COMPUTER VISION BASED STREET WIDTH MEASUREMENT FOR URBAN AESTHETICS IDENTIFICATION

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering.

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DHAKA, BANGLADESH

SEPTEMBER 2018

APPROVAL

This Project titled **"Computer Vision Based Street Width Measurement for Urban Aesthetics Identification"**, submitted by Umme Rubaiyat Chowdhury (143-15-4305) and Manoj Roy (143-15-4292) to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering (BSc) and approved as to its style and contents. The presentation has been held on 15-9-2018

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Dr. Md. Hasanuzzaman, Adjunct Professor, Department of CSE,** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ACKNOWLEDGEMENT

First we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year thesis successfully.

We really grateful and wish our profound our indebtedness to **Dr. Md. Hasanuzzaman**, **Adjunct Professor**, Department of CSE, Daffodil International University, Dhaka. Deep Knowledge and keen interest of our supervisor in the field of "*Computer Vision*" to carry out this project. His endless patience ,scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to **Prof. Dr. Syed Akhter Hossain, Head,** Department of CSE, for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

This paper presents a computer-vision based Street-Width measurement system for Urban Aesthetics identification. In this system image is captured using a digital camera. In the pre-processing section the image is scaled in high to low resolution. The methodology used to identify object was contour tracing and canny edge detection algorithm. Then the object is measured by generalizing the pixel mapping. Finally the finding output is matched with the Standard Street Measurement.

The measurement findings in this proposed methodology was then analyzed and based on some criteria the street aesthetics of Dhaka city was provided.

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CHAPTER 1

Introduction

1.1 Introduction

"Computer Vision Based Street Width Measurement for Urban Aesthetics Identification" is a thesis work with procedural Image processing techniques. In this work we tried to define Urban Aesthetics on the basis of Street Width criterion. Though the study of the aesthetic characteristics of cities must go beyond concern only for the design of some of their parts, such as boulevards, parks, and civic centers but it is necessary to maintain some standard. According to the "Interstate Highway standards" of United States of America a single lane road should use a 12-foot (3.7 m) standard lane width. [1]

Our thesis mainly focuses on the streets of Dhaka City. Dhaka is the most populated country in Bangladesh with a population of 18.237 million. [2] Being the capital city the daily crowd in the street of Dhaka is very superfluous. So, the necessity of standard maintenance is a must need. The aesthetics of any urban areas can also be defined through the condition of Street, Buildings, and Shops etc. Nowadays modern algorithms and processors enable us to extract hidden data from image using various specialized techniques. So, we have decided to measure the roads from image and analyze them with the standard to identify the street aesthetics of Dhaka city.

1.2 Motivation

A considerable amount of the streets and flyovers in the Dhaka city are in poor condition. The condition has become much serious as accidents are going on every day. It additionally makes serious harm to the running vehicles. It is a right of the citizens to have better streets for their vehicles. The entire transport framework is badly influenced because of the poor states of the streets. The concerned experts need to make an essential move in such manner. The current circumstance has truly turned out to be difficult and troubling for the citizens. To check and verify the condition and status of roads only the authority can take necessary steps. But to take any action they have to go through the existing manual procedure. From

here the motivation of our project comes. A digital image is a very easy and reliable data nowadays. High-resolution images are able to capture and store very subtle information to use for further processing. We want to measure the street width of various locations of Dhaka city and match it with standard road width to be able to find out the disproportion with Standard Roads. Through this, we will provide a statistical analysis of Urban Aesthetics of Streets of Dhaka City.

1.3 Rationale of Study

As most of the techniques are developed already we had to study all the existing methodologies. In this section we have added some literature review to support the proper Methodology of our work. The description is given below-

Mr. Nan Jiang and Zhongding Jiang in their research paper entitled *"Distance Measurement from Single Image Based on Circles" described* about processing separation. Processing separation from captured pictures is a typical undertaking in picture investigation and scene understanding. Separation fills in as building obstruct for computing other geometry data, for example, territory and volume. Other than straightforwardly estimating separation on the spot, it can be processed utilizing projective geometry from scene pictures. Existing work on separate estimation considers the point or line limitations. Since circles are basic in day by day life, this paper proposes two techniques for estimating separation utilizing hovers in one caught picture. The main technique manages two separate circles, which can be coplanar or in parallel planes. The second one handles two concentric circles on a similar plane, which offers higher precision than straightforwardly fathoming conditions of concentric circles. The two strategies are checked by explores different avenues regarding mimicked information and genuine pictures.

The primary result was two strategies for estimating separation in light of circles from a solitary picture. The principal technique handles two separate parallel circles while the

second one manages two concentric circles. Reproduced and genuine information tests confirm that the proposed techniques offer high precision and strength. They are helpful for straightforwardly estimating the separation between two focuses on the reference plane from the single uncalibrated picture. [3]

Mr. Khandaker Abir Rahman, Md. Shafaeat Hossain, Md. Al-Amin Bhuiyan, Tao Zhang, Md. Hasanuzzaman and H. Ueno in their research paper entitled *"Person to Camera Distance Measurement Based on Eye-Distance"* described about removing estimation framework in light of eye-separation. The separation between the focuses of two eyes is utilized for estimating the individual to camera separate. The variety in eye-separate (in pixels) with the adjustments in camera to individual separation (in inches) is utilized to define the separation estimating framework. The framework begins with figuring the separation between two eyes of a man and at that point individual to camera separate is estimated. The proposed separate estimation framework is moderately straightforward and modest to actualize as it doesn't require some other outer separation estimating devices. The trial comes about to show the viability of the framework with a normal exactness of 94.11%.

The proposed strategy has noteworthy significance as a result of its lower cost and less complex calculation for ongoing execution. In view of the straightforwardness of the proposed approach, equipment concentrated methods, for example, echo detection, extra CCD cameras, laser projector, spotlights and so on are never again required for getting a palatable individual to camera separate estimation. Conversely, the precision of the deliberate face to camera separate technique diminishes as the person moves far from the camera. [4]

Mr Limeng Pu, Rui Tian Hsiao-Chun Wu, Kun Yan in their research paper entitled *"Novel object-size measurement using the digital camera" described about* a novel way to deal with the measurement utilizing a customary advanced camera. These days, the remote protest estimation is exceptionally critical to numerous interactive media applications. The proposed method depends on another profundity data extraction (extend discovering) conspire to utilize a general advanced camera. The customary rangefinders are frequently

completed utilizing the detached strategy, for example, stereo cameras or the dynamic technique, for example, ultrasonic and infrared hardware. The proposed approach requires just an advanced camera with certain picture handling procedures and depends on the essential standards of noticeable light. The normal blunder level of this technique is underneath 2%. [5]

This new structure can quantify the sizes of various protests in the scene utilizing maybe a couple photographed shots. The viability of the proposed conspire is exhibited by means of different investigations.

1.4 Research Questions

This thesis tends to the development of urban lifestyle. We want to characterize the road standard of Dhaka by measuring width of roads from image. We found numbers of methodologies to perform object measurement. But in this proposed methodology we have focused on Camera to object distance ratio to properly measure the road width. Finally this paper tries to define the road aesthetics of Dhaka city whether it is standard or not being the capital city of Bangladesh.

1.5 Expected Outcome

The expected outcome of our project is to provide accurate result of roads from an image. We want to perform this task for main roads of Dhaka city. Here is an example image provided for the expected outcome result.

Figure 1.5.1: Expected Outcome of the Project

1.6 Report Layout

Chapter 1: Introduction

In this chapter we have analyzed the motivation behind choosing this project. We have also discussed about some literature review and expected outcome from the research work.

Chapter 2: Background

In this chapter we have discussed about the related works, limitations and challenges we faced.

Chapter 3: Research Methodology

The research methodology chapter includes all the basic needs to acquire final outcome of our project. This one is the most important chapter of this report where every step is discussed broadly. The data collection procedure and implementation is also analyzed here in this chapter.

Chapter 4: Experiment Result and Discussion

In this chapter we have analyzed the actual outcome we got from this thesis work. We also compared our result with existing system and found out error rate of our project.

Chapter 5: Summary, Conclusion and Implication for Future Research

Throughout the whole project what we have learnt out, the conclusion and our future plan is discussed in this chapter. This chapter will also include the surrounding to avoid the challenges of our project.

CHAPTER 2
Background

2.1 Introduction

Being a very popular topic of computing it has become very common to have similar projects in Image Processing sector. But the implication in road data and establishing urban Planning prototype does not exist. In further studies we will discuss about similar software and technologies.

2.2 Related Works

We found out lots of methodologies existing to measure the object size. The approach we proposed is quite similar to *Mr. Nan Jiang and Zhongding Jiang* [3]. They have measured the distance based on circle volume on uncalibrated image. The other methodology proposed by *Mr Limeng Pu, Rui Tian Hsiao-Chun Wu, Kun Yan* don't require any external hardware to measure the actual distance. But it requires multiple image of same object to finally obtain the measurement of the object. [5]. Here in this section we have also tried to cover all the existing commercial softwares that exist with the capability with object measurement features.

2.2.1 ImageJ

ImageJ is a public domain Java picture handling program enlivened by NIH Image for the Macintosh. It runs, either as an online applet or as a downloadable application, on any PC with a Java 1.4 or later virtual machine. Downloadable disseminations are accessible for Windows, Mac OS, Mac OS X, and Linux. It has the feature of selection from a particular image and then measure the object. [7]

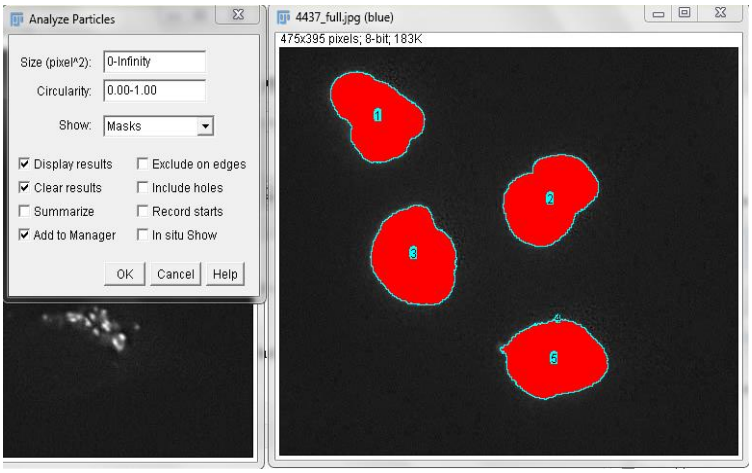

Figure 2.2.1: ImageJ Object Measure Example

2.2.2 Matlab

In Matlab there is also the feature entitled object measurement. But this measurement needs calibrated [8] image. Here is given an example of Matlab Object detection procedure.

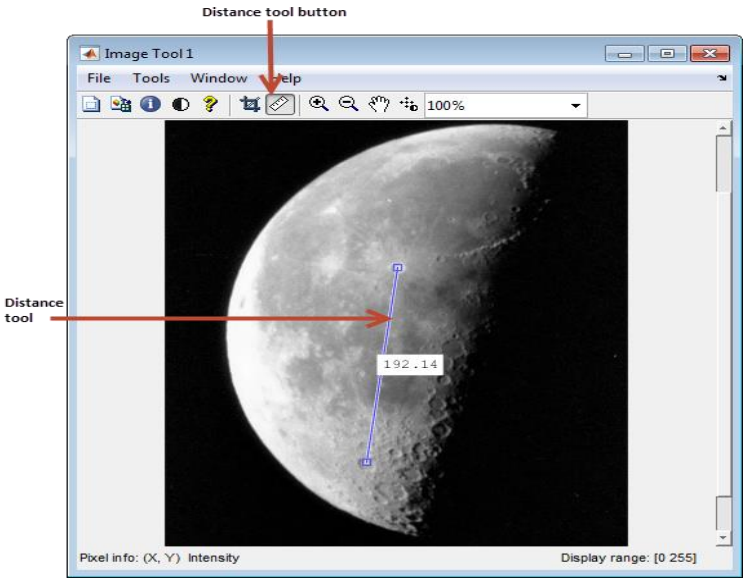

Figure 2.2.2: MatLab Object Measure Example

2.2.3 Fiji

Fiji is a picture preparing bundle. It can be portrayed as a dispersion of ImageJ together with Java, Java 3D and a ton of modules sorted out into a lucid menu structure. Fiji looks at to ImageJ as Ubuntu analyzes to Linux.

The fundamental focal point of Fiji is to help inquire about in life sciences.

2.2.4 JMicroVision

JMicroVision is a picture examination tool [9] compartment for estimating and measuring parts of top quality pictures. The program contains the majority of the basic picture handling tasks, has a straightforward and instinctive UI, a proficient representation framework and inventive highlights. It contains devices to evaluate either physically or naturally. But this tool is currently not available on the official domain.

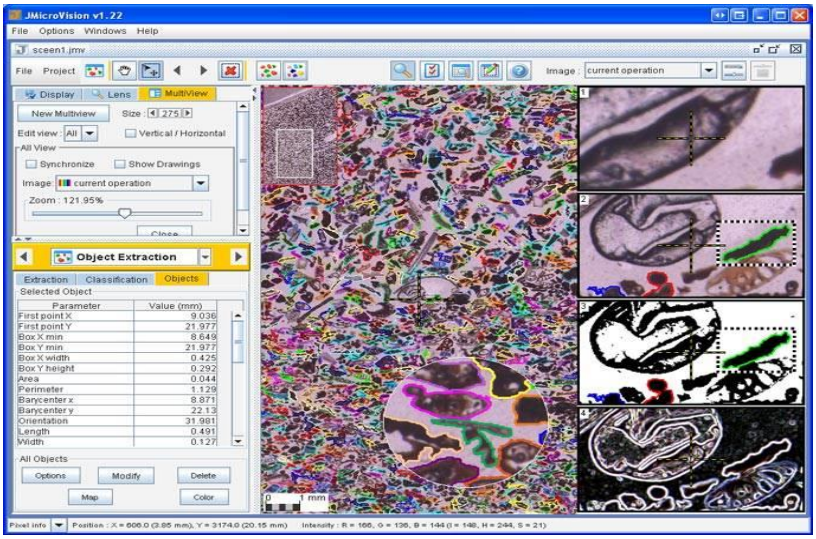

Figure 2.2.4: JMicroVision Object Measure Example

2.3 Research Summary

From the knowledge of all study and related work it is seen that the object size detection is an important issue to figure out, that may be applied in different aspects. But every existing method is specially designed for biological research and Improvements. This thesis work represents the whole procedure including road image acquisition, pre-processing the

image, detecting the road and measurement of the road from various camera distance. Finally, the proposed system in this thesis work can provide the street aesthetics information of Dhaka city.

2.4 Scope of the Problem

In this work we have shown a methodology to determine object width from a road image. The expected outcome is able to resolve lots of issues like urban planning, event management, interior design and of course medical processing.

2.5 Challenges

As in our work we have not used any external sensor and tried to measure object size from uncalibrated image there remains some challenges that needed to be resolved. Different distance from camera and camera calibration were the challenges that we resolved using our proposed methodology. As the further implication of this project needs a huge database The Google Street View and Google Map API might be a reliable source. But in this section we were facing the real-time data problem. As Google Street View data are not updated regularly.

CHAPTER 3

Proposed System Description

3.1 Introduction

Lots of techniques have been developed in the field of Image Processing in the last four to five decades. Among them, most of the methods are developed for enhancing images that have been acquired from unpopulated space pierces, space-shuttle and military reconnaissance flights. Image processing programs has become increasingly common due to the availability of powerful computers, memory equipment, technical software and more.

Image processing involves problems related to image representation, technical pressure, and complex complicated functionality, which can be presented on photo data. Functions performed under imagery photo enhancement activities such as sharpening, blurring, brightening, edge enhancement etc.

Using the features mentioned above to process an image, we suggest a procedure that can be used to measure the roads of Dhaka, The Capital of Bangladesh. The block diagram of the proposed algorithm is given below-

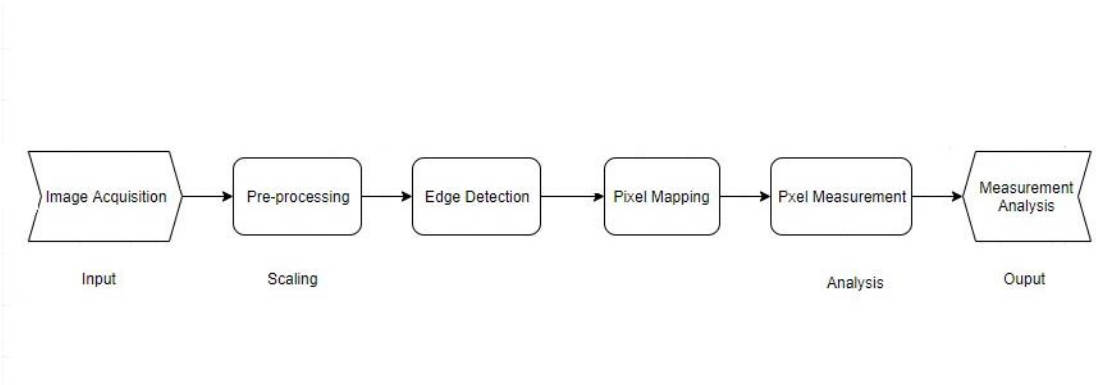

Figure 3.1: Block Diagram of "Object-Width Detection Using Image Processing"

The Block diagram above gives an overview of how we have measured an object using image processing. All the components in Block diagram are explained in the next Section.

3.2 Research Subject and Instrumentation

The area requires a lot of fundamental knowledge and procedure to achieve the goal of this research. We have tried to explain all of them in this section.

3.2.1 Image Acquisition

Typically, the image is in two-dimensional (x, y) (here x and y combine the plane). If the amplitude of the image anyhow is f, it is known as the image intensity. It is also called the gray level of an image at that point. We must change these x and y values to complete the correct value for the discrete digital image. The input image is a fundus taken from stare database. We need to convert the analog image to digital image to process it through a digital computer. Each digital image composed of finite elements and each finite element is called a pixel. [10]

In this project we have used images of the main road of Dhaka city. The project needed a vast amount of image database. As a result we decided to use Google street view image.

3.2.2 Image Preprocessing

3.2.2.1 Image Scaling

Image scaling in the digital image occurs at some certain points whether this is in Bayer demosaicing or in photo enlargement. It happens at any time when we need to resize our image from the one-pixel grid to another grid. Conversion of an image is required if we want to increase or decrease the total number of transmissions in an image. Although the same dimension is made, the result may differ depending on the algorithm.

In this project, Photos have been resized due to the number of reasons but one of them is very important to our project. All camera has its own solution, so when the system is created for some camera details it will not go correctly with any other camera depending

on the same features. So it is necessary to make a regular solution to the application and then make an image of conversion.

The original image we have captured in a mobile device is with resolution 5520*4140. If the original resolution is processed to detect the object width it outdoes the screen resolution as the testing device screen resolution is 1366*768. For this the image is resized using a python code to a resolution of 600*450. This one is the only one and major pre-processing used in our project.

3.2.2.2 BGR TO Gray Scale Conversion

People analyze colors using wavelength-sensitive cells known as cones. There are three different types of cones, each with a different sensitivity of magnetic radiation of a wide range of waves. Different cones are sensitive to different lights. One is sensitive to green light, one is to red and one is to blue light. When it flashes a combination of three colors (red, green, blue) and promotes three types of cones, it is also possible to make almost any of the colors to be seen by us. This is why the features of colors are always kept as three separate image matrices; One keeps as red (R) in each pixel, another one in green pixel (G) and the other one as Blue (B). This model is known as the RGB color model. However, we do not consider the amount of effuse in the grayscale image, rather than we emit the same amount in each channel of a grayscale image. Here little light gives dark pixels and much light is perceived as bright pixels. During the conversion of an RGB image into a Grayscale image, we need to consider the RGB parameters for each of the pixel and make as a single value output reflecting the brightness of that respective pixel. (R + B + C) / 3. Since the light is understood to be governed by the green section, a different, human-oriented method, the way to make it is to consider a weighted average of the notes, for example, 0.2R + 0.39G + 0.47B

3.2.2.3 Gaussian Blur

In picture preparing, a Gaussian [11] obscure (otherwise called Gaussian smoothing) is the consequence of obscuring a picture by a Gaussian capacity (named after mathematician

and researcher Carl Friedrich Gauss). It is a broadly utilized impact in designs programming, commonly to lessen picture clamor and decrease detail. The visual impact of this obscuring procedure is a smooth obscure looking like that of a survey the picture through a translucent screen, particularly not the same as the Bokeh impact delivered by an out-of-center focal point or the shadow of a question under normal enlightenment. Gaussian smoothing is likewise utilized as a pre-preparing stage in PC vision calculations keeping in mind the end goal to upgrade picture structures at various scales like scale space portrayal and scale space execution.

Numerically, if we apply a Gaussian dim to a picture it becomes the same as involving the image with a Gaussian capacity. This is otherwise called a two-dimensional Weierstrass change.

3.2.3 Edge Detection

Edge detection incorporates an assortment of scientific techniques that go for distinguishing focuses in an advanced picture at which the picture splendor changes forcefully or, all the more formally, has discontinuities. The focuses at which picture brilliance changes strongly are commonly sorted out into an arrangement of bended line portions named edges. A similar issue of discovering discontinuities in one-dimensional signs is known as step identification and the issue of discovering signal discontinuities after some time is known as change location. Edge location is a principal device in picture handling, machine vision, and PC vision, especially in the regions of highlight discovery and highlight extraction. [12]

In the perfect case, the consequence of applying an edge finder to a picture may prompt an arrangement of associated bends that demonstrate the limits of items, the limits of surface markings and additionally bends that relate to discontinuities in a surface introduction. In this manner, applying an edge identification calculation to a picture may essentially decrease the measure of information to be handled and may, along these lines, sift through data that might be viewed as less applicable, while saving the imperative basic properties

of a picture. On the off chance that the edge identification step is effective, the ensuing assignment of translating the data substance in the first picture may, along these lines, be significantly improved. In any case, it isn't generally conceivable to get such perfect edges from genuine pictures of direct multifaceted nature. [13][14]

3.2.3.1 Edge Detection Techniques:

In our task, we utilize "Canny EDGE Recognition System" due to its different points of features over other edge discovery procedures.

3.2.3.2 Canny Edge Detection

The Canny Edge detection [16] is a standout amongst the most ordinarily utilized picture handling devices identifying edges in an extremely vigorous way. It is a multi-step process, which can be actualized on the GPU as an arrangement of channels. Canny edge recognition strategy depends on three fundamental targets. [15] [17]

- Low mistake rate
- Edge point ought to be very much restricted
- Single edge point reaction

3.2.4 Dilation and Erosion

Morphology is an expansive arrangement of picture handling activities that procedure pictures in light of shapes. Morphological tasks apply an organizing component to an information picture, making a yield picture of a similar size. In a morphological task, the estimation of every pixel in the yield picture depends on a correlation of the relating pixel in the information picture with its neighbors. By picking the size and state of the area, you can build a morphological task that is delicate to particular shapes in the info picture. [18][19]

The most fundamental morphological tasks are widening and disintegration. Enlargement adds pixels to the limits of articles in a picture, while disintegration expels pixels on question limits. The quantity of pixels included or expelled from the articles in a picture relies upon the size and state of the organizing component used to process the picture. In the morphological expansion and disintegration tasks, the condition of any given pixel in the yield picture is controlled by applying an administer to the relating pixel and its neighbors in the information picture. The govern used to process the pixels characterizes the activity as an enlargement or a disintegration. This table records the principles for both widening and disintegration.

Widening and disintegration are two major morphological tasks. Widening adds pixels to the limits of articles in a picture, while disintegration expels pixels on question limits. The quantity of pixels included or expelled from the articles in a picture relies upon the size and state of the organizing component used to process the picture.

Table 1: Principles for Dilation and Erosion

Operation	Rule
Dilation	The estimation of the yield pixel is the most extreme estimation of the considerable number of pixels in the information pixel's neighborhood. In a paired picture, if any of the pixels is set to the esteem 1, the yield pixel is set to 1.
Erosion	The estimation of the yield pixel is the base estimation of the considerable number of pixels in the information pixel's neighborhood. In a paired picture, if any of the pixels is set to 0, the yield pixel is set to 0.

3.2.5 Contour Tracing

Also called as border following or boundary following or limit following; contour tracing is a system that is connected to advanced pictures so as to extricate their limit. [20][21]
An advanced picture is a gathering of pixels on a square decoration each having a specific esteem. We will consider this with bi-level pictures i.e. every pixel can have one of 2 conceivable qualities to be specific:
1, in which case we'll think of it as a "dark" pixel and it will be a piece of the example, OR
0, in which case we'll think of it as a "white" pixel and it will be a piece of the foundation.

3.2.6 Image Calibration

A CCD cluster is mechanically very steady; the pixels have a settled geometric relationship. Every pixel inside the exhibit, notwithstanding, has special light affectability attributes. Since these qualities influence camera execution, they should be expelled through adjustment. The procedure by which a CCD picture is aligned is known as fat fielding or shading rectification.[5]

Geometric camera alignment, additionally alluded to as camera re-sectioning, gauges the parameters of a focal point and picture sensor of a picture or camcorder. You can utilize these parameters to revise for focal point twisting, measure the extent of a protest in world units, or decide the area of the camera in the scene.[6] These errands are utilized as a part of uses, for example, machine vision to distinguish and measure objects. They are likewise utilized as a part of apply autonomy, for route frameworks, and 3-D scene remaking.[22][23]

3.3 Data Collection Procedure

We have performed the width detection in 2-D images. We tried to collect 2-D images by doing a simple python code. To find out the desired location, first we searched those locations longitude and latitude from Google Map. But we faced some difficulty in doing so. The main motto of our project was to determine the road width from street view image. But the longitude and latitude value functionality were not so much of ease to use. The

code needed a generated API key to perform the search operation. After providing all the longitude and latitude value the code returned all the images. But the output images were not in the same orientation we were expecting. After lots of attempts finally we decided to capture image manually.

All the images have been captured using mobile device. The specification of the device we have used to capture images is given below.

Model : Sony Xperia X
Specification: 23 MP (f/2.0, 24mm, 1/2.3")

The images of the roads were captured from the foot-over bridges of the main roads of Dhaka city. A reference object used in all the images as a known sized object. The whole procedure is analyzed in the “Statistical Analysis” section.

3.4 Statistical Analysis

Estimating the extent of items in a picture is like registering the separation from our camera to a protest — in the two cases, we have to characterize a proportion that measures the number of pixels per a given metric.
We call this the "pixels per metric" proportion, which we have all the more formally characterized in the accompanying segment.

3.4.1 The “per_pixel_ratio”

To decide the extent of a question in a picture, we first need to play out a “calibration” utilizing a reference object. Our reference object ought to have two critical properties

- We should know the measurements of this object (regarding width or tallness) in a quantifiable unit, (for example, millimeters, inches, and so on.).

- We ought to have the capacity to effortlessly discover this reference object in a picture, either in view of the situation of the object, (for example, the reference object continually being set in the upper left corner of a picture) or by means of appearances (like being an unmistakable shading or shape, special and not quite the same as every single other object in the picture). In either case, our reference ought to be interestingly identifiable in some way.

In this example, we'll use the Bangladeshi Coin (1 Taka Coin) as our reference object and in all examples, make sure it's always the leftmost object in our image-

Figure 3.4.1: Reference Object Example

We'll utilize a Bangladeshi 1 Taka coin as our reference object and guarantee it is constantly set at the furthest left objects in the picture, making it simple for us to extricate it by arranging forms in view of their area.

By ensuring that "Bangladeshi one of Taka's coin" is the bottom left, we can edit the line of objects from left to right, taking a “one Taka coin” (which will be the first contour in the scheduled list), and use it to define our per_pixel_ratio, which defines:

per_pixel_ratio = object_width_per_pixel / the_known_width

Bangladeshi one Taka Coin has a known width of 1.35 inch. Now, think that our object_width (measured by pixels) is calculated to be 150 pixels wide (based on the joint box).

per_pixel_ratio = 150px / 1.35in = 111.11px

That is why there are apparently 111.11 pixels per 1.35 inches in our image. Using this ratio, we can estimate the amount of objects in the image.

3.5 Implementation Requirements

The Product necessities particular is created at the zenith of the examination undertaking. The capacity and execution apportioned to programming as a major aspect of framework building are defined by setting up an entire data depiction, a nitty-gritty utilitarian and social portrayal, a sign of execution prerequisites and configuration compels, suitable approval criteria and other information correlated to necessities. The tools and dependencies used to implement the project are provided below.

3.5.1 Software Specification

- OpenCV
- Python 2.7

Image processing Package List

- Scipy
- Numpy
- Imutils

CHAPTER 4

Experimental Results and Discussion

4.1 Introduction

In this section we have covered all our experiences related to the experiment. Our main goal was to correctly provide the actual width of the road. The main challenge was to get the actual result from different distance from the object. Here first we have discussed about the methodology and final outcome step by step.

4.2 Experiment Result

As we have collected road image data manually it was very challenging to capture image from different distance from an over-bridge. For that we have tested the experiment in Bangladeshi coins. The result is shown in inches.

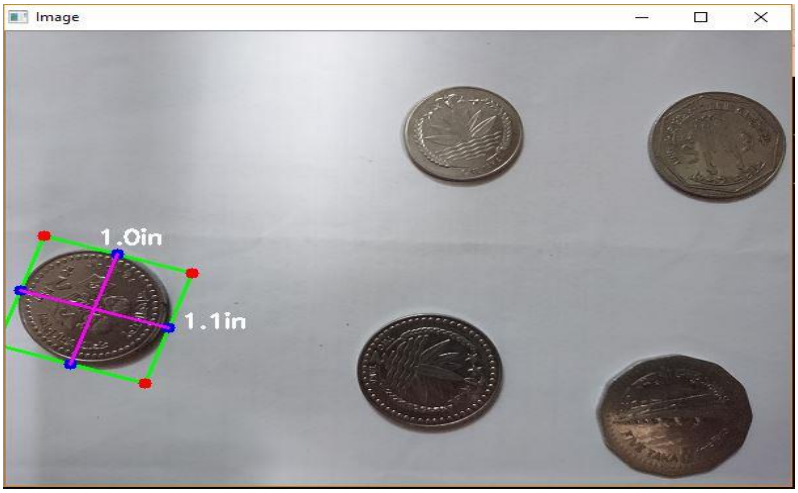

Figure 4.2.1: Demo Experiment 1

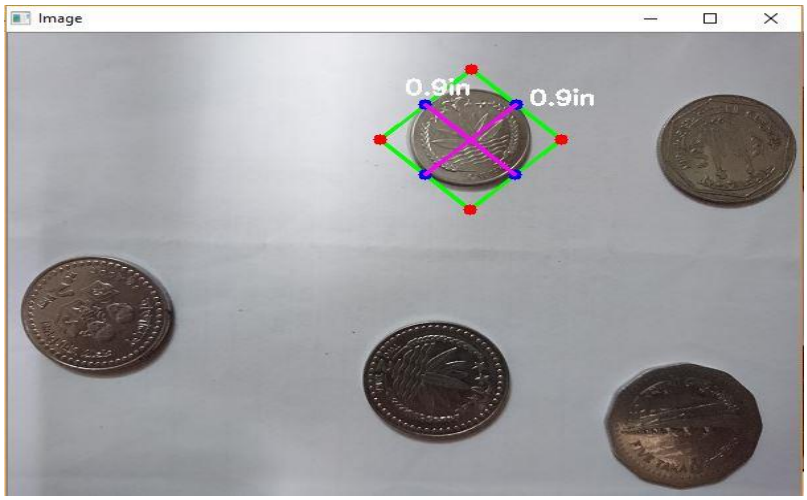

Figure 4.2.2: Demo Experiment 2

4.2.1 Application on Road Step By Step

4.2.1.1 Image Acquisition

We have used mobile camera for image acquisition. The road images are captured from various main roads of Dhaka city consisting main roads. For road images we have chosen the flag of Bangladesh in a board as our reference object.

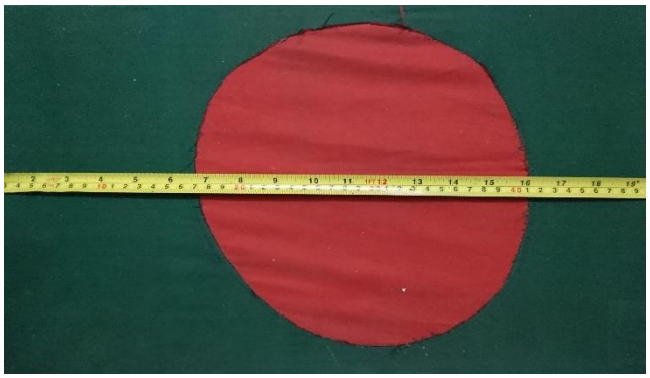

Figure 4.2.1.1: Reference Object Used In the Road

4.2.1.2 Preprocessing

The image is then scaled to a lower resolution image due to the screen size f testing device.

Original Image Resolution: 5520*4140

Image Resolution after Pre-Processing: 600*450

We also apply GrayScale filtering in this section to make the further processing easier.

4.2.1.3 Edge Detection

Then we perform edge detection along with erosion + dilation to remove any gaps in between edges in the edge lines. We find outlines that correspond to the objects in our edge lines.

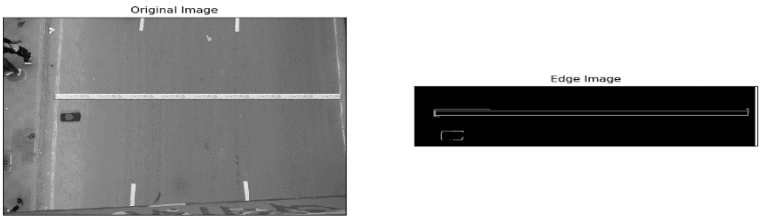

Figure 4.2.1.3: Image after Edge Detection

4.2.1.4 Pixel Mapping

These contours are then sorted from left-to-right. Through this procedure we are able to find out the Reference object from the input image. We also initialize our per-pixel metric.

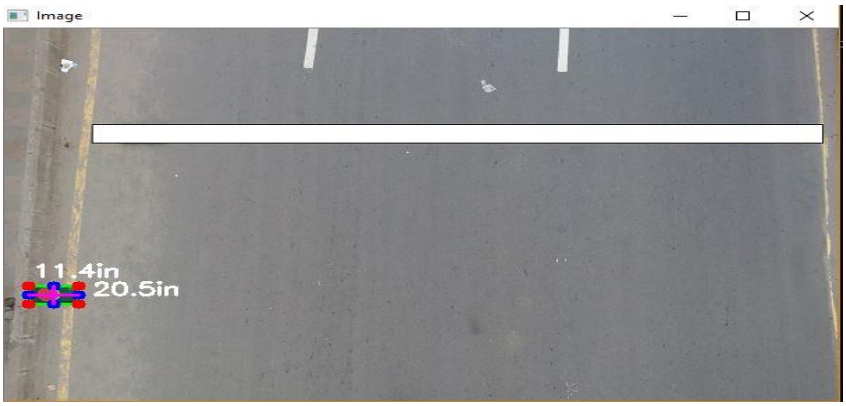

Figure 4.2.1.4: Reference Object Size Detection

4.2.1.5 Analysis

Figure 4.2.1.5: Road width Detection

Table 2: Actual object measurement vs Output Result

Actual Measurement		Generated Result	
Reference Object	20.47*11.8 inch	Reference Object	20.5*11.4 inch
Road Width	154 inch	Road Width	151.3 inch

4.3 Descriptive Analysis

The result we have got capturing single image worked with some error rate. The error percentage rate is in next section. After acquiring the result then we captured the same image from different distance location. The descriptive analysis of our experiment is analyzed and shown in the graph and Table.

4.3.1 Object Distance Calculation from Different Distance

Table 3: Object Distance Calculation from Different Distance

Camera Distance	Size Of Different Object	Size of Real Object
5.910 inch	1, 1, 0.9, 1.1, 1 inch	1.060, 1.060, 0.87, 1.14, 1.02 inch
11.810 inch	1.1, 1, 0.9, 1.1, 1 inch	1.060, 1.060, 0.87, 1.14, 1.02 inch
17.720 inch	1.1, 1.1, 0.9, 1.1, 1 inch	1.060, 1.060, 0.87, 1.14, 1.02 inch

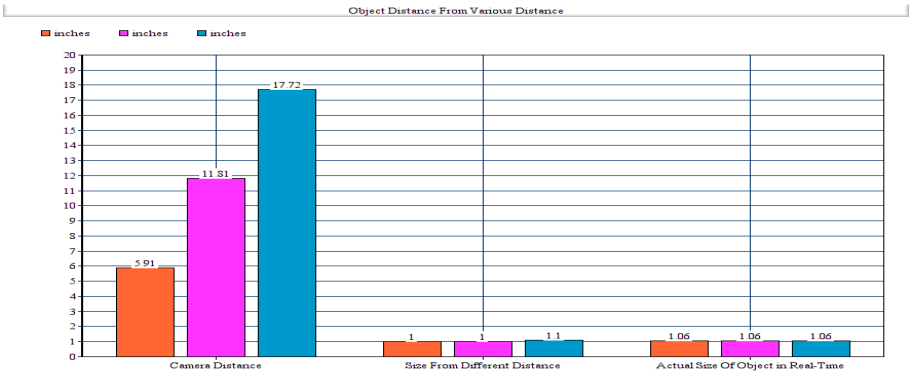

Figure 4.3.1: Object Distance Calculation Graph from Different Distance

4.3.2 Error Rate Analysis

The image below describes the error rate of this thesis work. The project is to be 96% accurate. With the increasing distance, the effect of the distance does not interrupt object distance very much.

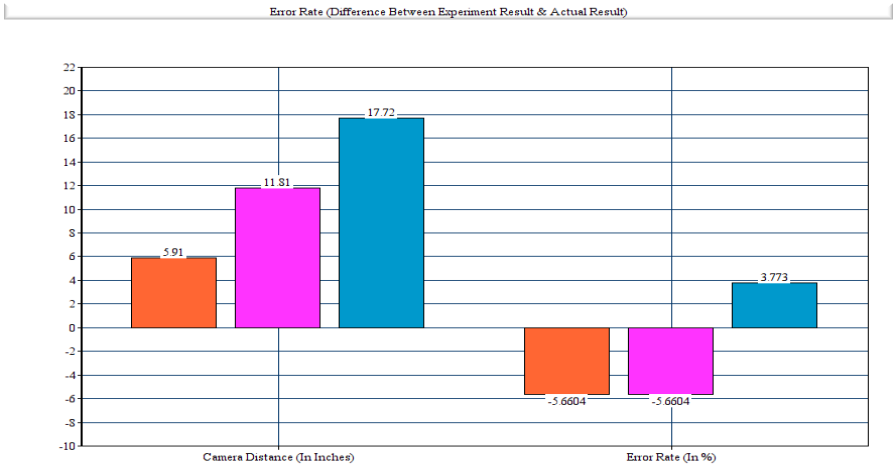

Figure 4.3.2: Error Rate Analysis between Experiment Result and Actual Result

4.3.3 Google Map Distance

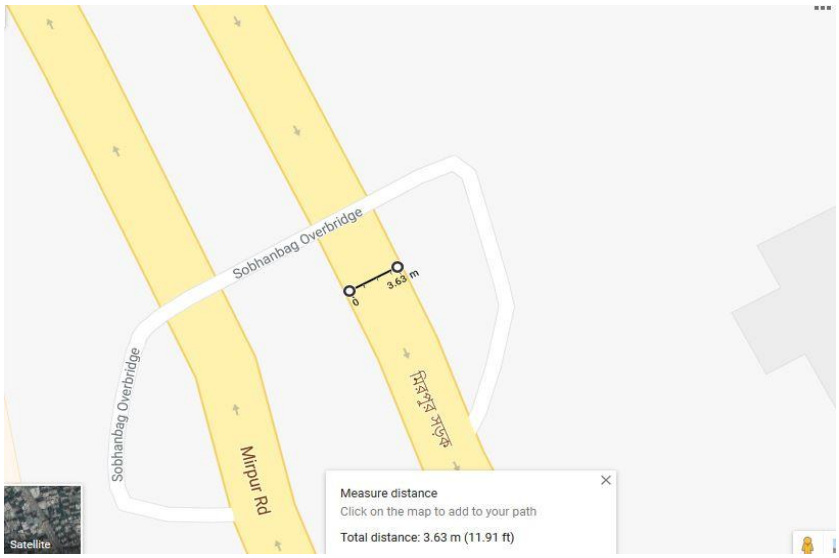

Figure 4.3.3: Road width Detection using Google Map

4.3.4 Error Rate Comparison

Table 4: Error Rate of the Project

Real Data	Google	Our Proposed Method
3.92 meter	3.63 meter	3.84 meter
0%	-7.398%	-2.0408%

4.3.5 Some Data Analyzed Around Dhaka City

Here we have included some road-width values of different places and applied different Data Mining Algorithms to find out the aesthetics of Dhaka Urban Life.

The data are compared with the standard road length (3.7 meter) [1] of United States of America. We defined three attributes **worst, beneath, precise** to find out the condition of the road. We classified them Precise if the roads are above 3.7 meter, beneath if the roads are between 3.5-3.69 meters and worst if the roads are less than 3.5 meter in length. Here we have provided a table to represent all the data.

Table 5: Output Result of different locations of Dhaka

Place Name	Road-Width (in meter)	Attribute
Shyamoli	3.88	Precise
CollegeGate	3.76	Precise
AsadGate	3.54	Beneath
Dhanmondi 27	3.54	Beneath
SobhanBag	3.64	Beneath
Dhanmondi 32	3.54	Beneath
KolaBagan	3.56	Beneath
LabAid	3.51	Beneath
ScienceLab	3.42	Worst
NewMarket	3.52	Beneath
Nilkhet	3.48	Worst
Ajimpur	3.76	Precise

Shahbag	3.38	Worst
Ramna Park	3.41	Worst
SegunBagicha	3.36	Worst
Baitum Mukarram	3.22	Worst
Motijhil	3.42	Worst
Arambag	3.59	Beneath
Rajarbag	3.70	Precise
Kakrail	3.6	Beneath
Poribag	3.08	Worst

All the data have been collected from real-life images and using proposed methodology. After we applied "Naïve Bayes" to all these data, we found out that, if we consider Dhaka on the basis of these roads (All the roads are very Main points of Dhaka City) the result comes worst.

We also tried to match this data with Authorized and Verified road Information in Govt. records to find out the real condition and corruption. But those information were inaccessible due to proper Authority issue.

4.4 Summary

The summary of this thesis work ended up to the accuracy of 96%. We would like to add that, we have tried to capture the images with 90 degree view. But as it is captured by hand it can't be said a perfect 90 degree angle. But the methodology we used is quite suitable for cost-effective solution.

CHAPTER 5
Conclusion

5.1 Summary of the Study

After the finishing of this project we are able to come on some epilogues. First of all we are now aware of the limitations. The calibration is an important issue in Distance measurement from images. On the other hand, this research also provides us the current condition of roads (A glimpse of Urban Life) of Dhaka city. This data may be used in various fields.

5.2 Conclusions

Throughout the whole procedure in the research project we have tried to focus on the main roads of Dhaka city. The actual data fetched from the real-life image are able to provide lots of statistical analysis of Urban Planning, Interior Design and event management. In this field there are lots of future scopes as it is a very cost effective procedure in prospect of our country.

5.3 Implication of Further Study

This thesis project is based on 2-D images. Now-a-days 3-D images are being commonly available to all. The measurement concept is totally different in 3-D from 2-D. Our future target is to work with 3-D images.

The reference object will always not available in all the images. So, we tend to measure the object size without a reference object in future. As Google Street view images do not provide updated images of locations, the issue of getting image data automatically using API calling remains question marked. But after all this issues we are going to develop an application using this methodology to provide ease of use.

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