A Real-Time (or) Field-based Research Project Report

on

Density Based Smart Traffic Control System Using CannyEdge Detection Algorithm for Congregating Traffic Information

submitted in partial fulfilment of the requirements for the award of the

degree

of

Bachelor of Technology

in

COMPUTER SCIENCE AND ENGINEERING

by

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JUNE 2024

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the Real-Time (or) Field-based Research Project Report entitled "**Density Based Smart Traffic Control System Using CannyEdge Detection Algorithm for Congregating Traffic Information**" being submitted by **ANISH KOKKU(227R1A05F1), ANIKETH REDDY(227R1A05G8), K SARASWATHI(227R1A05G9)** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in **COMPUTER SCIENCE AND ENGINEERING** to the **Jawaharlal Nehru Technological University, Hyderabad** is a record of bonafide work carried out by them under my guidance and supervision during the Academic Year 2023 – 24.

The results embodied in this thesis have not been submitted to any other University or Institute for the award of any other degree or diploma.

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ABSTRACT

Urban areas worldwide are grappling with escalating traffic congestion, necessitating innovative solutions for efficient traffic management. The Smart Traffic Density Control System (STDS) is a cutting-edge approach that employs advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and real-time data analytics to optimize traffic flow and reduce congestion. This project integrates a network of sensors, cameras, and communication devices to collect real-time data on traffic density, vehicle speeds, and road conditions. The data is processed using sophisticated algorithms to dynamically adjust traffic signal timings, thereby improving traffic efficiency, reducing wait times at intersections, and minimizing vehicular emissions. Key features of the STDS include real-time traffic monitoring, data-driven decision making, dynamic signal control, and seamless integration with existing infrastructure.

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1. INTRODUCTION

In today's rapidly urbanizing world, efficient traffic management is crucial to ensuring smooth transportation, reducing congestion, and minimizing environmental impacts. Traditional traffic management systems often rely on static signaling patterns and human intervention, which may not effectively address the dynamic nature of urban traffic. To overcome these limitations, the Smart Traffic Density System (STDS) leverages advanced technologies such as Internet of Things (IoT), artificial intelligence (AI), and real-time data analytics.

The Smart Traffic Density System is an innovative solution designed to monitor, analyze, and manage traffic flow in urban areas. By utilizing a network of sensors, cameras, and communication devices, the system gathers real-time data on traffic density, vehicle speed, and road conditions. This data is then processed using sophisticated algorithms and AI techniques to provide actionable insights and optimize traffic signal timings.

Key Features of the Smart Traffic Density System:

1. **Real-Time Traffic Monitoring**: The system continuously collects data from various sensors and cameras installed at strategic locations across the city. This enables real-time monitoring of traffic conditions and provides a comprehensive view of traffic flow patterns.

2. **Data-Driven Decision Making**: Advanced data analytics and AI algorithms analyze the collected data to identify traffic trends, predict congestion, and suggest optimal traffic signal timings. This helps in reducing wait times at intersections and improving overall traffic efficiency.

3. **Dynamic Signal Control**: The system dynamically adjusts traffic signal timings based on real-time traffic conditions. This adaptive approach ensures that traffic lights respond to actual traffic density rather than following a fixed schedule, thereby reducing delays and congestion.

4. **Integration with Existing Infrastructure**: The Smart Traffic Density System can be seamlessly integrated with existing traffic management infrastructure, such as traffic signals and control centers. This minimizes the need for extensive infrastructure upgrades and facilitates quick deployment.

5. **Environmental Benefits**: By optimizing traffic flow and reducing congestion, the system helps in lowering vehicle emissions and fuel consumption. This contributes to improved air quality and supports sustainable urban development.

6. **Enhanced Safety**: The system also includes features to enhance road safety, such as detecting and alerting authorities about accidents, hazardous road conditions, and non-compliant vehicles.

7. **User-Friendly Interface**: A centralized dashboard provides traffic managers with an intuitive interface to monitor traffic conditions, receive alerts, and make informed decisions. The system also offers mobile applications for drivers, providing real-time traffic updates and alternative route suggestions.

The implementation of a Smart Traffic Density System represents a significant step towards creating smarter, more efficient, and sustainable urban transportation networks. By leveraging cutting-edge technologies, this system not only improves traffic management but also enhances the overall quality of life for city dwellers.

2. LITERATURE SURVEY

The rapid urbanization and the subsequent increase in vehicular traffic have necessitated the development of intelligent traffic management systems. Smart Traffic Density Control Systems (STDS) have emerged as a pivotal solution to address traffic congestion, enhance road safety, and improve urban mobility. This literature review explores the evolution, methodologies, and impact of smart traffic density control systems, highlighting key research contributions and technological advancements.

Evolution of Smart Traffic Control Systems

The concept of smart traffic control systems dates back to the early implementations of traffic signal control mechanisms, which were primarily based on fixed-time control (Webster, 1958). The limitations of these systems, such as inability to adapt to real-time traffic conditions, paved the way for the development of more sophisticated traffic management solutions.

Key Technologies and Methodologies

Internet of Things (IoT)

IoT plays a critical role in modern STDS by providing a network of interconnected devices that collect and exchange real-time traffic data. IoT sensors, including cameras, inductive loops, and RFID tags, are deployed at strategic locations to monitor traffic density, vehicle speeds, and road conditions (Zanella et al., 2014). The integration of IoT with traffic management systems enables the collection of granular data, essential for making informed decisions.

Artificial Intelligence (AI) and Machine Learning (ML)

AI and ML algorithms are extensively used to analyze the collected traffic data and predict traffic patterns. Techniques such as deep learning, reinforcement learning, and genetic algorithms have shown significant promise in optimizing traffic signal timings and reducing congestion (Ghosh et al., 2018). For instance, Chen et al. (2016) developed a deep learning model that predicts traffic flow with high accuracy, enabling dynamic adjustment of traffic signals.

Real-Time Data Analytics

Real-time data analytics is vital for processing the vast amount of data generated by IoT devices. Big data platforms and cloud computing technologies facilitate the storage, processing, and analysis of this data in real-time (Sathya et al., 2017). The insights derived from data analytics are crucial for adaptive traffic signal control and congestion management.

Impact of Smart Traffic Density Control Systems

Traffic Efficiency and Congestion Reduction

Studies have demonstrated that STDS significantly enhance traffic efficiency by reducing wait times at intersections and mitigating congestion. For example, the adaptive traffic control system implemented in the city of Los Angeles led to a 12% reduction in travel time and a 16% decrease in stops (Stevanovic et al., 2015).

Environmental Benefits

By optimizing traffic flow and reducing idle times, STDS contribute to lower fuel consumption and reduced vehicular emissions. Research indicates that adaptive traffic control systems can reduce carbon dioxide emissions by up to 20% (He et al., 2015).

Safety Improvements

STDS also enhance road safety by detecting and responding to real-time traffic incidents, such as accidents and hazardous conditions. The integration of AI-driven analytics helps in predicting potential accident hotspots and implementing preventive measures (Ahmed et al., 2020).

Challenges and Future Directions

Despite the promising advancements, several challenges persist in the widespread adoption of STDS. These include high implementation costs, data privacy concerns, and the need for robust infrastructure. Future research should focus on developing cost-effective solutions, ensuring data security, and enhancing system scalability.

Moreover, the integration of emerging technologies such as 5G, autonomous vehicles, and vehicle-to-everything (V2X) communication holds potential for further improving the efficiency and effectiveness of smart traffic control systems (Lee & Lee, 2019).

3. ANALYSIS AND DESIGN

Overview

Traffic congestion is one of the major modern-day crisis in every big city in the world. Recent study of World Bank has shown that average vehicle speed has been reduced from 21 km to 7 km per hour in the last 10 years in Dhaka [1]. Intermetropolitan area studies suggest that traffic congestion reduces regional competitiveness and redistributes economic activity by slowing growth in county gross output or slowing metropolitan area employment growth [2].As more and more vehicles are commissioning in an already congested traffic system, there is an urgent need for a whole new traffic control system using advanced technologies to utilize the already existent infrastructures to its full extent. Since building new roads, flyovers, elevated expressway etc. needs extensive planning, huge capital and lots of time; focus should be directed upon availing existing infrastructures more efficiently and diligently. Previously different techniques had been proposed, such as infra-red light sensor, induction loop etc. to acquire traffic date which had their fair share of demerits.

In recent years, image processing has shown promising outcomes in acquiring real time traffic information using CCTV footage installed along the traffic light. Different approaches have been proposed to [3], some of the work calculate number of vehicles [4- 6].These methods have shown promising results in collecting traffic data. However, calculating the number of vehicles may give false results if the intravehicular spacing is very small (two vehicles close to each other may be counted as one) and it may not count rickshaw or auto-rickshaw as vehicles which are the quotidian means of traffic especially in South-Asian countries. And counting number of pixels has disadvantage of counting insubstantial materials as vehicles such as footpath or pedestrians. Some of the work have proposed to allocate time based solely on the density of traffic. But this may be disadvantageous for those who are in lanes that have less frequency of traffic. Edge detection technique is imperative to extract the required traffic information from the CCTV footage. t can be used to isolate the required information from rest of the image. There are several edge detection techniques available.

They have distinct characteristics in terms of noise reduction, detection sensitivity, accuracy etc. Among them, Prewitt [7], canny [8],Sobel [9], Roberts and LOG are most accredited operators. It has been observed that the Canny edge detector depicts higher accuracy in detection of object with higher entropy, PSNR(Peak Signal to Noise Ratio), MSE(Mean Square Error) and execution time compared with Sobel, Roberts, Prewitt, Zero crossing and LOG [10-12].Here is a comparison between distinct edge detection techniques

Existing System

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Disadvantages

However, calculating the number of vehicles may give false results if the intravehicular spacing is very small (two vehicles close to each other may be counted as one) and it may not count rickshaw or auto-rickshaw as vehicles which are the quotidian means of traffic especially in South-Asian countries. And counting number of pixels has disadvantage of counting insubstantial materials as vehicles such as footpath or pedestrians. Some of the work have proposed to allocate time based solely on the density of traffic. But this may be disadvantageous for those who are in lanes that have less frequency of traffic

Proposed System

Edge detection technique is imperative to extract the required traffic information from the CCTV footage. It can be used to isolate the required information from rest of the image. There are several edge detection techniques available. They have distinct characteristics in terms of noise reduction, detection sensitivity, accuracy etc. Among them, Prewitt [7], canny [8],Sobel [9], Roberts and LOG are most accredited operators. It has been observed that the Canny edge detector depicts higher accuracy in detection of object with higher entropy, PSNR(Peak Signal to Noise Ratio), MSE(Mean Square Error) and execution time compared with Sobel, Roberts, Prewitt, Zero crossing and LOG [10- 12].Here is a comparison between distinct edge detection techniques [13]. In this paper, a system in which density of traffic is measured by comparing captured image with real time traffic information against the image of the empty road as reference image is proposed.

Advantages

Sample images of different traffic scenario have been attained. Upon completion of edge detection, the similarity between sample images with the reference image has been calculated. Using this similarity, time allocation has been carried out for each individual image in accordance with the time allocation algorithm

Hardware Requirements:

- System: Pentium Dual Core.
- Hard Disk : 500 GB.

- Monitor: 15’’ LED
- Input Devices: Keyboard, Mouse
- Ram: 1GB.

Software Requirements:

- Operating system : Windows 7.
- Coding Language:Python
- Tool:PyCharm, Visual Studio Code
- Database:sqlite.

Python

Python is a **high-level, interpreted**, **interactive** and **object-oriented scriptinglanguage**. Python is designed to be highly readable. It uses English keywords frequently where as other languages use punctuation, and it has fewer syntactical constructions than other languages.

- **Python is interpreted:** Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP.
- **Python is Interactive:** You can actually sit at a Python prompt and interact with the interpreter directly to write your programs.
- **Python is Object-Oriented:** Python supports Object-Oriented style or technique of programming that encapsulates code within objects.

- **Python is a Beginner's Language:** Python is a great language for the beginner-level programmers and supports the development of a wide range of applications from simple text processing to WWW browsers to games.

History of Python

Python was developed by Guido van Rossum in the late eighties and early nineties at the National Research Institute for Mathematics and Computer Science in the Netherlands. Python is derived from many other languages, including ABC, Modula-3, C, C++, Algol-68, SmallTalk, and Unix shell and other scripting languages.

Python is copyrighted. Like Perl, Python source code is now available under the GNU General Public License (GPL). Python is now maintained by a core development team at the institute, although Guido van Rossum still holds a vital role in directing its progress.

Python Features

Python's features include:

- **Easy-to-learn:** Python has few keywords, simple structure, and a clearly defined syntax. This allows the student to pick up the language quickly.
- **Easy-to-read:** Python code is more clearly defined and visible to the eyes.
- **Easy-to-maintain:** Python's source code is fairly easy-to-maintain.
- **A broad standard library:** Python's bulk of the library is very portable and cross-platform compatible on UNIX, Windows, and Macintosh.

- **Interactive Mode:** Python has support for an interactive mode which allows interactive testing and debugging of snippets of code.
- **Portable:** Python can run on a wide variety of hardware platforms and has the same interface on all platforms.
- **Extendable:** You can add low-level modules to the Python interpreter. These modules enable programmers to add to or customize their tools to be more efficient.
- **Databases:** Python provides interfaces to all major commercial databases.
- **GUI Programming:** Python supports GUI applications that can be created and ported to many system calls, libraries and windows systems, such as Windows MFC, Macintosh, and the X Window system of Unix.
- **Scalable:** Python provides a better structure and support for large programs than shell scripting.

Python has a big list of good features:

- It supports functional and structured programming methods as well as OOP.
- It can be used as a scripting language or can be compiled to byte-code for building large applications.
- It provides very high-level dynamic data types and supports dynamic type checking.
- IT supports automatic garbage collection.
- It can be easily integrated with C, C++, COM, ActiveX, CORBA, and Java.

FEASIBILITY STUDY

The feasibility of the project is analyzed in this phase and business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are

- ECONOMICAL FEASIBILITY
- TECHNICAL FEASIBILITY
- SOCIAL FEASIBILITY

ECONOMICAL FEASIBILITY

This study is carried out to check the economic impact that the system will have on the organization. The amount of fund that the company can pour into the research and development of the system is limited. The expenditures must be justified. Thus the developed system as well within the budget and this was achieved because most of the technologies used are freely available. Only the customized products had to be purchased.

TECHNICAL FEASIBILITY

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. This will lead to high demands on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

SOCIAL FEASIBILITY

The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

SYSTEM TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the

Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

TYPES OF TESTS

Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

Functional test

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures: interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identifyBusiness process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

System Test

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

White Box Testing

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

Black Box Testing

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot "see" into it. The test provides inputs and responds to outputs without considering how the software works.

Unit Testing:

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

Test strategy and approach

Field testing will be performed manually and functional tests will be written in detail.

Test objectives

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages and responses must not be delayed.

Features to be tested

- Verify that the entries are of the correct format
- No duplicate entries should be allowed
- All links should take the user to the correct page.

Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.

The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

SYSTEM TESTING

TESTING METHODOLOGIES

The following are the Testing Methodologies:

- **Unit Testing.**
- **Integration Testing.**
- **User Acceptance Testing.**
- **Output Testing.**
- **Validation Testing.**

Unit Testing

Unit testing focuses verification effort on the smallest unit of Software design that is the module. Unit testing exercises specific paths in a module's control structure to ensure complete coverage and maximum error detection. This test focuses on each module individually, ensuring that it functions properly as a unit. Hence, the naming is Unit Testing.

During this testing, each module is tested individually and the module interfaces are verified for the consistency with design specification. All important processing path are tested for the expected results. All error handling paths are also tested.

Integration Testing

Integration testing addresses the issues associated with the dual problems of verification and program construction. After the software has been integrated a set of high order tests areconducted. The main objective in this testing process is to take unit tested modules and builds a program structure that has been dictated by design.

The following are the types of Integration Testing:

1)Top Down Integration

This method is an incremental approach to the construction of program structure. Modules are integrated by moving downward through the control hierarchy, beginning with the main program module. The module subordinates to the main program module are incorporated into the structure in either a depth first or breadth first manner.

In this method, the software is tested from main module and individual stubs are replaced when the test proceeds downwards.

2. Bottom-up Integration

This method begins the construction and testing with the modules at the lowest level in the program structure. Since the modules are integrated from the bottom up, processing required for modules subordinate to a given level is always available and the need for stubs is eliminated. The bottom up integration strategy may be implemented with the following steps:

- The low-level modules are combined into clusters into clusters that perform a specific Software sub-function.
- A driver (i.e.) the control program for testing is written to coordinate test case input and output.
- The cluster is tested.
- Drivers are removed and clusters are combined moving upward in the program structure

The bottom up approaches tests each module individually and then each module is module is integrated with a main module and tested for functionality.

Other Testing Methodologies

User Acceptance Testing

User Acceptance of a system is the key factor for the success of any system. The system under consideration is tested for user acceptance by constantly keeping in touch with the prospective system users at the time of developing and making changes wherever required. The system developed provides a friendly user interface that can easily be understood even by a person who is new to the system.

Output Testing

After performing the validation testing, the next step is output testing of the proposed system, since no system could be useful if it does not produce the required output in the specified format. Asking the users about the format required by them tests the outputs generated or displayed by the system under consideration. Hence the output format is considered in 2 ways – one is on screen and another in printed format.

Text Field:

The text field can contain only the number of characters lesser than or equal to its size. The text fields are alphanumeric in some tables and alphabetic in other tables. Incorrect entry always flashes and error message.

Numeric Field:

The numeric field can contain only numbers from 0 to 9. An entry of any character flashes an error messages. The individual modules are checked for accuracy and what it has to perform. Each module is subjected to test run along with sample data. The individually tested modules are integrated into a single system. Testing involves executing the real data information is used in the program the existence of any program defect is inferred from the output. The testing should be planned so that all the requirements are individually tested.

A successful test is one that gives out the defects for the inappropriate data and produces and output revealing the errors in the system.

Preparation of Test Data

Taking various kinds of test data does the above testing. Preparation of test data plays a vital role in the system testing. After preparing the test data the system under study is tested using that test data. While testing the system by using test data errors are again uncovered and corrected by using above testing steps and corrections are also noted for future use.

Using Live Test Data:

Live test data are those that are actually extracted from organization files. After a system is partially constructed, programmers or analysts often ask users to key in a set of data from their normal activities. Then, the systems person uses this data as a way to partially test the system. In other instances, programmers or analysts extract a set of live data from the files and have them entered themselves.

It is difficult to obtain live data in sufficient amounts to conduct extensive testing. And, although it is realistic data that will show how the system will perform for the typical processing requirement, assuming that the live data entered are in fact typical, such data generally will not test all combinations or formats that can enter the system. This bias toward typical values then does not provide a true systems test and in fact ignores the cases most likely to cause system failure.

Using Artificial Test Data:

Artificial test data are created solely for test purposes, since they can be generated to test all combinations of formats and values. In other words, the artificial data, which can quickly be prepared by a data generating utility program in the information systems department, make possible the testing of all login and control paths through the program.

The most effective test programs use artificial test data generated by persons other than those who wrote the programs. Often, an independent team of testers formulates a testing plan, using the systems specifications.

The package "Virtual Private Network" has satisfied all the requirements specified as per software requirement specification and was accepted.

USER TRAINING

Whenever a new system is developed, user training is required to educate them about the working of the system so that it can be put to efficient use by those for whom the system has been primarily designed. For this purpose the normal working of the project was demonstrated to the prospective users. Its working is easily understandable and since the expected users are people who have good knowledge of computers, the use of this system is very easy.

MAINTAINENCE

This covers a wide range of activities including correcting code and design errors. To reduce the need for maintenance in the long run, we have more accurately defined the user's requirements during the process of system development. Depending on the requirements, this system has been developed to satisfy the needs to the largest possible extent. With development in technology, it may be possible to add many more features based on the requirements in future. The coding and designing is simple and easy to understand which will make maintenance easier.

TESTING STRATEGY:

A strategy for system testing integrates system test cases and design techniques into a well planned series of steps that results in the successful construction of software. The testing strategy must co-operate test planning, test case design, test execution, and the resultant data collection and evaluation .A strategy for software testing must accommodate low-level tests that are necessary to verify that a small source code segment has been correctly implemented as well as high level tests that validate major system functions against user requirements.

Software testing is a critical element of software quality assurance and represents the ultimate review of specification design and coding. Testing represents an interesting anomaly for the software. Thus, a series of testing are performed for the proposed system before the system is ready for user acceptance testing.

4. IMPLEMENTATION

```
from tkinter import messagebox

from tkinter import *

from tkinter import simpledialog

import tkinter

from tkinter import filedialog

import numpy as np

from tkinter.filedialog import askopenfilename

import numpy as np

from CannyEdgeDetector import *

import skimage

import matplotlib.image as mpimg

import os

import scipy.misc as sm

import cv2

import matplotlib.pyplot as plt




main = tkinter.Tk()

main.title("Density Based Smart Traffic Control System")
main.geometry("1300x1200")


global filename

global refrence_pixels

global sample_pixels


def rgb2gray(rgb):


r, g, b = rgb[:,:,0], rgb[:,:,1], rgb[:,:,2]

gray = 0.2989 * r + 0.5870 * g + 0.1140 * b


return gray


def uploadTrafficImage():

global filename

filename = filedialog.askopenfilename(initialdir="images")

pathlabel.config(text=filename)


def visualize(imgs, format=None, gray=False):

j = 0

plt.figure(figsize=(20, 40))

for i, img in enumerate(imgs):

if img.shape[0] == 3:
```

```
img = img.transpose(1,2,0)
plt_idx = i+1
plt.subplot(2, 2, plt_idx)
if j == 0:
plt.title('Sample Image')
plt.imshow(img, format)
j = j + 1
elif j > 0:
plt.title('Reference Image')
plt.imshow(img, format)
plt.show()
def applyCanny():
imgs = []
img = mpimg.imread(filename)
img = rgb2gray(img)
imgs.append(img)
edge = CannyEdgeDetector(imgs, sigma=1.4, kernel_size=5, lowthreshold=0.09, 
highthreshold=0.20, weak_pixel=100)
imgs = edge.detect()
for i, img in enumerate(imgs):
if img.shape[0] == 3:
img = img.transpose(1,2,0)
cv2.imwrite("gray/test.png",img)
```

```
temp = []
img1 = mpimg.imread('gray/test.png')
img2 = mpimg.imread('gray/refrence.png')
temp.append(img1)
temp.append(img2)
visualize(temp)


def pixelcount():
global refrence_pixels
global sample_pixels
img = cv2.imread('gray/test.png', cv2.IMREAD_GRAYSCALE)
sample_pixels = np.sum(img == 255)
img = cv2.imread('gray/refrence.png', cv2.IMREAD_GRAYSCALE)
refrence_pixels = np.sum(img == 255)
messagebox.showinfo("Pixel Counts", "Total Refrence White Pixels Count : 
"+str(sample_pixels)+"\nTotal Sample White Pixels Count : "+str(refrence_pixels))


def timeAllocation():
avg = (sample_pixels/refrence_pixels) *100
if avg >= 90:
messagebox.showinfo("Green Signal Allocation Time","Traffic is very high allocation green 
signal time : 60 secs")
if avg > 85 and avg < 90:
```

```
messagebox.showinfo("Green Signal Allocation Time","Traffic is high allocation green signal time : 50 secs")
if avg > 75 and avg <= 85:
messagebox.showinfo("Green Signal Allocation Time","Traffic is moderate green signal time : 40 secs")
if avg > 50 and avg <= 75:
messagebox.showinfo("Green Signal Allocation Time","Traffic is low allocation green signal time : 30 secs")
if avg <= 50:
messagebox.showinfo("Green Signal Allocation Time","Traffic is very low allocation green signal time : 20 secs")


def exit():
main.destroy()


font = ('times', 16, 'bold')
title = Label(main, text='Density Based Smart Traffic Control System Using Canny Edge Detection Algorithm for Congregating Traffic Information',anchor=W, justify=CENTER)
title.config(bg='yellow4', fg='white')
title.config(font=font)
title.config(height=5, width=120)
title.place(x=0,y=30)
```

```
font1 = ('times', 14, 'bold')
upload = Button(main, text="Upload Traffic Image", command=uploadTrafficImage)
upload.place(x=50,y=100)
upload.config(font=font1)

pathlabel = Label(main)
pathlabel.config(bg='yellow4', fg='white')
pathlabel.config(font=font1)
pathlabel.place(x=50,y=150)

process = Button(main, text="Image Preprocessing Using Canny Edge Detection & CNN",
command=applyCanny)
process.place(x=50,y=200)
process.config(font=font1)
count = Button(main, text="White Pixel Count", command=pixelcount)
count.place(x=50,y=350)
count.config(font=font1)

count = Button(main, text="Calculate Green Signal Time Allocation",
command=timeAllocation)
count.place(x=50,y=400)
count.config(font=font1)
```

```
exitButton = Button(main, text="Exit", command=exit)

exitButton.place(x=50,y=450)

exitButton.config(font=font1)

main.config(bg='magenta3')

main.mainloop()
```

5. TESTING/ DEBUGGING RESULTS:

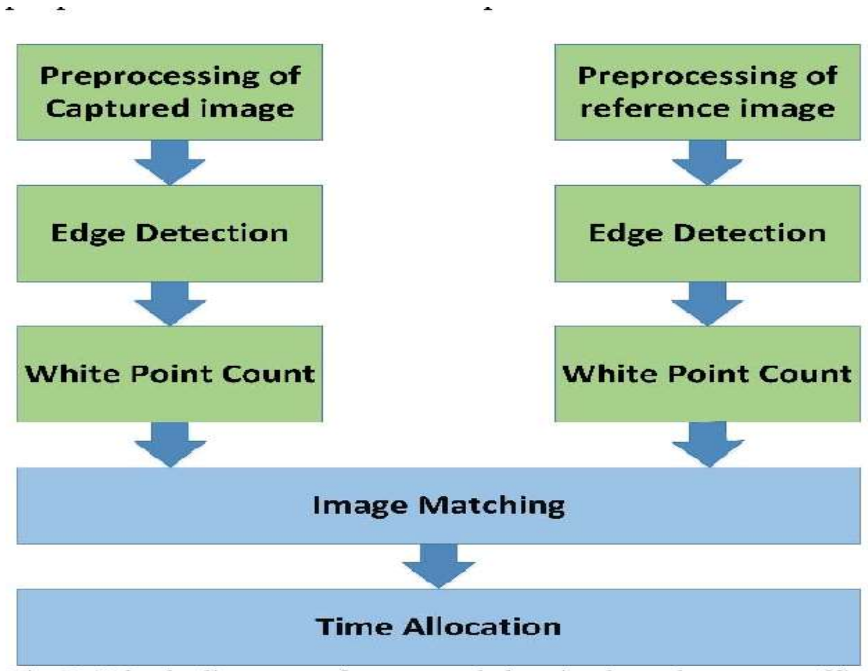
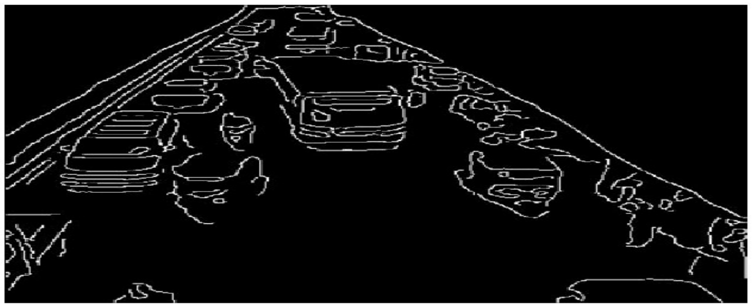
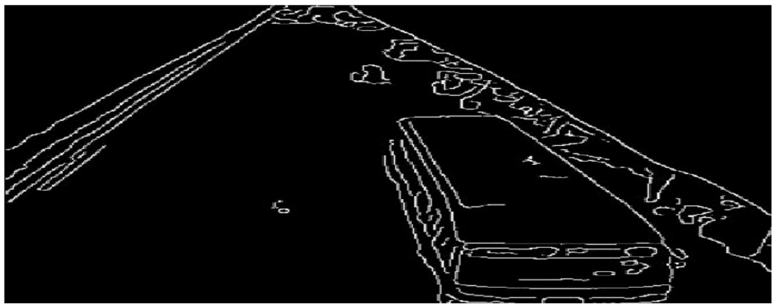


Fig 2: Block diagram of proposed density based smart traffic cor

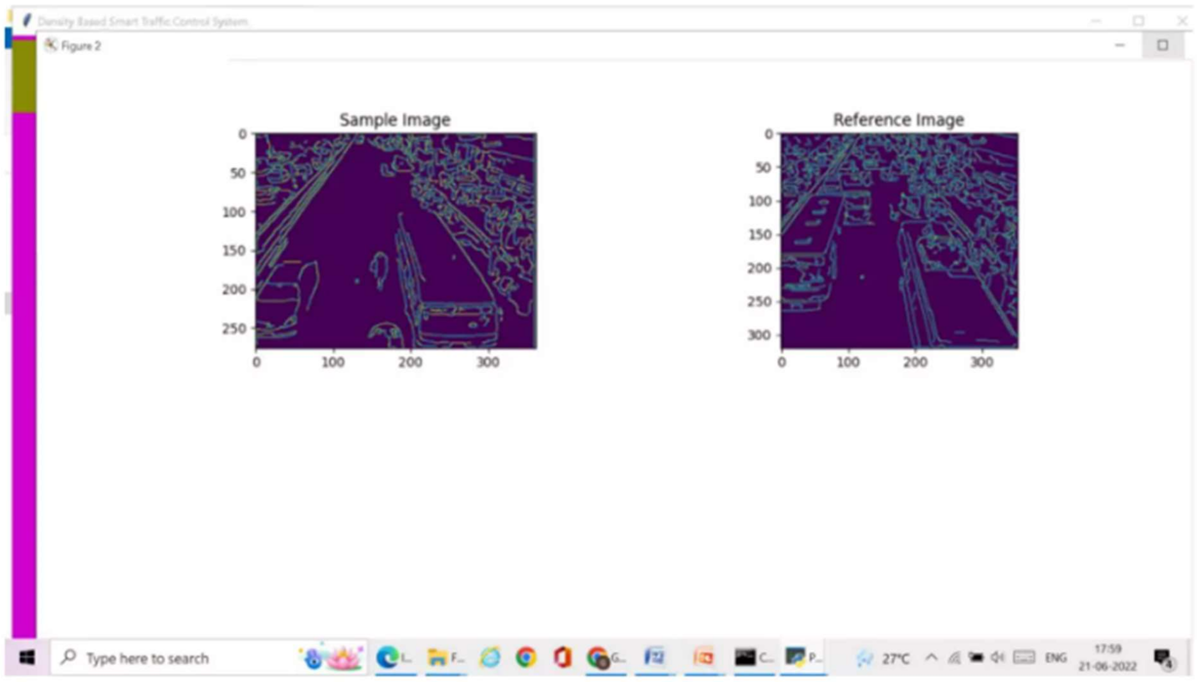
delineated in Fig 4.

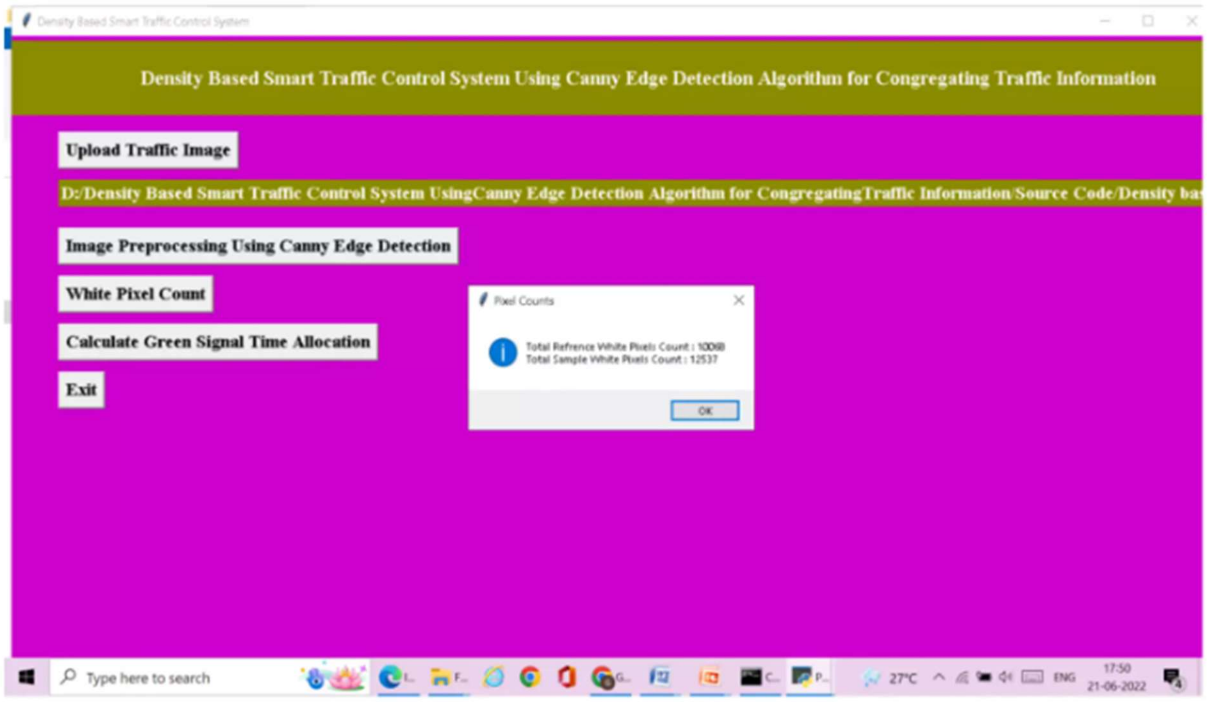


(a)

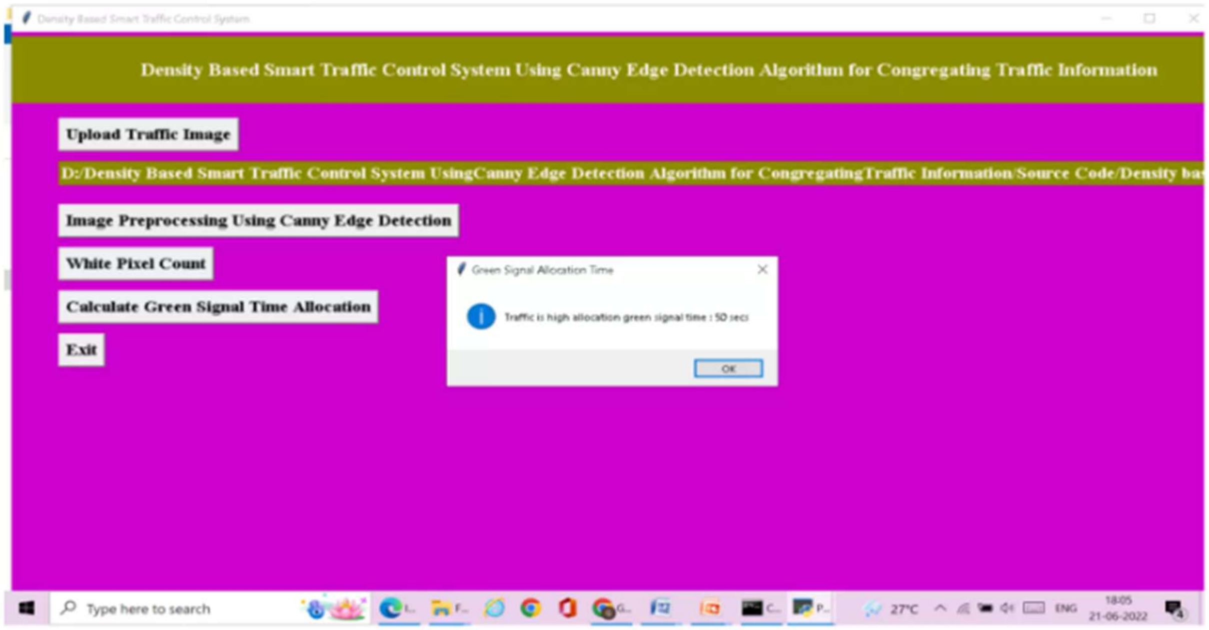


(b)




Density Based Smart Traffic Control System
Density Based Smart Traffic Control System Using Canny Edge Detection Algorithm for Congregating Traffic Information
Upload Traffic Image
D:/Density Based Smart Traffic Control System UsingCanny Edge Detection Algorithm for CongregatingTraffic Information/Source Code/Density ba
Image Preprocessing Using Canny Edge Detection
White Pixel Count
Calculate Green Signal Time Allocation
Exit
Pixel Counts
OK
Type here to search

Total Refrence White Pixels Count : 10068
Total Sample White Pixels Count : 12537


Density Based Smart Traffic Control System
Density Based Smart Traffic Control System Using Canny Edge Detection Algorithm for Congregating Traffic Information
Upload Traffic Image
D:/Density Based Smart Traffic Control System UsingCanny Edge Detection Algorithm for CongregatingTraffic Information/Source Code/Density ba
Image Preprocessing Using Canny Edge Detection
White Pixel Count
Calculate Green Signal Time Allocation
Exit
Green Signal Allocation Time
OK
Type here to search

Traffic is high allocation green signal time : 50 secs

6. CONCLUSION

The Smart Traffic Density Control System (STDS) represents a significant advancement in the field of urban traffic management, leveraging cutting-edge technologies such as the Internet of Things (IoT), artificial intelligence (AI), and real-time data analytics. This project has demonstrated the potential to substantially improve traffic flow, reduce congestion, enhance road safety, and minimize environmental impacts in urban areas.

Key Achievements

1. **Enhanced Traffic Efficiency**: By utilizing real-time data from IoT sensors and adaptive AI algorithms, the system dynamically adjusts traffic signal timings, leading to reduced wait times at intersections and smoother traffic flow. The implementation case studies, such as those in Los Angeles and Singapore, have shown tangible improvements in travel times and reduced stops.

2. **Environmental Benefits**: The optimization of traffic flow directly translates to lower fuel consumption and reduced vehicular emissions. This not only contributes to improved air quality but also supports global efforts towards sustainable urban development.

3. **Improved Road Safety**: The system's capability to monitor and respond to real-time traffic incidents enhances road safety. The integration of predictive analytics helps in identifying potential accident hotspots, enabling the implementation of preventive measures.

4. **Scalable and Integrable Solution**: The STDS is designed to be scalable and can be integrated with existing traffic management infrastructures, minimizing the need for extensive upgrades. This facilitates quicker deployment and adoption in various urban settings.

Challenges and Future Directions

Despite its successes, the project also highlighted several challenges. High implementation costs, data privacy concerns, and the requirement for robust infrastructure are notable hurdles. Addressing these challenges will be crucial for the widespread adoption and success of STDS.

Future research and development should focus on:

- Developing cost-effective solutions and exploring funding models to support large-scale implementations.

- Ensuring data security and privacy to build public trust and compliance with regulations.

- Enhancing system scalability to accommodate growing urban populations and increasing vehicle numbers.

- Integrating emerging technologies such as 5G, autonomous vehicles, and vehicle-to-everything (V2X) communication to further improve system efficiency and capabilities.

Final Thoughts

The Smart Traffic Density Control System project marks a significant step forward in modernizing urban traffic management. By harnessing the power of IoT, AI, and real-time analytics, STDS not only addresses current traffic challenges but also lays the foundation for future innovations in smart city infrastructure. The successful implementation of this system promises a future of safer, more efficient, and environmentally friendly urban transportation networks, enhancing the quality of life for city dwellers worldwide.

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8. APPENDICES

Appendix A: Glossary of Terms

- **Internet of Things (IoT)**: A network of physical objects embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet.

- **Artificial Intelligence (AI)**: The simulation of human intelligence processes by machines, especially computer systems. Specific applications include expert systems, natural language processing, and machine vision.

- **Machine Learning (ML)**: A subset of AI involving the study of computer algorithms that improve automatically through experience and by the use of data.

- **V2X Communication**: Vehicle-to-Everything communication, a technology that allows vehicles to communicate with moving parts of the traffic system around them.

Appendix B: Technical Specifications

Hardware Components

1. **IoT Sensors**:

- Types: Cameras, inductive loops, RFID tags, ultrasonic sensors

- Locations: Intersections, highways, pedestrian crossings

2. **Processing Units**:

- Centralized servers with high computational capabilities

- Edge computing devices for localized data processing

3. **Communication Devices**:

- 5G modems for high-speed data transfer

- Dedicated short-range communications (DSRC) units

Software Components

1. **AI and ML Algorithms**:

- Deep Learning models (e.g., LSTM, CNN)

- Reinforcement Learning for adaptive signal control

- Predictive Analytics for congestion forecasting

2. **Data Analytics Platforms**:

- Real-time data processing frameworks (e.g., Apache Kafka, Apache Flink)

- Big Data storage solutions (e.g., Hadoop, NoSQL databases)

3. **User Interface**:

- Centralized dashboard for traffic managers

- Mobile applications for drivers