developed and maintained publicly on GitHub by a vibrant, responsive, and diverse community.

To import NumPy :

```
import numpy as np
```

To read complete documentation on NumPy : <https://numpy.org/doc/stable/>

NumPy 1.19.0 has been used at the time of writing the code.

3.4.3. Printy

Printy is a light and cross-platform library that extends the functionalities of the built-in functions `print()` and `input()`. It is very simple and easy to use and lets us colorize and apply some standard formats to the text with an intuitive and friendly API based on flags.

Printy works on python 3.5 and above .

To install printy via pip go to cmd prompt and type :

```
pip install printy
```

Once installed we need to import the library :

```
from printy import printy
```

To read the complete documentation on printy : <https://pypi.org/project/printy/>

Printy version 2.1.1. has been used at time of writing the code.

3.5. Methodology

3.5.1. Program design

- The terminal :it appears when you double click the .exe file. On this screen you get the various options like printing instructions and choosing paint window background. All the options that require keyboard input appear on this terminal.
- The webcam frame :the web cam frame records the video and analysis it frame by frame .from here we detect the blue object by performing set of operations on every frame

captured. A mask is created for this window which overlays on it .this mask is created so that we can see pen and eraser working on the webcam frame as well.

- The paint window :it is a separate window that mirrors the drawing that occurs due to movement of the blue cap .It can be considered as our final output screen that we can save at any point of the program .it does not play any role in object detection.

3.5.2. Working

- The first part of the code is the print statements .this code gets displayed on terminal window. To add colour to these statements , printy () is used

```
printy("[o]hello@")
```

#prints the hello on screen in orange colour.

There are two questions asked before it opens the webcam frame and paint window .

The first question is that whether or not we want to see the help module and the second asks which kind of paint screen to open.

If we choose to open the image we need to specify the complete address of the image .

- The second step occurs when the web cam frame and paint window is opened.
Both the screens are designed with the help of opencv functions.

```
cv2.VideoCapture(0) #this statements start the web camera .
```

- The video through webcam is accepted frame by frame .every time a frame is captured we follow same step of code using while loop.
- Detect and track the colored object with contour detection.

We create a mask called bluemark by performing morphological operations like erosion and dilation to remove noise .then using contour detection we detect the blue coloured object and then draw a rectangle around it.

```
x2,y2,w,h =cv2.boundingRect(cnt)
```

- Find the object's x,y location coordinates to draw on the screen.

We use x,y location returned from function from a previous frame (F-1) and connect it with x,y coordinates of the object in the new frame (F). By connecting those two points we draw a line and we do that for each frame in the webcam feed, this way we'll see a real-time drawing with the pen.

We draw on a black canvas and then merge that canvas with the frame. This is because we are getting a new frame on every iteration so we can't draw on the actual frame.

- Adding features :
 - The BGR values of the colours are stored inside list of tuple . whenever user hovers over the colour on the webcam frame ,the program captures the coordinates of the object and draws a circle around it. If the circle lies in between a specific range the the color index is increased .according to the colour index the tuple BGR values are selected and the pen changes colour.
 - For eraser the colour of pen is white. On the web cam frame the colour of eraser is black to nullify the effect of drawing over the mask.
 - For clean all the canvas and paintwaindow is establishes again .the whole process occurs fastly so you are not able to see the transition.
 - The brush sizes are basically the size of line we are drawing .by altering between different cv2.line()statements we can draw with different width.
- Saving the image :cv2.imwrite () function is used to save the image screen at users convince .file name is entered in the terminal

```
cv2.imread(filename,paintWindow)
```

- Quit :when we press 'q' the program terminates by destroying all windows and the control is given back to the terminal.

3.6. Results

3.6.1. Welcome

```
*****WELCOME TO PEN AND PAINT*****
This program allows you to draw on the screen by moving the coloured cap in air.
Do you want to see help module :[y/n]y
1.Press q for exit , s for save ,c for enabling pen and w for disabling pen.
2.The default colour of cap that is detected is blue.
3.A yellow circle gets drawn around the cap that acts as the pointer.
4.Move the pointer circle to choose from options given on top and also for drawing on screen.
5.To save paint window you need to specify the complete filename \(\eg:image.jpg\) in terminal.
Do you want to open some image as background:[y/n]
```

Figure 5

3.6.2. Web cam frame

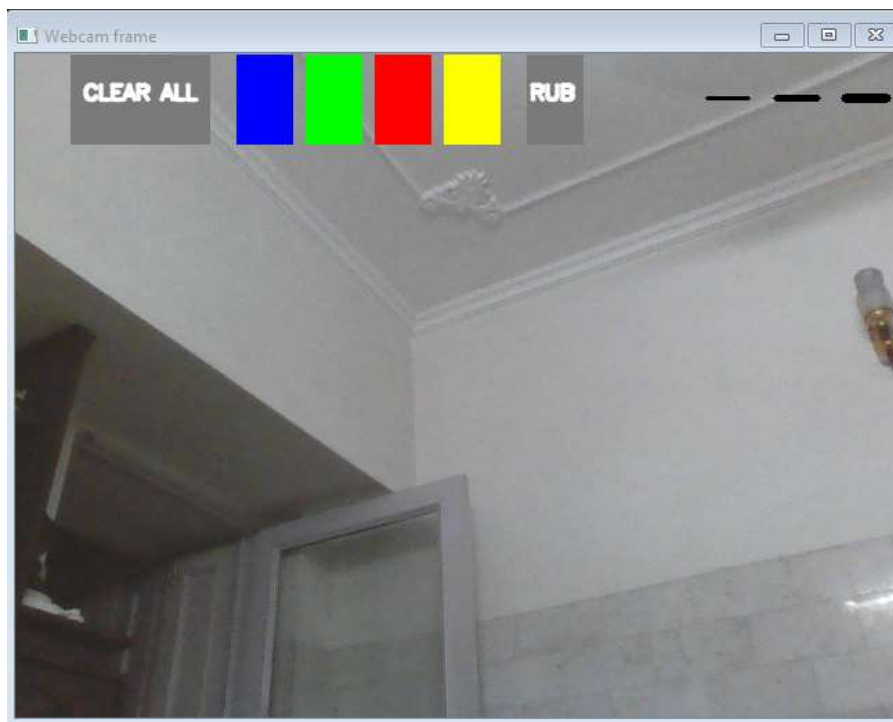


Figure 6

3.6.3. Paint window

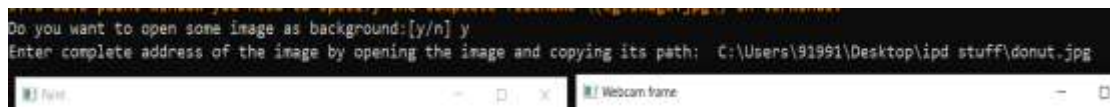


Figure 7

Entering the image path

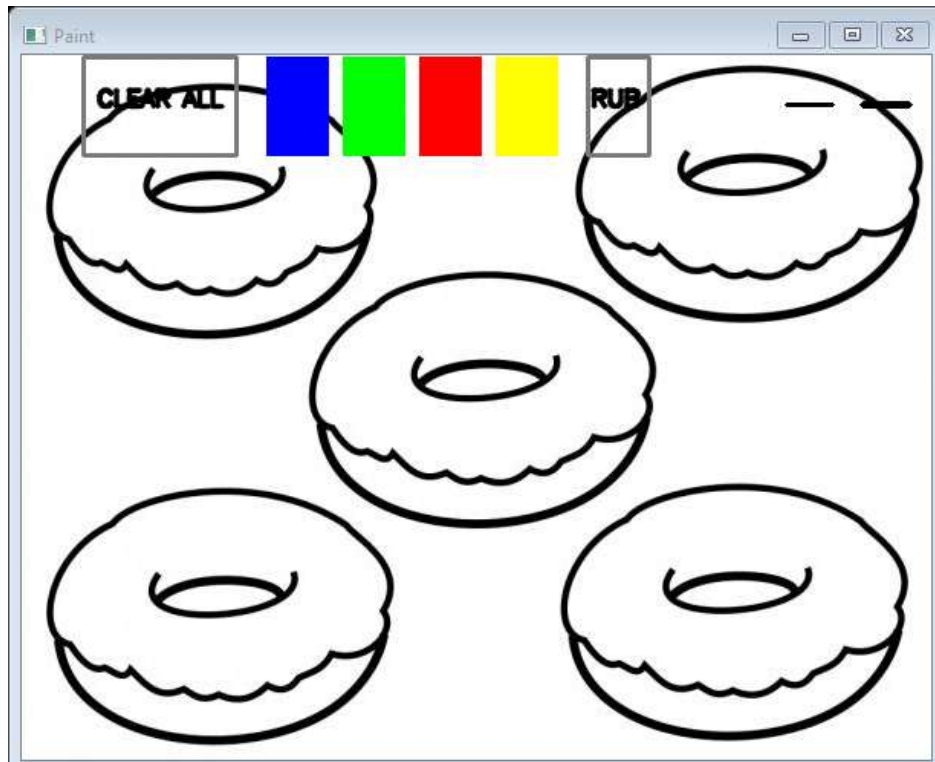


Figure 8

Image as background

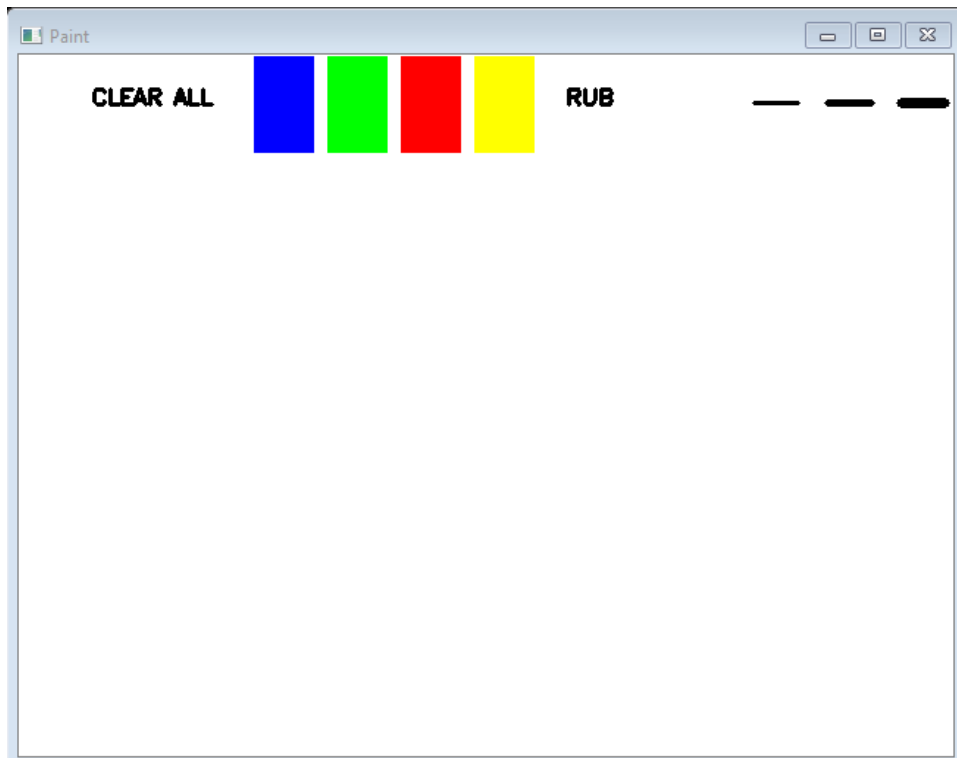


Figure 9

Default window

3.6.4. Draw and save image

```

C:\Windows\system32\cmd.exe
*****WELCOME TO PEN AND PAINT*****
This program allows you to draw on the screen by saving the coloured cap in air.
Do you want to see help module :[y/n]y
1.Press q for exit , s for save ,c for enabling pen and w for disabling pen.
2.The default colour of cap that is detected is blue.
3.A yellow circle gets drawn around the cap that acts as the pointer.
4.Move the pointer circle to choose from options given on top and also for drawing on screen.
5.To save paint window you need to specify the complete filename \eg:image.jpg\ in terminal.
Do you want to open some image as background:[y/n] n
enter the file name:paint.jpg
[ WARN:1] global C:\projects\opencv-python\opencv\modules\videoio\src\cap_mmf.cpp (436) 'anonymous-namespace':::SourceRead
ync callback
Thank you for using this program.I hope you had a wonderful experience.
For more details enter 'y'else press any key to end the program: y
This program is made as a part of IPD Training by :
Kriti Aggarwal
CSE, 1 st year
Chandigarh College of Engineering & Technology
Date of submission:02-08-2020
Contact details :
email:co19335@ccet.ac.in
linkden:https://www.linkedin.com/in/kriti-aggarwal-b572721a2

```

Figure 10

Terminal



Figure 11

Saved image

References:

- <https://www.coursera.org/specializations/python>
- <https://www.py4e.com/html3/01-intro>
- <https://www.python.org/downloads/windows>
- <https://code.visualstudio.com/docs/?dv=win>
- <https://pypi.org/project/printy/>
- <https://docs.python.org/release/3.8.3/glossary.html>
- <https://opencv.org/>
- <https://numpy.org/doc/stable/>