RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF DLECTRONICS & TELECOMMUNICATION ENGINEERING

Course No.: ETE 3200
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Project Report

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Vehicle Number Plate Detection and User Management System with Python

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Abstract:

The project aims at developing a secure and automated vehicle management system. Automatic License Plate Recognition system, detecting and recognizing the characters in the vehicle number plate and the classified characters are used further use in many traffic, security, access control applications. Accurate car plate recognition (ALPR) has complexity features due to diverse effects like light and speed. The more efficient technique for Vehicle Number Plate Recognition is Open Computer Vision (OpenCV). In this system OCR is performed by OpenCV. In this project Django framework is used to build a user database management system.

Object:

- To detect the number plate from vehicle
- To get the vehicle number with OCR using OpenCV
- To maintain user management database system
- To identify the vehicle and get the details about the vehicle

01. Introduction:

The vehicle Number Plate Detection and User Management System is a python based smart vehicle management system. The system consists of two section;

(i) Number Plate Recognition Using OpenCV Framework

(ii) User Management System Using Django Framework.

This is a very secured system. In this system we don't need a security grad or any man check the vehicles details every time. Here the system detects the car and identify the user automatically.

Every vehicle has standardized license plate through which all members are registered. The data about the registered members are kept in database management system. When a vehicle enters a camera captures the image of the license plate and send it to the system. Then the number on the license plate is recognized from the image and converted into text by using OpenCV framework. The number then sent to the user database system by selenium framework. Here the user databased system is made using Django framework. In user database system checks whether the number is registered or not automatically by the system. If the number is registered and matches then the system will show details about the user otherwise the system will deny the user's entry.

02. Software Tools:

(i) Environment:

- Virtual Machine Environment (VMware)
- Operating System Linux (Ubuntu 18.2)
- Python (version 3.8 /3.9)
- PyCharm IDE

(ii) Framework:

- OpenCV
- NumPy
- Django
- Selenium

03. Description of Tools:

(i) Environment:

Virtual Machine Environment (VMware):

A Virtual Machine (VM) is a compute resource that uses software instead of a physical computer to run programs and deploy apps. One or more virtual "guest" machines run on a physical "host" machine. Each virtual machine runs its own operating system and functions separately from the other VMs, even when they are all running on the same host. This means that, for example, a virtual MacOS virtual machine can run on a physical PC.

Virtual machine technology is used for many use cases across on-premises and cloud environments. More recently, public cloud services are using virtual machines to provide virtual application resources to multiple users at once, for even more cost efficient and flexible compute.

There are different kinds of virtual machines, each with different functions:

- System virtual machines (also termed full virtualization VMs) provide a substitute for a real machine. They provide functionality needed to execute entire operating systems. A hypervisor uses native execution to share and manage hardware, allowing for multiple environments which are isolated from one another, yet exist on the same physical machine. Modern hypervisors use hardware-assisted virtualization, virtualization-specific hardware, primarily from the host CPUs.

- Process virtual machines are designed to execute computer programs in a platform-independent environment.

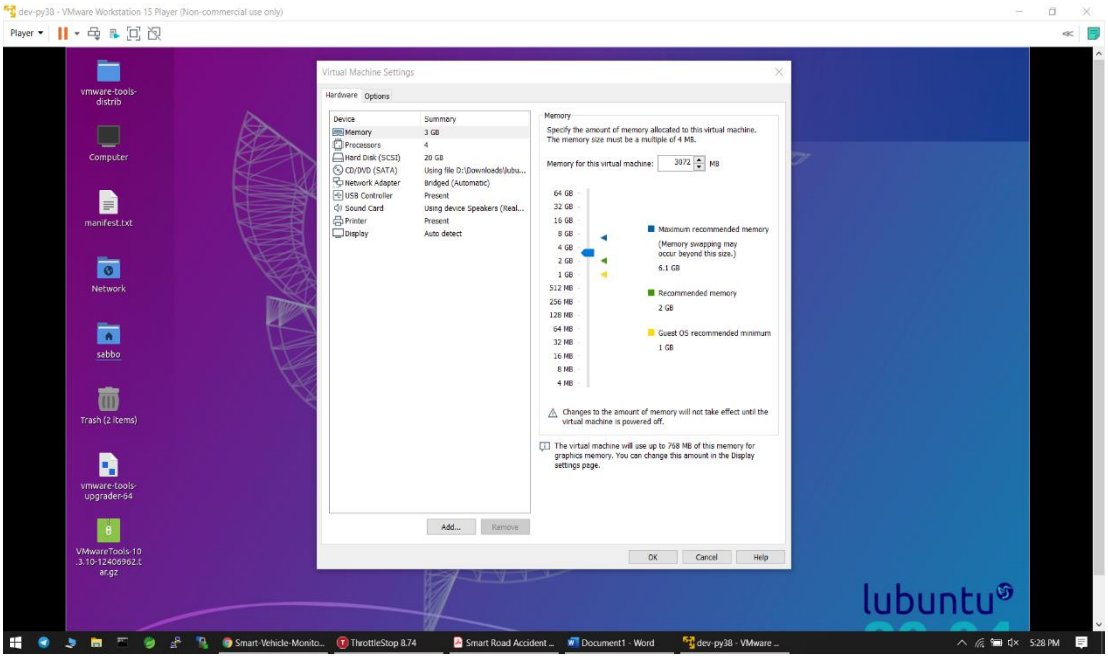


fig 01: Virtual Machine Settings

Operating system Linux (Ubuntu 18.2):

fig 02: Ubuntu 18.2

Ubuntu is a Linux distribution based on Debian and mostly composed of free and open-source software. Ubuntu is officially released in three editions: Desktop, Server, and Core for Internet of things devices and robots. All the editions can run on the computer alone, or in a virtual machine. Ubuntu is a popular operating system for cloud computing, with support for OpenStack. Ubuntu's default desktop has been GNOME, since version 17.10.

PyCharm IDE:

PyCharm is an integrated development environment (IDE) used in computer programming, specifically for the Python language. It is developed by the Czech company JetBrains. It provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems (VCSes), and supports web development with Django as well as data science with Anaconda.

fig 03: PyCharm IDE

PyCharm is cross-platform, with Windows, macOS and Linux versions. The Community Edition is released under the Apache License, and there is also Professional Edition with extra features – released under a proprietary license.

Python (version 3.8 /3.9):

Python is an interpreted, high-level and general-purpose programming language. 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.

fig 04: Python

Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly, procedural), object-oriented, and functional programming. Python is often described as a "batteries included" language due to its comprehensive standard library.

(ii) Framework:

OpenCV: OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code.

fig 05: OpenCV

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 18 million. The library is used extensively in companies, research groups and by governmental bodies.

NumPy: NumPy is the fundamental package for scientific computing in Python. It is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation and much more.

fig 06: NumPy

At the core of the NumPy package, is the ND array object. This encapsulates n-dimensional arrays of homogeneous data types, with many operations being performed in compiled code for performance. There are several important differences between NumPy arrays and the standard Python sequences:

NumPy arrays have a fixed size at creation, unlike Python lists (which can grow dynamically). Changing the size of an ND array will create a new array and delete the original.

The elements in a NumPy array are all required to be of the same data type, and thus will be the same size in memory. The exception: one can have arrays of (Python, including NumPy) objects, thereby allowing for arrays of different sized elements.

NumPy arrays facilitate advanced mathematical and other types of operations on large numbers of data. Typically, such operations are executed more efficiently and with less code than is possible using Python's built-in sequences.

A growing plethora of scientific and mathematical Python-based packages are using NumPy arrays; though these typically support Python-sequence input, they convert such input to NumPy arrays prior to processing, and they often output NumPy arrays. In other words, in order to efficiently use much (perhaps even most) of today's scientific/mathematical Python-based software, just knowing how to use Python's built-in sequence types is insufficient - one also needs to know how to use NumPy arrays.

Django: Django is a Python-based free and open-source web framework that follows the model-template-views (MTV) architectural pattern. It is maintained by the Django Software Foundation (DSF), an American independent organization established as a 501(c)(3) non-profit.

fig 07: Django

Django's primary goal is to ease the creation of complex, database-driven websites. The framework emphasizes reusability and "pluggability" of components, less code, low coupling, rapid development, and the principle of don't repeat yourself. Python is used throughout, even for settings, files, and data models. Django also provides an optional administrative create, read, update and delete interface that is generated dynamically through introspection and configured via admin models.

Selenium: Selenium is a free (open-source) automated testing framework used to validate web applications across different browsers and platforms. You can use multiple programming languages like Java, C#, Python etc. to create Selenium Test Scripts. Testing done using the Selenium tool is usually referred to as Selenium Testing.

fig 08: Selenium

Selenium Software is not just a single tool but a suite of software, each piece catering to different testing needs of an organization. Here is the list of tools,

- Selenium Integrated Development Environment (IDE)
- Selenium Remote Control (RC)
- WebDriver
- Selenium Grid

04. Block Diagram:

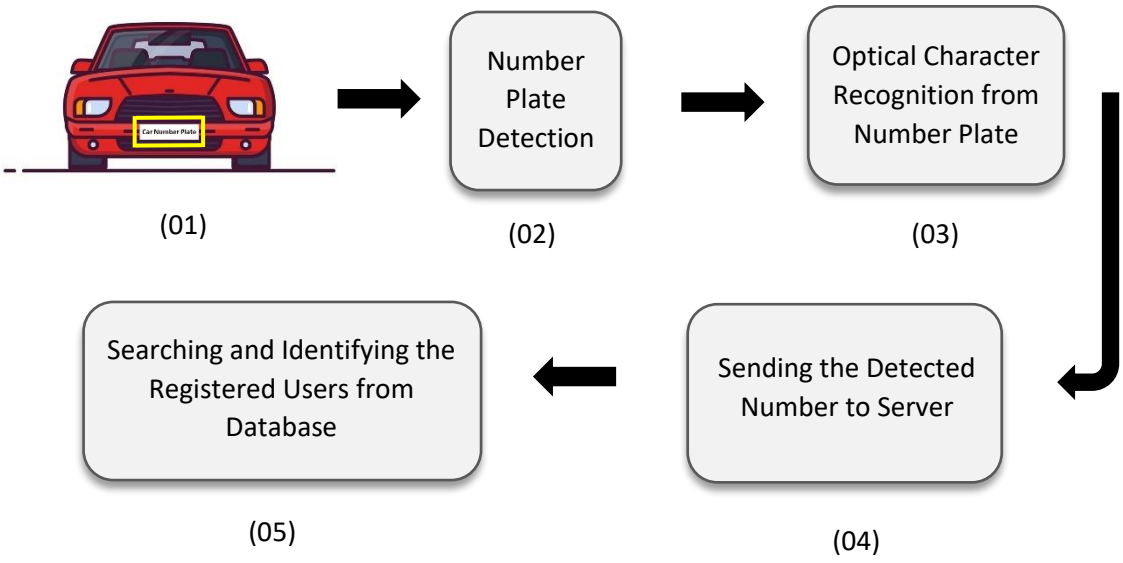


fig 09: Block Diagram

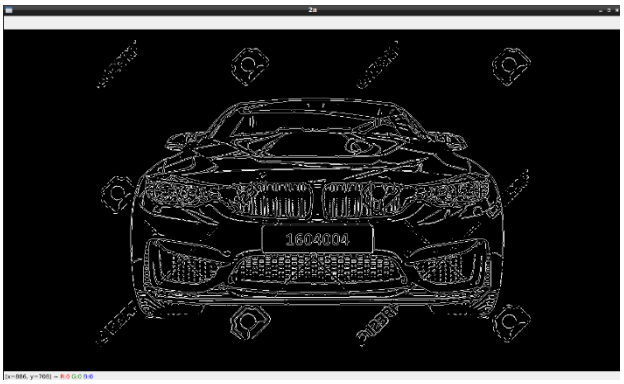
05. Working Principal:

(i) Number Plate Recognition using OpenCV:

Step (01)

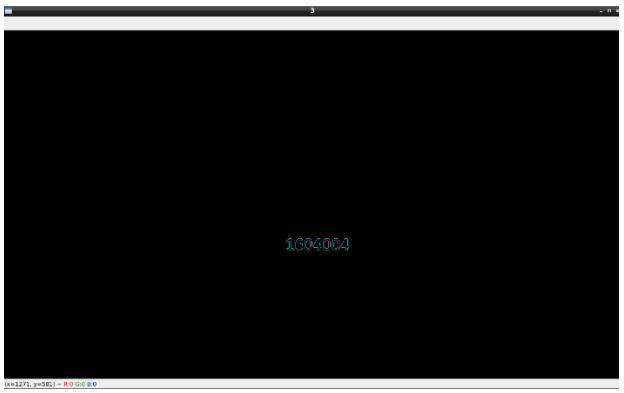
Step (02)

Step (03)

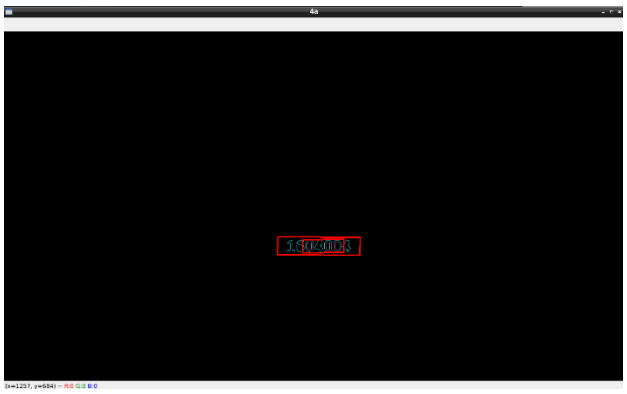


Step (04)

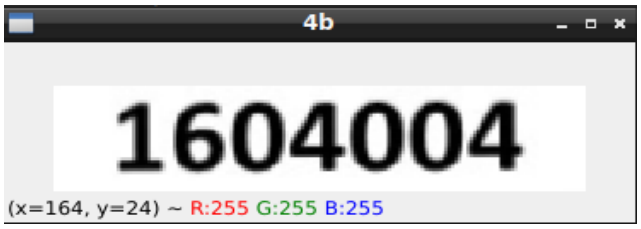
Step (05)



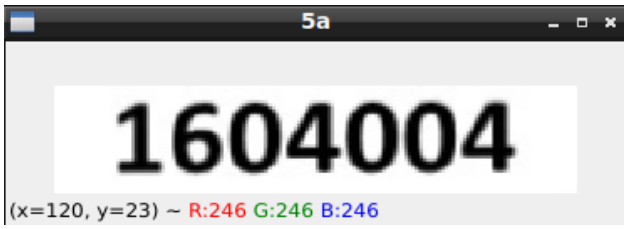
Step (06)



Step (07)

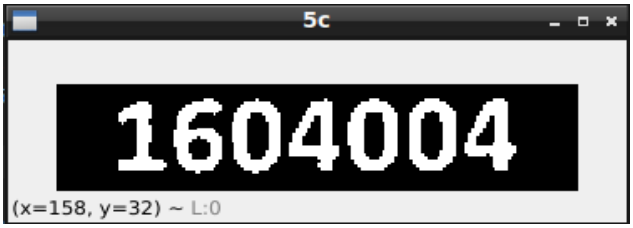


Step (08)

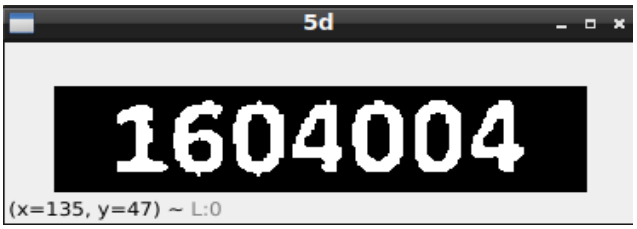


Step (09)

Step (10)



Step (11)



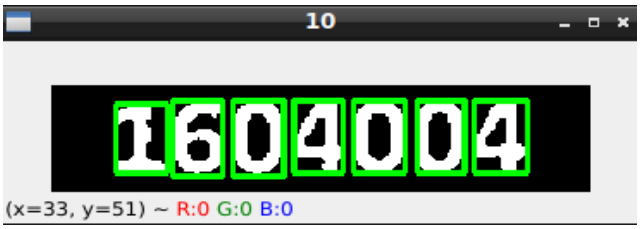
Step (12)

Step (13)

Step (14)

Step (15)

Step (16)



Step (17)

figs 10: Optical Character Recognition with OpenCV

(ii) User Management Data Base System:

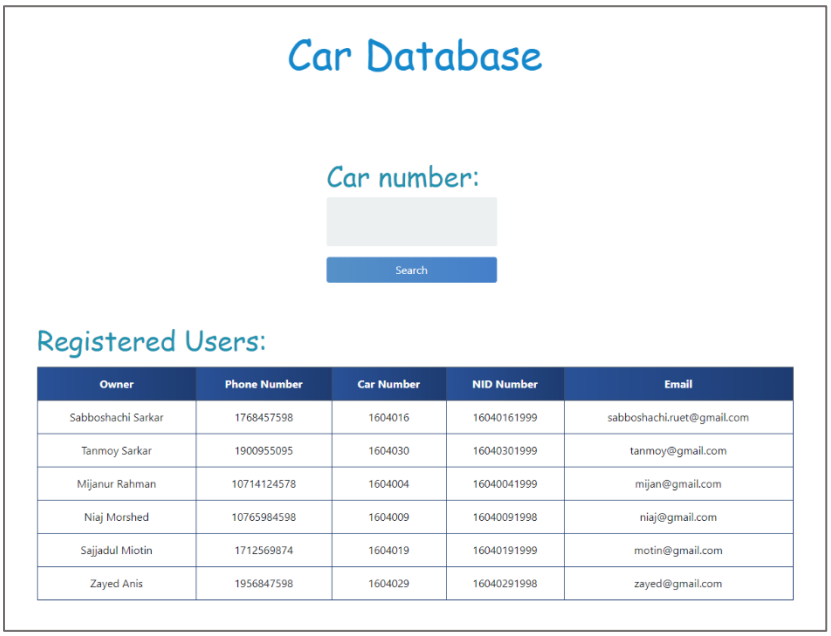


fig 11: User Data Base

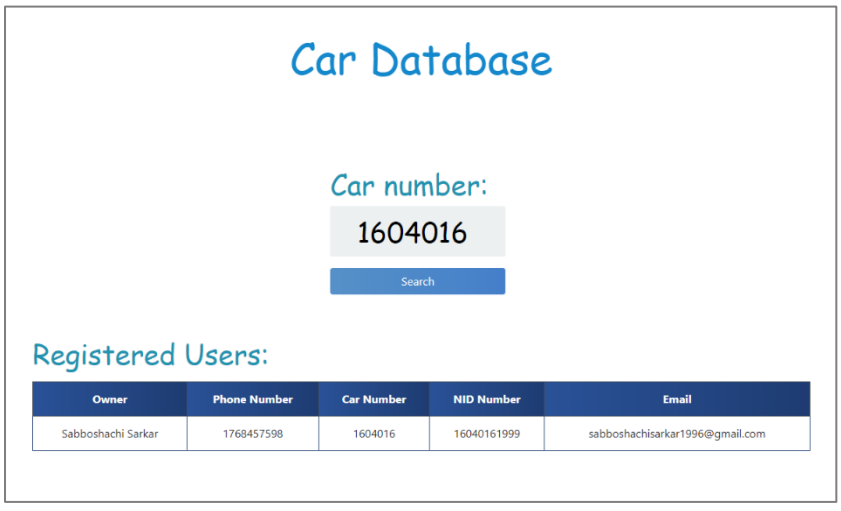


fig 12: Searched Result

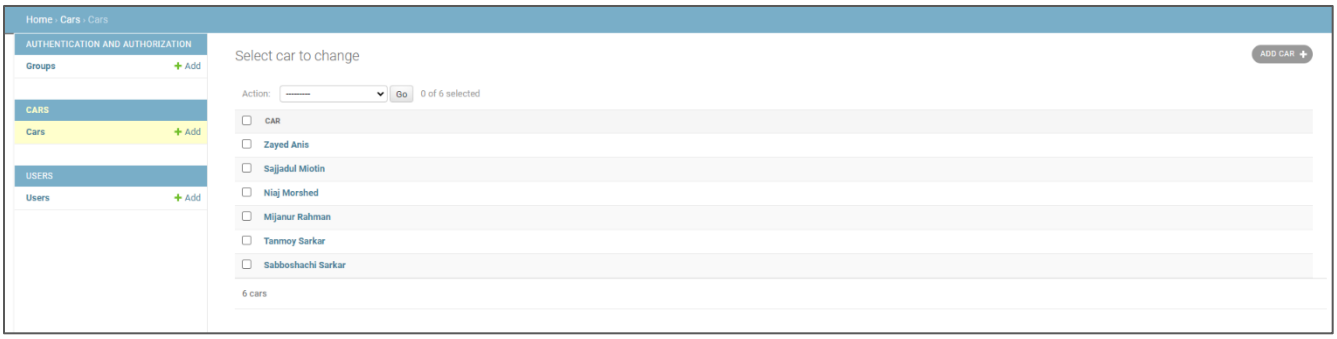


fig 13: Admin Panel

fig 14: User Registration

06. Result:

(i) Number Plate Recognition:

fig 15: License Plate Detection and Conversion

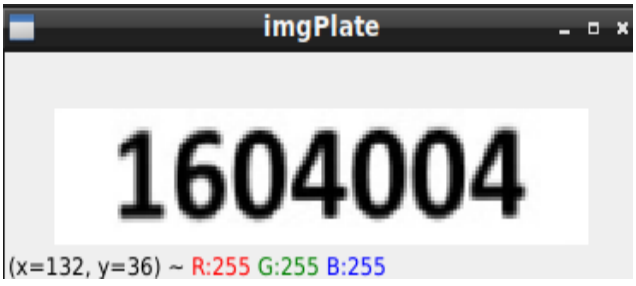


fig 16: Image Plate

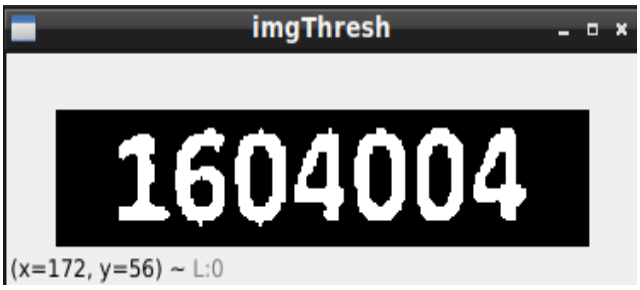


fig 17: Image Thresh

(ii) User Management Data Base System:

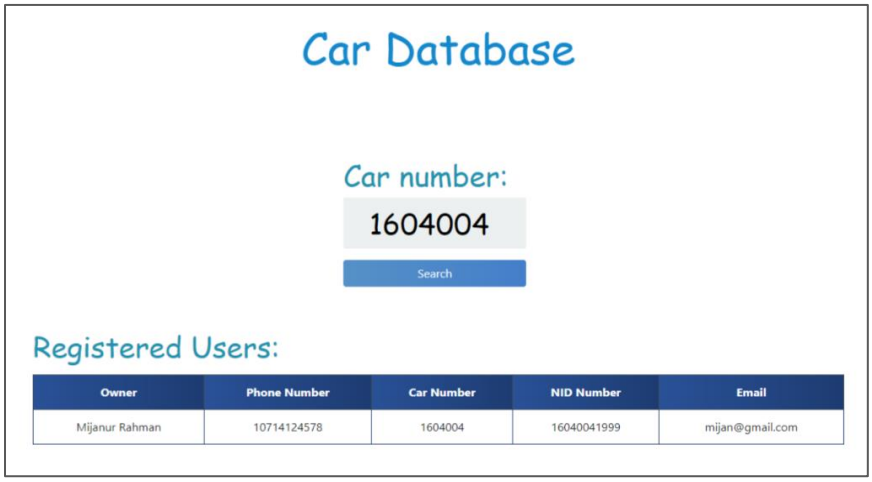


fig 18: Searched Result

07. Advantages & Disadvantages:

The main advantage of this project is to maintain the vehicle management system accurately and automatically. With this project we can find which vehicles are registered and which aren't. If the vehicle is registered then we can get information about the vehicle. By using this system in a large scale, we can get information about every vehicle in a city. Even we can trace which vehicles are not registered to capture them. Any crime / action made by a registered vehicle can easily be traced within a few seconds. This project can also be used in Smart Traffic control system.

The main disadvantage of this system is, it requires a huge database server and a high configured machine to process image fast. To keep a huge amount of data about the users the database system needs to be large and powerful which is a little bit costly to implement.

08. Applications:

- Smart parking system
- Vehicle management system in a city
- Smart traffic control system in a city
- To find a vehicle in a city in fastest time and many more.

09. Conclusion:

The project is designed for developing a secure and automated vehicle management system. Here we get the license plate number from the vehicle using OCR with OpenCV. Using the license plate number, we find out vehicles from the user database system.

Though in this project, I tried to make the OCR as much as accurate but it's not 100% accurate yet. The system in largely depends on image quality. But the image capturing system has complexity features due to diverse effects like lights and speed.

To build this project more accurately the camera quality and the processing machine needs to be improved.

10. References:

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10) Panchal, T., Patel, H., & Panchal, A. (2016). License plate detection using Harris corner and character segmentation by integrated approach from an image. Procedia Computer Science, 79, 419-425.

11) https://circuitdigest.com/

12) https://www.raspberrypi.org/

11. Code for System:

```
# DetectChars.py

import os
import cv2
import numpy as np
import math
import random

import Main
import Preprocess
import PossibleChar

# module level variables
##########################################################################

kNearest = cv2.ml.KNearest_create()

        # constants for checkIfPossibleChar, this checks one possible char only
(does not compare to another char)
MIN_PIXEL_WIDTH = 2
MIN_PIXEL_HEIGHT = 8

MIN_ASPECT_RATIO = 0.25
MAX_ASPECT_RATIO = 1.0

MIN_PIXEL_AREA = 80

        # constants for comparing two chars
MIN_DIAG_SIZE_MULTIPLE_AWAY = 0.3
MAX_DIAG_SIZE_MULTIPLE_AWAY = 5.0

MAX_CHANGE_IN_AREA = 0.5

MAX_CHANGE_IN_WIDTH = 0.8
MAX_CHANGE_IN_HEIGHT = 0.2

MAX_ANGLE_BETWEEN_CHARS = 12.0

        # other constants
MIN_NUMBER_OF_MATCHING_CHARS = 3

RESIZED_CHAR_IMAGE_WIDTH = 20
RESIZED_CHAR_IMAGE_HEIGHT = 30

MIN_CONTOUR_AREA = 100

###################################################################################
#################
def loadKNNDataAndTrainKNN():
    allContoursWithData = []                # declare empty lists,
    validContoursWithData = []              # we will fill these shortly
```

```
    try:
        npaClassifications = np.loadtxt("classifications.txt", np.float32)
# read in training classifications
    except:
# if file could not be opened
        print("error, unable to open classifications.txt, exiting program\n")

# show error message
        os.system("pause")
        return False
# and return False
    # end try

    try:
        npaFlattenedImages = np.loadtxt("flattened_images.txt", np.float32)
# read in training images
    except:
# if file could not be opened
        print("error, unable to open flattened_images.txt, exiting program\n")

# show error message
        os.system("pause")
        return False
# and return False
    # end try

    npaClassifications = npaClassifications.reshape((npaClassifications.size, 1))
# reshape numpy array to 1d, necessary to pass to call to train

    kNearest.setDefaultK(1)
# set default K to 1

    kNearest.train(npaFlattenedImages, cv2.ml.ROW_SAMPLE, npaClassifications)
# train KNN object

    return True           # if we got here training was successful so return true
# end function

###################################################################################
#################
def detectCharsInPlates(listOfPossiblePlates):
    intPlateCounter = 0
    imgContours = None
    contours = []

    if len(listOfPossiblePlates) == 0:        # if list of possible plates is empty
        return listOfPossiblePlates           # return
    # end if

# at this point we can be sure the list of possible plates has at least one plate
```

```
for possiblePlate in listOfPossiblePlates:          # for each possible plate, this
is a big for loop that takes up most of the function

        possiblePlate.imgGrayscale, possiblePlate.imgThresh =
Preprocess.preprocess(possiblePlate.imgPlate)     # preprocess to get grayscale and
threshold images

        if Main.showSteps == True: # show steps
###################################################
            cv2.imshow("5a", possiblePlate.imgPlate)
            cv2.imshow("5b", possiblePlate.imgGrayscale)
            cv2.imshow("5c", possiblePlate.imgThresh)
        # end if # show steps

#####################################################################

                # increase size of plate image for easier viewing and char
detection
        possiblePlate.imgThresh = cv2.resize(possiblePlate.imgThresh, (0, 0), fx =
1.6, fy = 1.6)

                # threshold again to eliminate any gray areas
        thresholdValue, possiblePlate.imgThresh =
cv2.threshold(possiblePlate.imgThresh, 0.0, 255.0, cv2.THRESH_BINARY |
cv2.THRESH_OTSU)

        if Main.showSteps == True: # show steps

###################################################
            cv2.imshow("5d", possiblePlate.imgThresh)
        # end if # show steps
#####################################################################
                # find all possible chars in the plate,
                # this function first finds all contours, then only includes
contours that could be chars (without comparison to other chars yet)
        listOfPossibleCharsInPlate =
findPossibleCharsInPlate(possiblePlate.imgGrayscale, possiblePlate.imgThresh)

        if Main.showSteps == True: # show steps
###################################################
            height, width, numChannels = possiblePlate.imgPlate.shape
            imgContours = np.zeros((height, width, 3), np.uint8)
            del contours[:]                                 # clear the
contours list

            for possibleChar in listOfPossibleCharsInPlate:
                contours.append(possibleChar.contour)
            # end for

            cv2.drawContours(imgContours, contours, -1, Main.SCALAR_WHITE)

            cv2.imshow("6", imgContours)
        # end if # show steps
```

```
#####################################################################
                # given a list of all possible chars, find groups of matching chars
within the plate
        listOfListsOfMatchingCharsInPlate =
findListOfListsOfMatchingChars(listOfPossibleCharsInPlate)

        if Main.showSteps == True: # show steps
#####################################################
            imgContours = np.zeros((height, width, 3), np.uint8)
            del contours[:]

            for listOfMatchingChars in listOfListsOfMatchingCharsInPlate:
                intRandomBlue = random.randint(0, 255)
                intRandomGreen = random.randint(0, 255)
                intRandomRed = random.randint(0, 255)

                for matchingChar in listOfMatchingChars:
                    contours.append(matchingChar.contour)
                # end for
                cv2.drawContours(imgContours, contours, -1, (intRandomBlue,
intRandomGreen, intRandomRed))
            # end for
            cv2.imshow("7", imgContours)
        # end if # show steps
#####################################################################

        if (len(listOfListsOfMatchingCharsInPlate) == 0):        # if no groups of
matching chars were found in the plate

            if Main.showSteps == True: # show steps
#################################################
                print("chars found in plate number " + str(
                    intPlateCounter) + " = (none), click on any image and press a
key to continue . . .")
                intPlateCounter = intPlateCounter + 1
                cv2.destroyWindow("8")
                cv2.destroyWindow("9")
                cv2.destroyWindow("10")
                cv2.waitKey(0)
            # end if # show steps
#################################################################
            possiblePlate.strChars = ""
            continue                    # go back to top of for loop
        # end if
        for i in range(0, len(listOfListsOfMatchingCharsInPlate)):
# within each list of matching chars
            listOfListsOfMatchingCharsInPlate[i].sort(key = lambda matchingChar:
matchingChar.intCenterX)        # sort chars from left to right
            listOfListsOfMatchingCharsInPlate[i] =
removeInnerOverlappingChars(listOfListsOfMatchingCharsInPlate[i])              #
and remove inner overlapping chars
        # end for
```

```
        if Main.showSteps == True: # show steps
###################################################
            imgContours = np.zeros((height, width, 3), np.uint8)

            for listOfMatchingChars in listOfListsOfMatchingCharsInPlate:
                intRandomBlue = random.randint(0, 255)
                intRandomGreen = random.randint(0, 255)
                intRandomRed = random.randint(0, 255)

                del contours[:]

                for matchingChar in listOfMatchingChars:
                    contours.append(matchingChar.contour)
                # end for

                cv2.drawContours(imgContours, contours, -1, (intRandomBlue,
intRandomGreen, intRandomRed))
            # end for
            cv2.imshow("8", imgContours)
        # end if # show steps
#################################################################

                # within each possible plate, suppose the longest list of potential
matching chars is the actual list of chars
        intLenOfLongestListOfChars = 0
        intIndexOfLongestListOfChars = 0

                # loop through all the vectors of matching chars, get the index of
the one with the most chars
        for i in range(0, len(listOfListsOfMatchingCharsInPlate)):
            if len(listOfListsOfMatchingCharsInPlate[i]) >
intLenOfLongestListOfChars:
                intLenOfLongestListOfChars =
len(listOfListsOfMatchingCharsInPlate[i])
                intIndexOfLongestListOfChars = i
            # end if
        # end for
# suppose that the longest list of matching chars within the plate is the actual
list of chars
        longestListOfMatchingCharsInPlate =
listOfListsOfMatchingCharsInPlate[intIndexOfLongestListOfChars]
        if Main.showSteps == True: # show steps
###################################################
            imgContours = np.zeros((height, width, 3), np.uint8)
            del contours[:]
            for matchingChar in longestListOfMatchingCharsInPlate:
                contours.append(matchingChar.contour)
            # end for
            cv2.drawContours(imgContours, contours, -1, Main.SCALAR_WHITE)

            cv2.imshow("9", imgContours)
        # end if # show steps
```

```
#################################################################

        possiblePlate.strChars = recognizeCharsInPlate(possiblePlate.imgThresh,
longestListOfMatchingCharsInPlate)

        if Main.showSteps == True: # show steps
#################################################
            print("chars found in plate number " + str(
                intPlateCounter) + " = " + possiblePlate.strChars + ", click on any
image and press a key to continue . . .")
            intPlateCounter = intPlateCounter + 1
            cv2.waitKey(0)
        # end if # show steps
#################################################################

    # end of big for loop that takes up most of the function

    if Main.showSteps == True:
        print("\nchar detection complete, click on any image and press a key to
continue . . .\n")
        cv2.waitKey(0)
    # end if

    return listOfPossiblePlates
# end function

#########################################################################################
def findPossibleCharsInPlate(imgGrayscale, imgThresh):
    listOfPossibleChars = []                        # this will be the return value
    contours = []
    imgThreshCopy = imgThresh.copy()

            # find all contours in plate
    contours, npaHierarchy = cv2.findContours(imgThreshCopy, cv2.RETR_LIST,
cv2.CHAIN_APPROX_SIMPLE)

    for contour in contours:                        # for each contour
        possibleChar = PossibleChar.PossibleChar(contour)

        if checkIfPossibleChar(possibleChar):              # if contour is a
possible char, note this does not compare to other chars (yet) . . .
            listOfPossibleChars.append(possibleChar)       # add to list of
possible chars
        # end if
    # end if

    return listOfPossibleChars
# end function

#########################################################################################
```

```
def checkIfPossibleChar(possibleChar):
            # this function is a 'first pass' that does a rough check on a contour
to see if it could be a char,
            # note that we are not (yet) comparing the char to other chars to look
for a group
    if (possibleChar.intBoundingRectArea > MIN_PIXEL_AREA and
        possibleChar.intBoundingRectWidth > MIN_PIXEL_WIDTH and
possibleChar.intBoundingRectHeight > MIN_PIXEL_HEIGHT and
        MIN_ASPECT_RATIO < possibleChar.fltAspectRatio and
possibleChar.fltAspectRatio < MAX_ASPECT_RATIO):
        return True
    else:
        return False
    # end if
# end function

#################################################################################
def findListOfListsOfMatchingChars(listOfPossibleChars):
            # with this function, we start off with all the possible chars in one
big list
            # the purpose of this function is to re-arrange the one big list of
chars into a list of lists of matching chars,
            # note that chars that are not found to be in a group of matches do not
need to be considered further
    listOfListsOfMatchingChars = []                  # this will be the return
value

    for possibleChar in listOfPossibleChars:                        # for each
possible char in the one big list of chars
        listOfMatchingChars = findListOfMatchingChars(possibleChar,
listOfPossibleChars)        # find all chars in the big list that match the current
char

        listOfMatchingChars.append(possibleChar)                # also add the
current char to current possible list of matching chars

        if len(listOfMatchingChars) < MIN_NUMBER_OF_MATCHING_CHARS:     # if
current possible list of matching chars is not long enough to constitute a possible
plate
            continue                                # jump back to the top of the for
loop and try again with next char, note that it's not necessary
                                                    # to save the list in any way since
it did not have enough chars to be a possible plate
        # end if

                                                    # if we get here, the current list
passed test as a "group" or "cluster" of matching chars
        listOfListsOfMatchingChars.append(listOfMatchingChars)      # so add to our
list of lists of matching chars

        listOfPossibleCharsWithCurrentMatchesRemoved = []

                                                    # remove the current list of
```

```
matching chars from the big list so we don't use those same chars twice,
                                                    # make sure to make a new big list
for this since we don't want to change the original big list
        listOfPossibleCharsWithCurrentMatchesRemoved =
list(set(listOfPossibleChars) - set(listOfMatchingChars))

        recursiveListOfListsOfMatchingChars =
findListOfListsOfMatchingChars(listOfPossibleCharsWithCurrentMatchesRemoved)      #
recursive call

        for recursiveListOfMatchingChars in recursiveListOfListsOfMatchingChars:
# for each list of matching chars found by recursive call
            listOfListsOfMatchingChars.append(recursiveListOfMatchingChars)
# add to our original list of lists of matching chars
        # end for

        break       # exit for

    # end for

    return listOfListsOfMatchingChars
# end function

#################################################################################
def findListOfMatchingChars(possibleChar, listOfChars):
            # the purpose of this function is, given a possible char and a big list
of possible chars,
            # find all chars in the big list that are a match for the single
possible char, and return those matching chars as a list
    listOfMatchingChars = []                # this will be the return value

    for possibleMatchingChar in listOfChars:                # for each char in big
list
        if possibleMatchingChar == possibleChar:    # if the char we attempting to
find matches for is the exact same char as the char in the big list we are
currently checking
                                                    # then we should not include it
in the list of matches b/c that would end up double including the current char
            continue                                # so do not add to list of
matches and jump back to top of for loop
        # end if
                    # compute stuff to see if chars are a match
        fltDistanceBetweenChars = distanceBetweenChars(possibleChar,
possibleMatchingChar)

        fltAngleBetweenChars = angleBetweenChars(possibleChar,
possibleMatchingChar)

        fltChangeInArea = float(abs(possibleMatchingChar.intBoundingRectArea -
possibleChar.intBoundingRectArea)) / float(possibleChar.intBoundingRectArea)

        fltChangeInWidth = float(abs(possibleMatchingChar.intBoundingRectWidth -
possibleChar.intBoundingRectWidth)) / float(possibleChar.intBoundingRectWidth)
```

```
        fltChangeInHeight = float(abs(possibleMatchingChar.intBoundingRectHeight -
possibleChar.intBoundingRectHeight)) / float(possibleChar.intBoundingRectHeight)

                # check if chars match
        if (fltDistanceBetweenChars < (possibleChar.fltDiagonalSize *
MAX_DIAG_SIZE_MULTIPLE_AWAY) and
            fltAngleBetweenChars < MAX_ANGLE_BETWEEN_CHARS and
            fltChangeInArea < MAX_CHANGE_IN_AREA and
            fltChangeInWidth < MAX_CHANGE_IN_WIDTH and
            fltChangeInHeight < MAX_CHANGE_IN_HEIGHT):

            listOfMatchingChars.append(possibleMatchingChar)        # if the chars
are a match, add the current char to list of matching chars
        # end if
    # end for

    return listOfMatchingChars                  # return result
# end function

###################################################################################
# use Pythagorean theorem to calculate distance between two chars
def distanceBetweenChars(firstChar, secondChar):
    intX = abs(firstChar.intCenterX - secondChar.intCenterX)
    intY = abs(firstChar.intCenterY - secondChar.intCenterY)

    return math.sqrt((intX ** 2) + (intY ** 2))
# end function

###################################################################################
# use basic trigonometry (SOH CAH TOA) to calculate angle between chars
def angleBetweenChars(firstChar, secondChar):
    fltAdj = float(abs(firstChar.intCenterX - secondChar.intCenterX))
    fltOpp = float(abs(firstChar.intCenterY - secondChar.intCenterY))

    if fltAdj != 0.0:                           # check to make sure we do not
divide by zero if the center X positions are equal, float division by zero will
cause a crash in Python
        fltAngleInRad = math.atan(fltOpp / fltAdj)      # if adjacent is not zero,
calculate angle
    else:
        fltAngleInRad = 1.5708                          # if adjacent is zero, use
this as the angle, this is to be consistent with the C++ version of this program
    # end if

    fltAngleInDeg = fltAngleInRad * (180.0 / math.pi)       # calculate angle in
degrees

    return fltAngleInDeg
# end function
```

```
###################################################################################
# if we have two chars overlapping or to close to each other to possibly be
separate chars, remove the inner (smaller) char,
# this is to prevent including the same char twice if two contours are found for
the same char,
# for example for the letter 'O' both the inner ring and the outer ring may be
found as contours, but we should only include the char once
def removeInnerOverlappingChars(listOfMatchingChars):
    listOfMatchingCharsWithInnerCharRemoved = list(listOfMatchingChars)
# this will be the return value

    for currentChar in listOfMatchingChars:
        for otherChar in listOfMatchingChars:
            if currentChar != otherChar:        # if current char and other char
are not the same char . . .
                                                                                # if
current char and other char have center points at almost the same location . . .
                if distanceBetweenChars(currentChar, otherChar) <
(currentChar.fltDiagonalSize * MIN_DIAG_SIZE_MULTIPLE_AWAY):
                                    # if we get in here we have found overlapping chars
                                    # next we identify which char is smaller, then if
that char was not already removed on a previous pass, remove it
                    if currentChar.intBoundingRectArea <
otherChar.intBoundingRectArea:          # if current char is smaller than other char
                        if currentChar in listOfMatchingCharsWithInnerCharRemoved:
# if current char was not already removed on a previous pass . . .

listOfMatchingCharsWithInnerCharRemoved.remove(currentChar)         # then remove
current char
                        # end if
                    else:
# else if other char is smaller than current char
                        if otherChar in listOfMatchingCharsWithInnerCharRemoved:
# if other char was not already removed on a previous pass . . .

listOfMatchingCharsWithInnerCharRemoved.remove(otherChar)           # then remove
other char
                        # end if
                    # end if
                # end if
            # end if
        # end for
    # end for

    return listOfMatchingCharsWithInnerCharRemoved
# end function

###################################################################################
################
# this is where we apply the actual char recognition
def recognizeCharsInPlate(imgThresh, listOfMatchingChars):
    strChars = ""               # this will be the return value, the chars in the
lic plate
```

```
    height, width = imgThresh.shape

    imgThreshColor = np.zeros((height, width, 3), np.uint8)

    listOfMatchingChars.sort(key = lambda matchingChar: matchingChar.intCenterX)
# sort chars from left to right

    cv2.cvtColor(imgThresh, cv2.COLOR_GRAY2BGR, imgThreshColor)
# make color version of threshold image so we can draw contours in color on it

    for currentChar in listOfMatchingChars:
# for each char in plate
        pt1 = (currentChar.intBoundingRectX, currentChar.intBoundingRectY)
        pt2 = ((currentChar.intBoundingRectX + currentChar.intBoundingRectWidth),
(currentChar.intBoundingRectY + currentChar.intBoundingRectHeight))

        cv2.rectangle(imgThreshColor, pt1, pt2, Main.SCALAR_GREEN, 2)           #
draw green box around the char

                # crop char out of threshold image
        imgROI = imgThresh[currentChar.intBoundingRectY :
currentChar.intBoundingRectY + currentChar.intBoundingRectHeight,
                           currentChar.intBoundingRectX :
currentChar.intBoundingRectX + currentChar.intBoundingRectWidth]

        imgROIResized = cv2.resize(imgROI, (RESIZED_CHAR_IMAGE_WIDTH,
RESIZED_CHAR_IMAGE_HEIGHT))           # resize image, this is necessary for char
recognition

        npaROIResized = imgROIResized.reshape((1, RESIZED_CHAR_IMAGE_WIDTH *
RESIZED_CHAR_IMAGE_HEIGHT))        # flatten image into 1d numpy array

        npaROIResized = np.float32(npaROIResized)               # convert from 1d
numpy array of ints to 1d numpy array of floats

        retval, npaResults, neigh_resp, dists = kNearest.findNearest(npaROIResized,
k = 1)              # finally we can call findNearest !!!

        strCurrentChar = str(chr(int(npaResults[0][0])))            # get character
from results
        strChars = strChars + strCurrentChar                        # append
current char to full string
    # end for
    if Main.showSteps == True: # show steps
#######################################################
        cv2.imshow("10", imgThreshColor)
    # end if # show steps
#########################################################################

    return strChars
# end function
```

```
# DetectPlates.py

import cv2
import numpy as np
import math
import Main
import random

import Preprocess
import DetectChars
import PossiblePlate
import PossibleChar

# module level variables
##########################################################################
PLATE_WIDTH_PADDING_FACTOR = 1.3
PLATE_HEIGHT_PADDING_FACTOR = 1.5

##########################################################################################################
def detectPlatesInScene(imgOriginalScene):
    listOfPossiblePlates = []                   # this will be the return value

    height, width, numChannels = imgOriginalScene.shape

    imgGrayscaleScene = np.zeros((height, width, 1), np.uint8)
    imgThreshScene = np.zeros((height, width, 1), np.uint8)
    imgContours = np.zeros((height, width, 3), np.uint8)

    cv2.destroyAllWindows()

    if Main.showSteps == True: # show steps #######################################################
        cv2.imshow("0", imgOriginalScene)
    # end if # show steps
    imgGrayscaleScene, imgThreshScene = Preprocess.preprocess(imgOriginalScene)        # preprocess to get
grayscale and threshold images

    if Main.showSteps == True: # show steps
        cv2.imshow("1a", imgGrayscaleScene)
        cv2.imshow("1b", imgThreshScene)
    # end if # show steps

##########################################################################
        # find all possible chars in the scene,
        # this function first finds all contours, then only includes contours that could be chars (without
comparison to other chars yet)
```

```
    listOfPossibleCharsInScene = findPossibleCharsInScene(imgThreshScene)

    if Main.showSteps == True: # show steps #######################################################
        print("step 2 - len(listOfPossibleCharsInScene) = " + str(
            len(listOfPossibleCharsInScene)))  # 131 with MCLRNF1 image
        imgContours = np.zeros((height, width, 3), np.uint8)
        contours = []
        for possibleChar in listOfPossibleCharsInScene:
            contours.append(possibleChar.contour)
        # end for
        cv2.drawContours(imgContours, contours, -1, Main.SCALAR_WHITE)
        cv2.imshow("2b", imgContours)
    # end if # show steps
#################################################################################
            # given a list of all possible chars, find groups of matching chars
            # in the next steps each group of matching chars will attempt to be recognized as a plate
    listOfListsOfMatchingCharsInScene = DetectChars.findListOfListsOfMatchingChars(listOfPossibleCharsInScene)

    if Main.showSteps == True: # show steps
        print("step 3 - listOfListsOfMatchingCharsInScene.Count = " + str(
            len(listOfListsOfMatchingCharsInScene)))  # 13 with MCLRNF1 image

        imgContours = np.zeros((height, width, 3), np.uint8)

        for listOfMatchingChars in listOfListsOfMatchingCharsInScene:
            intRandomBlue = random.randint(0, 255)
            intRandomGreen = random.randint(0, 255)
            intRandomRed = random.randint(0, 255)

            contours = []

            for matchingChar in listOfMatchingChars:
                contours.append(matchingChar.contour)
            # end for

            cv2.drawContours(imgContours, contours, -1, (intRandomBlue, intRandomGreen, intRandomRed))
        # end for

        cv2.imshow("3", imgContours)
    # end if # show steps
```

```
    ###################################################################################
    for listOfMatchingChars in listOfListsOfMatchingCharsInScene:               # for each group of matching chars
        possiblePlate = extractPlate(imgOriginalScene, listOfMatchingChars)         # attempt to extract plate

        if possiblePlate.imgPlate is not None:                          # if plate was found
            listOfPossiblePlates.append(possiblePlate)                  # add to list of possible plates
        # end if
    # end for

    print("\n" + str(len(listOfPossiblePlates)) + " possible plates found")  # 13 with MCLRNF1 image

    if Main.showSteps == True: # show steps

        print("\n")
        cv2.imshow("4a", imgContours)

        for i in range(0, len(listOfPossiblePlates)):
            p2fRectPoints = cv2.boxPoints(listOfPossiblePlates[i].rrLocationOfPlateInScene)

            cv2.line(imgContours, tuple(p2fRectPoints[0]), tuple(p2fRectPoints[1]), Main.SCALAR_RED, 2)
            cv2.line(imgContours, tuple(p2fRectPoints[1]), tuple(p2fRectPoints[2]), Main.SCALAR_RED, 2)
            cv2.line(imgContours, tuple(p2fRectPoints[2]), tuple(p2fRectPoints[3]), Main.SCALAR_RED, 2)
            cv2.line(imgContours, tuple(p2fRectPoints[3]), tuple(p2fRectPoints[0]), Main.SCALAR_RED, 2)

            cv2.imshow("4a", imgContours)

            print("possible plate " + str(i) + ", click on any image and press a key to continue . . .")

            cv2.imshow("4b", listOfPossiblePlates[i].imgPlate)
            cv2.waitKey(0)
        # end for
        print("\nplate detection complete, click on any image and press a key to begin char recognition . . .\n")
        cv2.waitKey(0)
    # end if # show steps
    ###################################################################################

    return listOfPossiblePlates
# end function

#########################################################################################################
```

```
def findPossibleCharsInScene(imgThresh):
    listOfPossibleChars = []                # this will be the return value

    intCountOfPossibleChars = 0

    imgThreshCopy = imgThresh.copy()

    contours, npaHierarchy = cv2.findContours(imgThreshCopy, cv2.RETR_LIST, cv2.CHAIN_APPROX_SIMPLE)  # find all contours

    height, width = imgThresh.shape
    imgContours = np.zeros((height, width, 3), np.uint8)

    for i in range(0, len(contours)):                   # for each contour

        if Main.showSteps == True: # show steps
#######################################################
            cv2.drawContours(imgContours, contours, i, Main.SCALAR_WHITE)
        # end if # show steps
#######################################################################

        possibleChar = PossibleChar.PossibleChar(contours[i])

        if DetectChars.checkIfPossibleChar(possibleChar):               # if contour is a possible char, note this does not compare to other chars (yet) . . .
            intCountOfPossibleChars = intCountOfPossibleChars + 1           # increment count of possible chars
            listOfPossibleChars.append(possibleChar)                    # and add to list of possible chars
        # end if
    # end for

    if Main.showSteps == True: # show steps
#############################################################
        print("\nstep 2 - len(contours) = " + str(len(contours)))  # 2362 with MCLRNF1 image
        print("step 2 - intCountOfPossibleChars = " + str(intCountOfPossibleChars))  # 131 with MCLRNF1 image
        cv2.imshow("2a", imgContours)
    # end if # show steps
#################################################################################

    return listOfPossibleChars
# end function
```

```
#################################################################################################
def extractPlate(imgOriginal, listOfMatchingChars):
    possiblePlate = PossiblePlate.PossiblePlate()          # this will be the return value

    listOfMatchingChars.sort(key = lambda matchingChar: matchingChar.intCenterX)       # sort chars from left to right based on x position

        # calculate the center point of the plate
    fltPlateCenterX = (listOfMatchingChars[0].intCenterX + listOfMatchingChars[len(listOfMatchingChars) - 1].intCenterX) / 2.0
    fltPlateCenterY = (listOfMatchingChars[0].intCenterY + listOfMatchingChars[len(listOfMatchingChars) - 1].intCenterY) / 2.0

    ptPlateCenter = fltPlateCenterX, fltPlateCenterY

        # calculate plate width and height
    intPlateWidth = int((listOfMatchingChars[len(listOfMatchingChars) - 1].intBoundingRectX + listOfMatchingChars[len(listOfMatchingChars) - 1].intBoundingRectWidth - listOfMatchingChars[0].intBoundingRectX) * PLATE_WIDTH_PADDING_FACTOR)

    intTotalOfCharHeights = 0

    for matchingChar in listOfMatchingChars:
        intTotalOfCharHeights = intTotalOfCharHeights + matchingChar.intBoundingRectHeight
    # end for

    fltAverageCharHeight = intTotalOfCharHeights / len(listOfMatchingChars)

    intPlateHeight = int(fltAverageCharHeight * PLATE_HEIGHT_PADDING_FACTOR)

        # calculate correction angle of plate region
    fltOpposite = listOfMatchingChars[len(listOfMatchingChars) - 1].intCenterY - listOfMatchingChars[0].intCenterY
    fltHypotenuse = DetectChars.distanceBetweenChars(listOfMatchingChars[0], listOfMatchingChars[len(listOfMatchingChars) - 1])
    fltCorrectionAngleInRad = math.asin(fltOpposite / fltHypotenuse)
    fltCorrectionAngleInDeg = fltCorrectionAngleInRad * (180.0 / math.pi)

        # pack plate region center point, width and height, and correction angle into rotated rect member variable of plate
    possiblePlate.rrLocationOfPlateInScene = ( tuple(ptPlateCenter), (intPlateWidth, intPlateHeight), fltCorrectionAngleInDeg )
```

```
        # final steps are to perform the actual rotation

        # get the rotation matrix for our calculated correction angle
    rotationMatrix = cv2.getRotationMatrix2D(tuple(ptPlateCenter), fltCorrectionAngleInDeg, 1.0)

    height, width, numChannels = imgOriginal.shape      # unpack original image width and height

    imgRotated = cv2.warpAffine(imgOriginal, rotationMatrix, (width, height))      # rotate the entire image

    imgCropped = cv2.getRectSubPix(imgRotated, (intPlateWidth, intPlateHeight), tuple(ptPlateCenter))

    possiblePlate.imgPlate = imgCropped         # copy the cropped plate image into the applicable member
variable of the possible plate

    return possiblePlate
# end function
```

PossibleChar.py

```
import cv2
import numpy as np
import math
##################################################################################
class PossibleChar:
    # constructor
##################################################################################
    def __init__(self, _contour):
        self.contour = _contour
        self.boundingRect = cv2.boundingRect(self.contour)

        [intX, intY, intWidth, intHeight] = self.boundingRect

        self.intBoundingRectX = intX
        self.intBoundingRectY = intY
        self.intBoundingRectWidth = intWidth
        self.intBoundingRectHeight = intHeight
        self.intBoundingRectArea = self.intBoundingRectWidth * self.intBoundingRectHeight
        self.intCenterX = (self.intBoundingRectX + self.intBoundingRectX + self.intBoundingRectWidth) / 2
        self.intCenterY = (self.intBoundingRectY + self.intBoundingRectY + self.intBoundingRectHeight) / 2
        self.fltDiagonalSize = math.sqrt((self.intBoundingRectWidth ** 2) + (self.intBoundingRectHeight ** 2))
        self.fltAspectRatio = float(self.intBoundingRectWidth) / float(self.intBoundingRectHeight)
    # end constructor
# end class
```

PossiblePlate.py

```
import cv2
import numpy as np
#################################################################################################
class PossiblePlate:
    # constructor
#################################################################################################
    def __init__(self):
        self.imgPlate = None
        self.imgGrayscale = None
        self.imgThresh = None
        self.rrLocationOfPlateInScene = None
        self.strChars = ""
    # end constructor
# end class
```

Preprocess.py

```
import cv2
import numpy as np
import math
# module level variables
##################################################################################
GAUSSIAN_SMOOTH_FILTER_SIZE = (5, 5)
ADAPTIVE_THRESH_BLOCK_SIZE = 19
ADAPTIVE_THRESH_WEIGHT = 9
#################################################################################################
def preprocess(imgOriginal):
    imgGrayscale = extractValue(imgOriginal)
    imgMaxContrastGrayscale = maximizeContrast(imgGrayscale)
    height, width = imgGrayscale.shape
    imgBlurred = np.zeros((height, width, 1), np.uint8)
    imgBlurred = cv2.GaussianBlur(imgMaxContrastGrayscale, GAUSSIAN_SMOOTH_FILTER_SIZE, 0)
    imgThresh = cv2.adaptiveThreshold(imgBlurred, 255.0, cv2.ADAPTIVE_THRESH_GAUSSIAN_C,
cv2.THRESH_BINARY_INV, ADAPTIVE_THRESH_BLOCK_SIZE, ADAPTIVE_THRESH_WEIGHT)
    return imgGrayscale, imgThresh
# end function

#################################################################################################
def extractValue(imgOriginal):
    height, width, numChannels = imgOriginal.shape
    imgHSV = np.zeros((height, width, 3), np.uint8)
```

```
    imgHSV = cv2.cvtColor(imgOriginal, cv2.COLOR_BGR2HSV)
    imgHue, imgSaturation, imgValue = cv2.split(imgHSV)
    return imgValue
# end function

###################################################################################################
def maximizeContrast(imgGrayscale):
    height, width = imgGrayscale.shape
    imgTopHat = np.zeros((height, width, 1), np.uint8)
    imgBlackHat = np.zeros((height, width, 1), np.uint8)
    structuringElement = cv2.getStructuringElement(cv2.MORPH_RECT, (3, 3))
    imgTopHat = cv2.morphologyEx(imgGrayscale, cv2.MORPH_TOPHAT, structuringElement)
    imgBlackHat = cv2.morphologyEx(imgGrayscale, cv2.MORPH_BLACKHAT, structuringElement)
    imgGrayscalePlusTopHat = cv2.add(imgGrayscale, imgTopHat)
    imgGrayscalePlusTopHatMinusBlackHat = cv2.subtract(imgGrayscalePlusTopHat, imgBlackHat)
    return imgGrayscalePlusTopHatMinusBlackHat
# end function

###################################################################################################
```

```
# Main.py

import cv2
import numpy as np
import os

import DetectChars
import DetectPlates
import PossiblePlate

from selenium import webdriver
from selenium.webdriver.common.keys import Keys

# module level variables

SCALAR_BLACK = (0.0, 0.0, 0.0)
SCALAR_WHITE = (255.0, 255.0, 255.0)
SCALAR_YELLOW = (0.0, 255.0, 255.0)
SCALAR_GREEN = (0.0, 255.0, 0.0)
SCALAR_RED = (0.0, 0.0, 255.0)
plate_no = ""

showSteps = False

###################################################################################################
def main():

    blnKNNTrainingSuccessful = DetectChars.loadKNNDataAndTrainKNN()         #
attempt KNN training
```

```
    if blnKNNTrainingSuccessful == False:                               # if KNN
training was not successful
        print("\nerror: KNN traning was not successful\n")  # show error message
        return                                                          # and exit
program
    # end if

    imgOriginalScene  = cv2.imread("LicPlateImages/1.png")               # open
image

    if imgOriginalScene is None:                            # if image was not read
successfully
        print("\nerror: image not read from file \n\n")  # print error message to
std out
        os.system("pause")                                  # pause so user can see
error message
        return                                              # and exit program
    # end if

    listOfPossiblePlates = DetectPlates.detectPlatesInScene(imgOriginalScene)
# detect plates

    listOfPossiblePlates = DetectChars.detectCharsInPlates(listOfPossiblePlates)
# detect chars in plates

    cv2.imshow("imgOriginalScene", imgOriginalScene)            # show scene image

    if len(listOfPossiblePlates) == 0:                          # if no plates were
found
        print("\nno license plates were detected\n")  # inform user no plates were
found
    else:                                                       # else
                # if we get in here list of possible plates has at leat one plate
                # sort the list of possible plates in DESCENDING order (most number
of chars to least number of chars)
        listOfPossiblePlates.sort(key = lambda possiblePlate:
len(possiblePlate.strChars), reverse = True)

                # suppose the plate with the most recognized chars (the first plate
in sorted by string length descending order) is the actual plate
        licPlate = listOfPossiblePlates[0]

        cv2.imshow("imgPlate", licPlate.imgPlate)           # show crop of plate
and threshold of plate
        cv2.imshow("imgThresh", licPlate.imgThresh)

        if len(licPlate.strChars) == 0:                     # if no chars were
found in the plate
            print("\nno characters were detected\n\n")  # show message
            return                                          # and exit program
        # end if

        drawRedRectangleAroundPlate(imgOriginalScene, licPlate)             # draw
red rectangle around plate

        print("\nlicense plate read from image = " + licPlate.strChars + "\n")  #
```

```
write license plate text to std out
        print("----------------------------------------")

        writeLicensePlateCharsOnImage(imgOriginalScene, licPlate)           # write
license plate text on the image

        cv2.imshow("imgOriginalScene", imgOriginalScene)                # re-show
scene image

        cv2.imwrite("imgOriginalScene.png", imgOriginalScene)           # write
image out to file

    # end if else

       path = "/home/sabbo/Downloads/chromedriver"
         driver = webdriver.Chrome(path)

         driver.get("http://127.0.0.1:8000/")
         search = driver.find_element_by_id("id_car_number")
         search.send_keys(plate_no)
         search.send_keys(Keys.RETURN)

    cv2.waitKey(0)              # hold windows open until user presses a key

    return
# end main


###################################################################################
def drawRedRectangleAroundPlate(imgOriginalScene, licPlate):

    p2fRectPoints = cv2.boxPoints(licPlate.rrLocationOfPlateInScene)            #
get 4 vertices of rotated rect

    cv2.line(imgOriginalScene, tuple(p2fRectPoints[0]), tuple(p2fRectPoints[1]),
SCALAR_RED, 2)          # draw 4 red lines
    cv2.line(imgOriginalScene, tuple(p2fRectPoints[1]), tuple(p2fRectPoints[2]),
SCALAR_RED, 2)
    cv2.line(imgOriginalScene, tuple(p2fRectPoints[2]), tuple(p2fRectPoints[3]),
SCALAR_RED, 2)
    cv2.line(imgOriginalScene, tuple(p2fRectPoints[3]), tuple(p2fRectPoints[0]),
SCALAR_RED, 2)
# end function

###################################################################################
def writeLicensePlateCharsOnImage(imgOriginalScene, licPlate):
    ptCenterOfTextAreaX = 0                             # this will be the center
of the area the text will be written to
    ptCenterOfTextAreaY = 0

    ptLowerLeftTextOriginX = 0                          # this will be the bottom
left of the area that the text will be written to
    ptLowerLeftTextOriginY = 0
```

```
    sceneHeight, sceneWidth, sceneNumChannels = imgOriginalScene.shape
    plateHeight, plateWidth, plateNumChannels = licPlate.imgPlate.shape

    intFontFace = cv2.FONT_HERSHEY_SIMPLEX                      # choose a plain
jane font
    fltFontScale = float(plateHeight) / 30.0                    # base font scale
on height of plate area
    intFontThickness = int(round(fltFontScale * 1.5))           # base font
thickness on font scale

    textSize, baseline = cv2.getTextSize(licPlate.strChars, intFontFace,
fltFontScale, intFontThickness)        # call getTextSize

            # unpack roatated rect into center point, width and height, and angle
    ( (intPlateCenterX, intPlateCenterY), (intPlateWidth, intPlateHeight),
fltCorrectionAngleInDeg ) = licPlate.rrLocationOfPlateInScene

    intPlateCenterX = int(intPlateCenterX)              # make sure center is an
integer
    intPlateCenterY = int(intPlateCenterY)

    ptCenterOfTextAreaX = int(intPlateCenterX)         # the horizontal location of
the text area is the same as the plate

    if intPlateCenterY < (sceneHeight * 0.75):

# if the license plate is in the upper 3/4 of the image
        ptCenterOfTextAreaY = int(round(intPlateCenterY)) + int(round(plateHeight *
1.6))      # write the chars in below the plate
    else:
# else if the license plate is in the lower 1/4 of the image
        ptCenterOfTextAreaY = int(round(intPlateCenterY)) - int(round(plateHeight *
1.6))      # write the chars in above the plate
    # end if

    textSizeWidth, textSizeHeight = textSize                # unpack text size
width and height

    ptLowerLeftTextOriginX = int(ptCenterOfTextAreaX - (textSizeWidth / 2))
# calculate the lower left origin of the text area
    ptLowerLeftTextOriginY = int(ptCenterOfTextAreaY + (textSizeHeight / 2))
# based on the text area center, width, and height

            # write the text on the image
    cv2.putText(imgOriginalScene, licPlate.strChars, (ptLowerLeftTextOriginX,
ptLowerLeftTextOriginY), intFontFace, fltFontScale, SCALAR_YELLOW,
intFontThickness)
# end function

#################################################################################
if __name__ == "__main__":
    main()
```