**SONOPANT DANDEKAR SHIKSHAN MANDALI’S**

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A

Project Report On

**VIRTUAL CALCULATOR USING OPENCV & PYTHON**

SUBMITTED BY

**Mr. KARTIK POOJARI**

**66033**

UNDER THE GUIDANCE OF

**Dr. YUGHANDHARA MORE.**

THIRD YEAR BACHELOR OF SCIENCE

IN

COMPUTER SCIENCE

SEMESTER-VI

**MUMBAI UNIVERSITY**

**2021-2022**

**SONOPANT DANDEKAR SHIKSHAN MANDALI’S**



**SONOPANT DANDEKAR ARTS, V.S. APTE COMMERCE**

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**CERTIFICATE**

This is to certify that **KARTIK POOJARI** is a student studying in TY.BSC.CS SEM VI. He has completed project work entitled **VIRTUAL CALCULATOR USING OPENCV & PYTHON** under the guidance of Faculty Member **Dr. YUGHANDHARA MORE** satisfactorily and has submitted to the University ofMumbai in partial fulfilment of the requirement during the academic year 2021- 2022. The matter presented in the project report has not been submitted earlier.

**College Stamp**

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**H.O.D Project Guide External**



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Words 3006 Date March 25, 2022

Characters 16,669 Excluded URL

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# ACKNOWLEDGEMENT

The gratification and joy that accompanies the successful completion of any task would be incomplete without the humble and deep-felt expression of gratitude to everyone who has made it possible.

I would like to extend my heartfelt gratitude to **Asst Prof. RASHMI VARADE** who gave me an opportunity to work under her guidance in this department.

Further would like to place on record my grateful thanks to friends and family who spent their valuable time in guiding me in this project, whose cooperation and encouragement, has immensely helped in the completion of the project.

I also would like to convey my sincere thanks to **Dr. YUGHANDHARA MORE** my internal project guide, who has been a constant source of motivation and inspiration and has helped in bring out the best in me. I am also thankful to all staff members of computer science department who as a team have contributed in the successful completion of this project.

Place: Palghar Date:

**Kartik Poojari**

# REQUIREMENT

1. Hardware requirement:
   * Laptop(8GB RAM)
   * i3/i5 Processor
   * 256GB/1TB hard disk
   * Camera/Webcam(4-8 megapixel)

1. Software requirement:
   * Python IDLE 3.9(64 bits)
   * PyCharm Professional or Community Edition
   * Cvzone package(ver. 1.4.1)
   * Numpy (Library For Array Processing Package)
   * Mediapipe package (ver. 0.8.7)
   * Hand Detector (Library For Hand Detection)
   * Open CV (Machine Learning Software Library)  Tenser Flow

# ABSTRACT

This work was centered on the Design and implementation of a Virtual calculator for education organization. The study traced calculator system as a tool to completely change mathematical knowledge and sophisticated problems solving strategies had advanced the field of simulated engine in mathematic.

This project work also focused principally on numbers and arithmetic operation. This researcher investigated the manual system in detail with a view to finding out the need to automate the system.

Interestingly, the end result of Virtual calculator system was its ability to process number, operators and provides a useful result.

Therefore, this project will help immensely in the following way. Easy calculating of tedious mathematical problems, easy to retrieval of errors and it will also be of a good assistance to any researcher on these topics.

This Virtual Calculator application is created using OpenCV module and python programming language which is an apex machine learning tool to create an application like this. Given the real time webcam data, this Virtual Calculator python application uses OpenCV library to track an object-of-interest and allows the user to Click Button by moving their hands, which makes it both awesome and challenging to get the result.

Keywords: Machine learning, OpenCV, Morphing Techniques, Human-Computer Interactions, Air Writing.

# INTRODUCTION

The Calculator was written by Rolf Howarth in early 1996.

A fully featured Virtual Calculator with proper operator precedence is implemented, including trig functions and logarithms, factorials, 12 level of parenthesis, logs to base 2 (a handy function for information entropists!), bitwise logical operators, hex, octal, binary and ASCII display.

My Virtual calculator is written in Python, and you are welcome to view the python source for personal educational purposes.

OpenCV was launched in August 1999 at the Computer Vision and Pattern Recognition conference (and so turns 17 years old at the publication of this book). Gary Bradski founded OpenCV at Intel with the intention to accelerate both the research and use of real applications of computer vision in society. OpenCV has nearly 3,000 functions, has had 14 million downloads, is trending well above 200,000 downloads per month, and is used daily in millions of cell phones, recognizing bar codes, stitching panoramas together, and improving images through computational photography.

OpenCV is at work in robotics systems—picking lettuce, recognizing items on conveyor belts, helping self-driving cars see, flying quad-rotors, doing tracking and mapping in virtual and augmented reality systems, helping unload trucks and pallets in distribution centres, and more—and is built into the Robotics Operating System (ROS).It is used in applications that promote mine safety, prevent swimming pool drownings, process Google Maps and street view imagery, and implement Google X robotics, to name a few examples.

OpenCV has been re-architected from C to modern, modular C++ compatible with STL and Boost. The library has been brought up to modern software development standards with distributed development on Git. Computer vision is an interdisciplinary scientific field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do. OpenCV is a computer vision and machine learning software library that includes many common image analysis algorithms that will help us build custom, intelligent computer vision applications. In this application frequent image feed results in video tracking of our particular object of interest. Video tracking is the process of locating a moving object (or multiple objects) over time using a camera. It has a variety of uses humancomputer interaction, security and augmented reality, traffic control, medical imaging, and video editing.

# BASIC FUNCTIONS

Addition

The addition (sum function) is used by clicking on the "+" button or using the keyboard. The function results in a+b.

Subtraction

The subtraction (minus function) is used by clicking on the "-" button or using the keyboard. The function results in a-b.

Multiplication

The multiplication (times function) is used by clicking on the "x" button or using the keyboard"\*" key. The function results in a\*b.

Division

The division (divide function) is used by clicking on the "/" button or using the keyboard "/"key. The function results in a/b.

Sign

The sign key (negative key) is used by clicking on the "(-)" button. The function results in -1\*x.

Square

The square function is used by clicking on the "x^2" button or type "^2". The function results inx\*x.

Square Root

The square root function is used by clicking on the "x" button or type "sqrt()". This function represents x^.5 where the result squared is equal to x.

Raise to the Power

The raise to the power (y raised to the x function) is used by clicking on the "y^x" button or type "^".

Natural Exponential

The natural exponential (e raised to the x) is used by clicking on the "e^x" button or type "exp()". The result is e (2.71828...) raised to x.

Logarithm

The logarithm (LOG) is used by clicking on the "LOG" button or type "LOG()".

Natural Logarithm

The Natural logarithm (LN) is used by clicking on the "LN" button or type "LN()".

Inverse

Multiplicative inverse (reciprocal function) is used by pressing the "1/x" button or typing "inv()". This function is the same as x^-1 or dividing 1 by the number.

Exponent

Numbers with exponents of 10 are displayed with an "e", for example 4.5e+100 or 4.5e-100.This function represents 10^x. Numbers are automatically displayed in the format when the number is too large or too small for the display. To enter a number in this format, use the exponent key "EEX". To do this enter the mantissa (the non-exponent part) then press "EEX" or type "e" and then enter the exponent.

Factorial

The Factorial function is used by clicking the "!" button or type "!".

PI

PI is a mathematical constant of the ratio of a circle's circumference to its diameter.

# OBJECTIVES AND FEATURES

* Move the hands toward buttons to find distance between two fingers.
* Press or Click buttons with two fingers, the hand detection module or other pointing device to evaluate the equation and display result.
* Virtual scientific calculator allows you to perform basic and complex mathematical operations such as modulus, square root, cube root, addition, subtraction, division, hyperbolic functions, etc.
* The purpose of a Virtual calculator is to do correct calculations, and to do so efficiently.
* Virtual Calculator it can reduce the problem to simpler tasks and allows the student or person to devote more time in understanding the problem.
* To clear, equation or numbers in loading calculator which user put you have to press “C” in keyboard.

**SYSTEM DESIGN**

we began with the design phase of the system. System design is a

solution, a “HOW TO” approach to the creation of a new system. It

translates system requirements into ways by which they can be made operational. It is a translational from a user-oriented document to a document-oriented programmers. For that, it provides the understanding and procedural details necessary for the implementation. Here we use Flowchart to supplement the working of the new system. The system thus made should be reliable, durable and above all should have least possible maintenance costs. It should overcome all the drawbacks of the Old existing system and most important of all meet the user requirements.

**FLOW CHART**

Diagram

Description automatically generated

**HAND RECOGNITION**

Text

Description automatically generated

In hand Recognition First I have created a Scrypt which detects and tract the hands, initially I have set the threshold to hands, but we can also edit that and increase the number of hands which has to be detected. I have also created a module for this project so that we don't have to write the whole code process again and again in other projects like “Finger-Count”.

# System Implementation (Coding)

import cv2  
from cvzone.HandTrackingModule import HandDetector  
import time  
  
class Button:  
 def \_\_init\_\_(self, pos, width, height, value):  
 self.pos = pos  
 self.width = width  
 self.height = height  
 self.value = value  
  
 def draw(self, img):  
 cv2.rectangle(img, self.pos, (self.pos[0]+self.width, self.pos[1]+self.height),  
 (225, 225, 225), cv2.FILLED)  
 cv2.rectangle(img, self.pos, (self.pos[0]+self.width, self.pos[1]+self.height),  
 (50, 50, 50), 3)  
 cv2.putText(img, self.value, (self.pos[0] + 40, self.pos[1] + 60), cv2.FONT\_HERSHEY\_PLAIN,  
 2, (50, 50, 50), 2)  
  
 def checkClick(self,x,y):  
 if self.pos[0]<x<self.pos[0] + self.width and \  
 self.pos[1] < y < self.pos[1] + self.height:  
 cv2.rectangle(img, self.pos, (self.pos[0] + self.width, self.pos[1] + self.height),  
 (255, 255, 255), cv2.FILLED)  
 cv2.rectangle(img, self.pos, (self.pos[0] + self.width, self.pos[1] + self.height),  
 (50, 50, 50), 3)  
 cv2.putText(img, self.value, (self.pos[0] + 25, self.pos[1] + 80), cv2.FONT\_HERSHEY\_PLAIN,  
 5, (0, 0, 0), 5)  
 return True  
 else:  
 return False  
  
# Webcam  
cap = cv2.VideoCapture(0)  
cap.set(3, 1280) # width  
cap.set(4, 720) # height  
detector = HandDetector(detectionCon=0.8, maxHands=1)  
  
# Creating Buttons  
buttonListValues = [['7', '8', '9', '\*'],  
 ['4', '5', '6', '-'],  
 ['1', '2', '3', '+'],  
 ['0', '/', '.', '=']]  
  
buttonList = []  
for x in range(4):  
 for y in range(4):  
 xpos = x \* 100 + 800  
 ypos = y \* 100 + 150  
 buttonList.append(Button((xpos, ypos), 100, 100, buttonListValues[y][x]))

# Variables  
myEquation = ''  
delayCounter = 0  
  
  
# Loop  
while True:  
 # Get image from webcam  
 success, img = cap.read()  
 img = cv2.flip(img, 1)  
  
 # Detection of hand  
 hands, img = detector.findHands(img, flipType=False)  
  
 # Draw all buttons  
 cv2.rectangle(img, (800,50), (800 + 400, 70 + 100),  
 (225, 225, 225), cv2.FILLED)  
 cv2.rectangle(img, (800,50), (800 + 400, 70 + 100),  
 (50, 50, 50), 3)  
 for button in buttonList:  
 button.draw(img)  
  
 # Check for Hand  
 if hands:  
 lmList = hands[0]['lmList']  
 length, \_, img = detector.findDistance(lmList[8],lmList[12],img)  
 x,y = lmList[8]  
 if length < 50:  
 for i, button in enumerate(buttonList):  
 if button.checkClick(x, y) and delayCounter ==0:  
 myValue = buttonListValues[int(i%4)][int(i/4)]  
 if myValue == "=":  
 myEquation = str(eval(myEquation))  
 else:  
 myEquation += myValue  
 delayCounter = 1  
  
 # Avoid Duplicates  
 if delayCounter != 0:  
 delayCounter += 1  
 if delayCounter > 10:  
 delayCounter = 0  
  
  
 # Display the Equation/Result  
 cv2.putText(img, myEquation, (810, 120), cv2.FONT\_HERSHEY\_PLAIN,  
 3, (50, 50, 50), 3)  
  
  
 # Display Image  
 cv2.imshow("Image", img)  
 key = cv2.waitKey(1)  
  
 if key == ord('c'):  
 myEquation = ''

# RESULT

**INPUT:**

A picture containing text

Description automatically generated

**OUTPUT:**

A person with a beard

Description automatically generated with low confidence

# CONCLUSION

Demonstration of the image processing capabilities of OpenCV. The ultimate goal is to create a computer vision machine learning application that promotes Human computer interaction (HCI) also named Man Machine Interaction (MMI)] refers to the relation between the human and the computer or more precisely the machine, and since the machine is insignificant without suitable utilize by the human there are two main characteristics should be deemed when designing a HCI system as mentioned: functionality and usability. System functionality referred to the set of functions or services that the system equips to the users while system usability

**APPLICATION**

In most countries, students use calculators for schoolwork. There was some initial resistance to the idea out of fear that basic arithmetic skills would suffer. There remains disagreement about the importance of the ability to perform calculations "in the head", with some curricula restricting calculator use until a certain level of proficiency has been obtained, while others concentrate more on teaching estimation techniques and problem-solving. Research suggests that inadequate guidance in the use of calculating tools can restrict the kind of mathematical thinking that students engage in. Others have argued that calculator use can even cause core mathematical skills to atrophy, or that such use can prevent understanding of advanced algebraic concepts.

There are other concerns - for example, that a pupil could use the calculator in the wrong fashion but believe the answer because that was the result given. Teachers try to combat this by encouraging the student to make an estimate of the result manually and ensuring it roughly agrees with the calculated result. Also, it is possible for a child to type in −1 × −1 and obtain the correct answer '1' without realizing the principle involved. In this sense, the calculator becomes a crutch rather than a learning tool, and it can slow down students in exam conditions as they check even the most trivial result on a calculator.

# FUTURE SCOPE OF THE PROJECT

Our project will be able to implement in future after making some changes and modifications as we make our project at a very low level. So, the modifications that can be done in our project are:

To make it screen touch so no need to touch key buttons as we did in this project and one more change which can we made is to add snaps of the person who use it.

Some examples that are being implemented in the near future are as follows:

Video Processing using Android Phone:

Mobile devices such as smart phones, iPads and tablet pcs are equipped with cameras, the demand of the image processing applications increased. These applications need to be faster and consumes lower power because the mobile device is only powered by a battery. The hardware technology depends on the semiconductor technology instead we can use an efficient programming language to write an image processing application for the mobile devices.

Robot Control:

Controlling the robot using gestures considered as one of the interesting applications in this field proposed a system that uses the numbering to count the five fingers for controlling a robot using hand pose signs. The orders are given to the robot to perform a particular task, where each sign has a specific meaning and represents different function.

# TESTING

Testing is the major control measure used during software development. Its basic function is to detect errors in the software. During requirement analysis and design, the output is a document that is usually textual and no executable.

After the coding phase, computer programs are available that can be executed for testing purpose. This implies that testing not only, has to uncover errors introduced during coding, but also errors introduced during previous phase. Thus, the goal of testing is to uncover the requirements, design, and coding errors in the programs. The Source code declared above for the program of Scientific Calculator has been tested and it has been found that the above source code is okay and correct. The program involves many types of conversions. These conversions has to done carefully.

# CHALLENGES

I faced one small challenge during this project that in code instead of writing def \_\_init\_\_() inside class button I wrote def \_\_int\_\_() by mistake and that take me 15-20 minutes to figure out what was wrong because of this small mistake code was not working. Also, I already work on OpenCV in my first project, So I did not faced that much problem in this project, But in my first project the very first issue I faced was of packages. First of all, I installed latest version of PyCharm and packages so nothing goes wrongs, but it was opposite, for this Hand detection module to detect hands virtually we have to use old version like cvzone package(ver. 1.4.1) and Mediapipe package(ver. 0.8.7). I used latest version package, so it was not detecting hands movements virtually. It, will take only videocapture. So, make sure before installing any packages first check his versions and do check code twice.

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