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Street width measurement for urban aesthetics identification in Bangladesh based on Computer Vision

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Abstract. **This research tends to the development of urban lifestyle. We want to characterize the road standard of Dhaka by measuring the width of roads from an image and found the number of methodologies to perform object measurement. 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. Identifying objects was contour tracing and a canny edge detection algorithm. Then the object is measured by generalizing the pixel mapping and finding output is matched with the street measurement. The implication in road data and establishing urban Planning prototypes does not exist. The measurement findings in this proposed methodology were then analyzed and based on some criteria the street aesthetics. This research work represents the whole procedure including road image acquisition, pre-processing the image, detecting the road, and measurement of the road from various camera distances. This research work ended up with an accuracy of 96% and we have tried to capture the images with a 90-degree view. We used is quite suitable for a cost-effective solution.**

Keywords: **Artificial Neural Network, Image Segmentation, Deep Learning, Computer Vision, Convolutional Network.**

1. INTRODUCTION

According to the "Interstate Highway standards" of the United States of America, a single-lane road should operate a 12-foot or 3.7-meter lane width [1]. Our research mainly focuses on the streets of Dhaka City which 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 area can also be defined through the condition of streets, Buildings, Shops, etc. Nowadays modern algorithms and processors enable us to extract hidden data from an image using various specialized techniques. So, we have decided to measure the roads from the image and analyze them with the standard to identify the street aesthetics of Dhaka city. A considerable amount of the streets and flyovers in Dhaka city are in poor condition and have become much more serious as accidents are going on every day. It additionally makes serious harm to the running vehicles. It is the right of the citizens to have better streets for their vehicles. The entire transport framework is badly influenced because of the poor state of the streets. The concerned experts need to make an essential move in such a 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 the necessary steps. But to take any action they have to go through the existing manual procedure. From here the motivation for our research comes. A digital image is very easy and reliable data nowadays. High-resolution images can 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 the Urban Aesthetics of the Streets of Dhaka City.

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2. BACKGROUND AND LITERATURE REVIEW

Nan Jiang [3] described processing separation. Processing separation from captured pictures is a typical undertaking in picture investigation and scene understanding. Separation fills in as building obstructs for computing other geometry data, for example, territory and volume. Other than straightforwardly estimating separation on the mark and processing utilizing projective geometry from scene images. This paper proposes two techniques for estimating separation utilizing hovers in one caught picture. The two strategies are checked by exploring 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. 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. Khandaker et al. [4] represent removing the 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 with the adjustments in camera to individual separation is utilized to define the separation estimating framework. The framework begins with figuring out the separation between the 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. Because of the straightforwardness of the proposed approach, equipment concentrated methods, for example, spotlights, and so on are never again required for getting a palatable individual to camera separate estimation. Limen et al. [5] propose a novel way to deal with the measurement utilizing a customary advanced camera. These days, 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 below 2% [6]. This new structure can quantify the sizes of various protests in the scene utilizing maybe a couple of photographed shots. The viability of the proposed conspire is exhibited by utilizing different investigations.

We found out lots of methodologies exist to measure object size. The approach we proposed is quite same [14]. They measured the distance based on the circle volume on an uncalibrated image. The other methodology [15] proposed doesn't require any external hardware to measure the actual distance. We cover all the existing commercial software that exists with the capability of object measurement features. ImageJ has the feature of selecting from a particular image and then measuring (Fig. 1) the object [7].

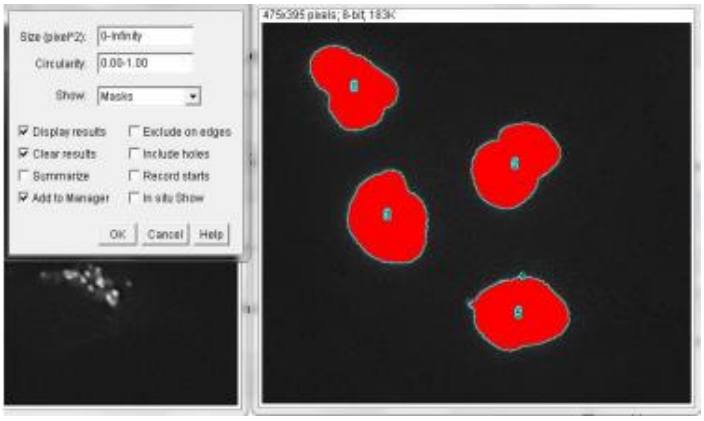

Fig. 1. Image J Object Measure Example

In Matlab, there is also the feature entitled object measurement but this measurement needs calibrated [8] image. Here, is an example of the Matlab Object detection procedure (Fig. 2).

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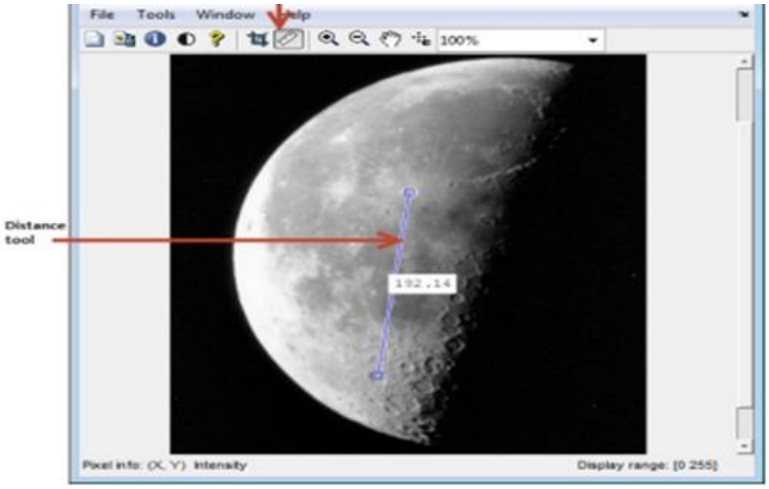

Fig. 2. MatLab Object Measure

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 and 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. From the knowledge of all studies and related work, it is seen that object size detection is an important issue to figure out, that may be applied in different aspects. This research work represents the whole procedure including road image acquisition, pre-processing the image, detecting the road, and measurement of the road from various camera distances. Finally, the proposed system in this research work can provide the street aesthetics information of Dhaka city. In this work, we have shown a methodology to determine object width from a road image. The expected outcome can resolve lots of issues like urban planning, event management, interior design, and of course medical processing. As in our work, we have not used any external sensor and tried to measure object size from the uncalibrated image there remain some challenges that needed to be resolved. Different distances from the 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 for real-time data and Google Street View data are updated regularly.

3. APPROACH AND EXPERIMENTS

Enhancing images that have been acquired from unpopulated space pierces, space shuttles, and military reconnaissance flights. Image processing programs have become increasingly common due to the availability of powerful computers, memory equipment, technical software, and more. 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 (Fig. 3.1) above gives an overview of how we have measured an object using image processing

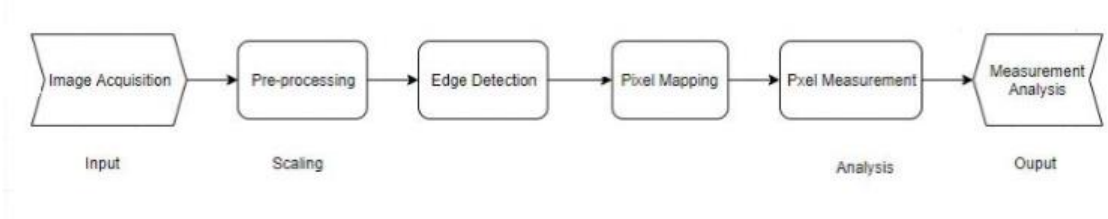

Fig. 3.1 Block Diagram of “Object-Width Detection Using Image Processing”

3.1 Research Subject and Instrumentation

Use Image Acquisition for an image in two-dimensional (x and y combine the plane) [10]. If the amplitude of the image anyhow is f, it is known as the image intensity. The project needed a vast amount of image databases therefore decided to use Google street view images. Image scaling in the digital image occurs at certain points. 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. Photos have been resized and the camera has its 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. Make a regular solution to the application and then make an image of the 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. Also, analyze colors using wavelength-sensitive cells known as cones. Different cones are sensitive to different lights. One is sensitive to "green light, one is too red and one is to blue light" [11][12]. When it flashes a combination of three colors (RGB) 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 3 isolated image matrices; red (R) in each pixel, another one in the green pixel (G), and the other one in Blue (B) [13]. 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 [16] [17].

Contour Tracing Also called border following or boundary following or limit following; contour tracing is a system that is connected to advanced pictures 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 [22][23].

3.2 Data Collection Procedure

We have performed the width detection in 2-D images. We tried to collect 2-D images by doing a python code. To find out the desired location, first, we searched those locations' longitude and latitude from Google Maps. But we faced some difficulty in doing so. The main motto of our research was to determine the road width from a street view image. But the longitude and latitude value functionality was not so much of easy to use. The code needed a generated API key to perform the search operation. After providing all the longitude and latitude values the code returned all the images. After lots of attempts finally we decided to capture the image manually. All the images have been captured using a 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 is used in all the images as a known-sized object.

3.3 Statistical Analysis

We call this the "pixels per metric" proportion, which we have all the more formally characterized in the accompanying segment. 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 like should know the measurements of this object (regarding width or tallness) in a quantifiable unit, (for example, millimeters, inches, and so on) [18][19].

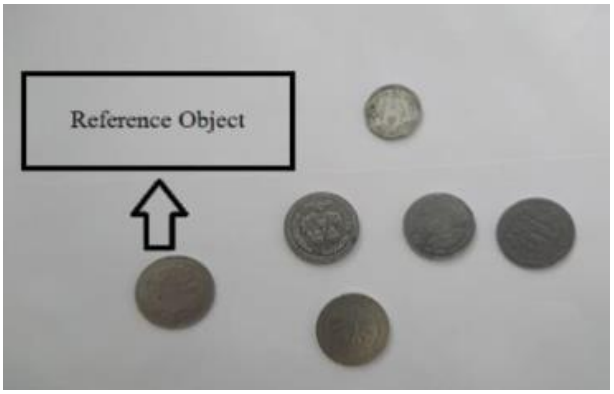

Fig. 3.2 Reference Object Example

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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 because of their area. By ensuring that "Bangladeshi one of Taka's coin" is at 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 (1)

Bangladeshi Taka Coin has a known width of 1.35 inches. 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 there are 111.11 pixels per 1.35 inches in our image. Using this ratio, we can estimate the number of objects in the image.

4. EXPERIMENTAL RESULTS AND DISCUSSION

As we have collected road image data manually it was very challenging to capture images from different distances from an over-bridge. For that, we tested the experiment in Bangladeshi coins. The result (Fig. 4.) is shown in inches.

Fig. 4. Experiment 1

We have used the 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 (Fig. 5.) on a board as object.

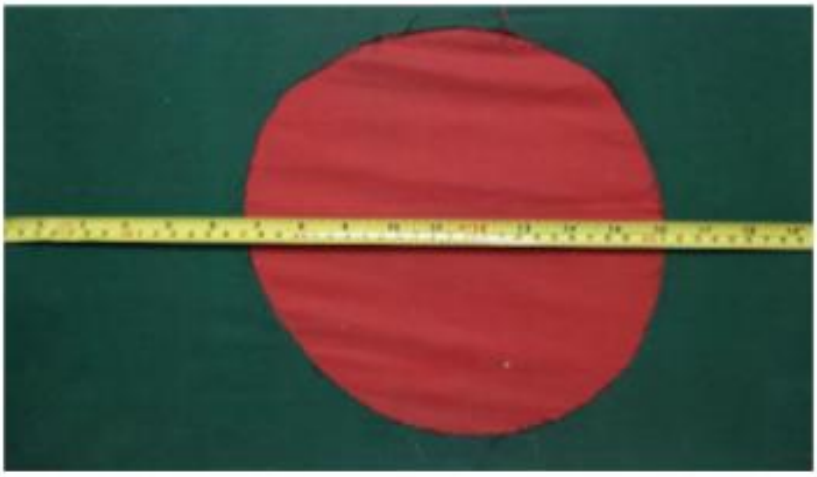

Fig. 5. Reference Object Used In the Road

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

Original Image Resolution: 5520*4140

Image Resolution after Pre-Processing: 600*450

Apply GrayScale filtering in this section to make further processing easier. Then we perform edge detection along with erosion + dilation to remove any gaps between edges in the edge lines. We find outlines that correspond to the objects in our edge lines.

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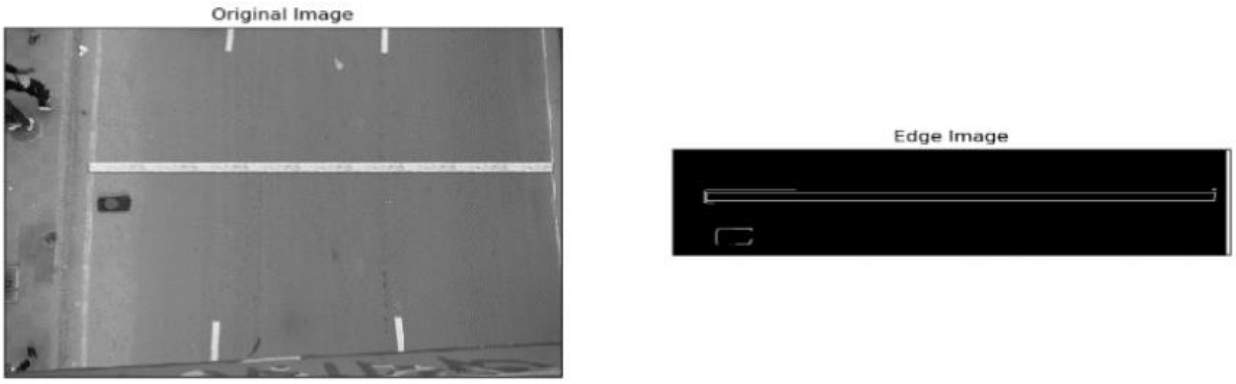

Fig. 6. Image after Edge Detection

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

Fig. 7. Reference Object Size Detection

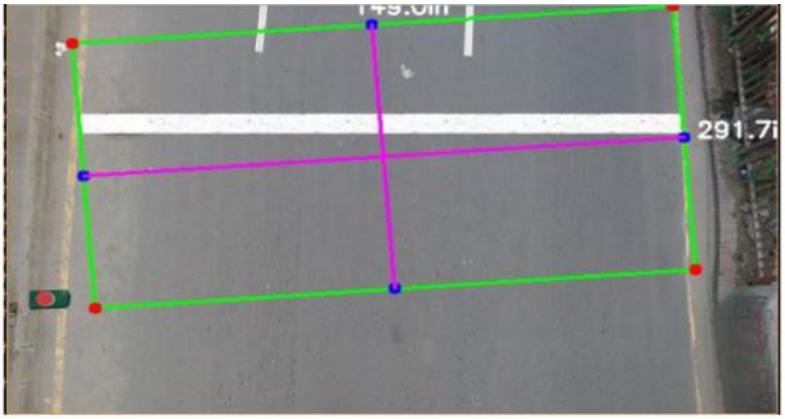

Fig. 8. Road width Detection

Table 1: Actual object measurement vs Output Result

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

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

Table 2: Object Distance Calculation from Different Distance

Camera Distance	Size Of Different Objects	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

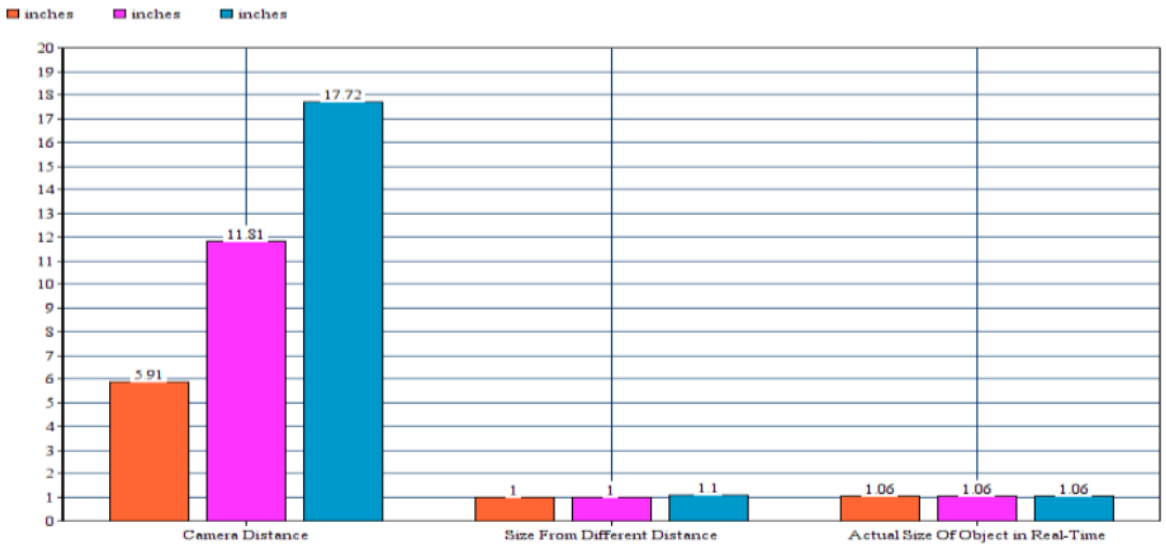

Fig. 9. Object Distance Calculation Graph from Different Distance

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

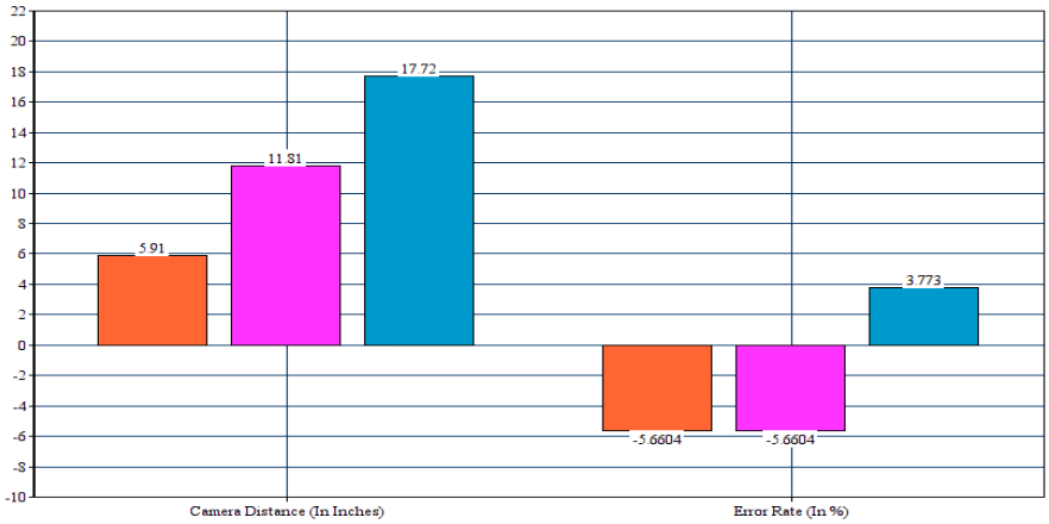

Fig. 10. Error Rate Analysis between Experiment Result and Actual Result

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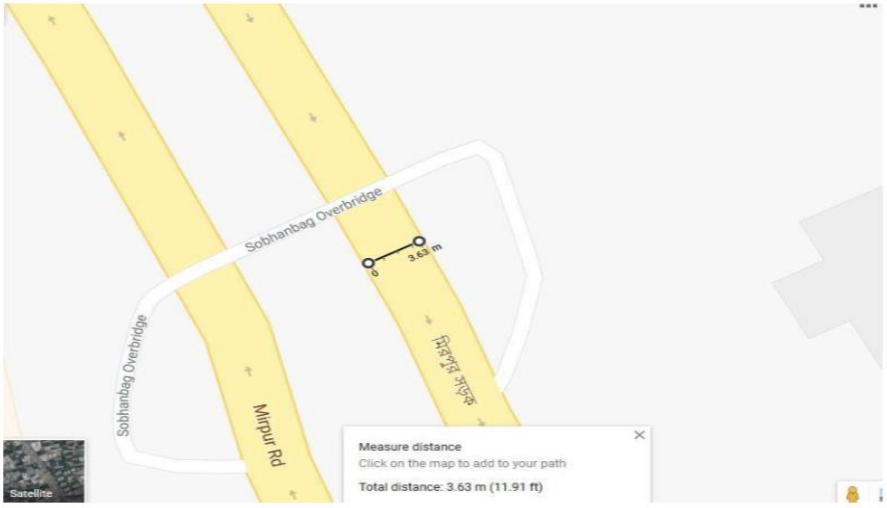

Fig. 11. Road width Detection using Google Map

Table 3: Error Rate

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

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 meters) of the United States of America. We defined three attributes worst, beneath, and precise to find out the condition of the road. We classified them as Precise if the roads are above 3.7 meters, beneath if the roads are between 3.5-3.69 meters, and worst if the roads are less than 3.5 meters in length. Here we have provided a table 4 to represent all the data.

Table 4: Output Result of different locations of Dhaka

Place Name	Road Width (in meters)	Attribute
Shyamoli	3.88	Precise
Shyamoli	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
Kakrail	3.08	Worst

All the data have been collected from real-life images and using the proposed methodology. After we applied "Naïve Bayes" to all these data, we found out that, if we consider Dhaka based on 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.

5. CONCLUSION AND FUTURE WORK

After finishing this research, we can come to some epilogues first calibration is an important issue in distance measurement from images. On the other hand, this research also provides the current condition of roads (A glimpse of Urban Life) in Dhaka city and data may be used in various fields. Throughout the whole procedure in the research, we have tried to focus on the main roads of Dhaka city. The actual data fetched from the real-life image can 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 the prospect of our country. This research is based on 2-D images but 3-D images are commonly available to all. The measurement concept is different in 3-D from 2-D, our future target is to work with 3-D images. The reference object will always not be available in all the images. So, we tend to measure the object size without a reference object in the future. As Google Street view images do not provide updated images of locations, the issue of getting image data automatically using API calling remains a question mark. But after all these issues we are going to develop an application using this methodology to provide ease of use.

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