CV Cube

Small object feature detector

Submitted by:

Himani Garg (201680018)
Divanshu Singh (201680039)

Submitted to:

Dr. Parteek Bhatia

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Introduction

In machine learning data is more important than algorithms. But, still while teaching machine learning little to no focus is given on how data set is collected and pre-processed. Same is the case with the field of computer vision. As a result of this students gain no experience of working with real data and hence never learn about problems that occur while collection of data set.
In this project we present a kit that allows us to work with real data and apply algorithms hence making our learning more practical.

About machine learning

Machine learning is a type of artificial intelligence (AI) that provides computers with the ability to learn without being explicitly programmed. Machine learning focuses on the development of computer programs that can change when exposed to new data.

The process of machine learning is similar to that of data mining. Both systems search through data to look for patterns. However, instead of extracting data for human comprehension -- as is the case in data mining applications -- machine learning uses that data to detect patterns in data and adjust program actions accordingly. Machine learning algorithms are often categorized as being supervised or unsupervised. Supervised algorithms can apply what has been learned in the past to new data. Unsupervised algorithms can draw inferences from datasets.

Facebook's News Feed uses machine learning to personalize each member's feed. If a member frequently stops scrolling in order to read or "like" a particular friend's posts, the News Feed will start to show more of that friend's activity earlier in the feed. Behind the scenes, the software is simply using statistical analysis and predictive analytics to

identify patterns in the user's data and use to patterns to populate the News Feed. Should the member no longer stop to read, like or comment on the friend's posts, that new data will be included in the data set and the News Feed will adjust accordingly.

About computer vision

Computer vision is an interdisciplinary field that deals with how computers can be made for gaining high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do.

Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g., in the forms of decisions. Understanding in this context means the transformation of visual images (the input of the retina) into descriptions of the world that can interface with other thought processes and elicit appropriate action. This image understanding can be seen as the disentangling of symbolic information from image data using models constructed with the aid of geometry, physics, statistics, and learning theory.

As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a medical scanner. As a technological discipline, computer vision seeks to apply its theories and models for the construction of computer vision systems.

Sub-domains of computer vision include scene reconstruction, event detection, video tracking, object recognition, object pose estimation, learning, indexing, motion estimation, and image restoration.

Problem Statement

In this project, we try to accomplish these:

- To make a general purpose kit to automatically collect feature data from small (handy) objects.
- To detect handy (small) objects based on their features by using supervised machine learning techniques

In future, we will also try to add the following :

- To make system to answer user queries related to the object

Objectives

In this implementation, we try to accomplish following:

- To Make general purpose kit (hardware + software) to detect features
- To train system to recognize object by its
    - Shape
    - Colour
    - Relative size to other objects

Future objectives include:

- To make system answer queries based on noted features
    - Example: Is phone bigger than coin ?
- To make system classify objects being seen for first time
    - Example: What is given object ?

The current feature detection scope is:

- Shape
- Colour
- Relative size

The future feature detection scope also includes:

- Absolute size
- 3D shape
- Height

Methodology

We have used the concepts of supervised machine learning and image processing techniques to achieve our goals.

Shape detection

Firstly, the system uses the number of sides to to identify the shape of object in view. As this is very simple parameter hence we are able to classify small number of objects. To make it classify more objects in future we can add more parameters such as various angles that the sides make with one another.

System is also able to calculate the ratio of various sides with one another hence able to differentiate between a square and a rectangle.

Color detection

The object contour is identified and average value of RGB (Red Green Blue) is calculated for every pixel in the contour. The system has been trained on just three colors i.e. red, green and blue.

Relative size

The number of pixel in object is used as measure of relative size.

Data set

We used only four shapes with colour labels to teach the system at initial state. Some of the shapes have been shown below in the image. System was given following labeled data:

- Shape : Square
- Shape : Circle
- Shape : Rectangle
- Shape : Triangle
- Color : Red
- Color : Green
- Color : Blue

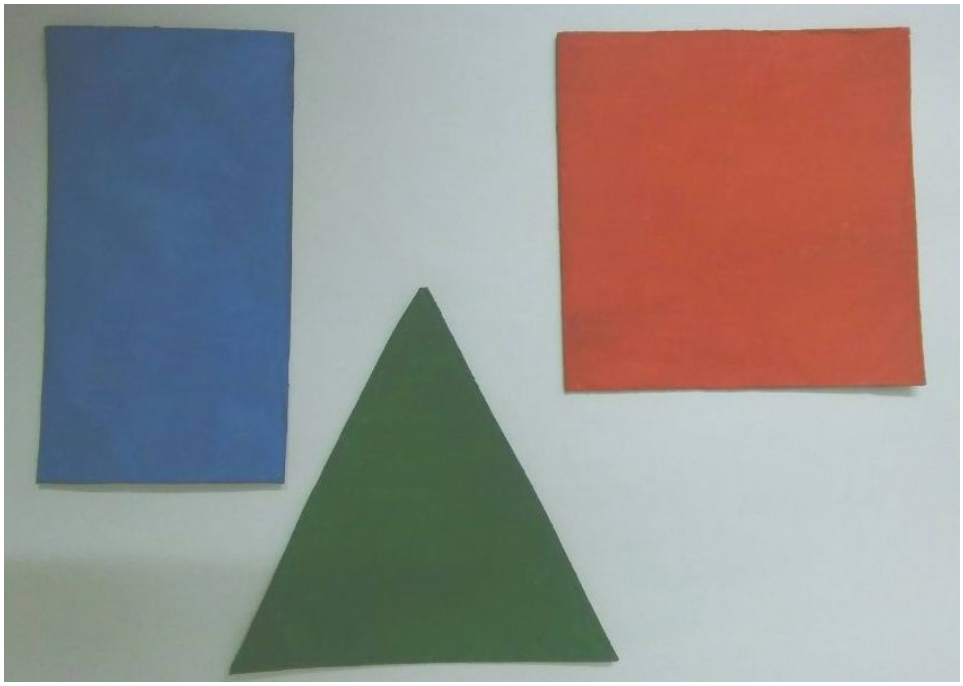


Figure 1 : Some shape on which system has been trained

Test data includes other coloured shapes.

Hardware description

The hardware consists of a cube structure which has four sided LED lightning with a control system. A USB camera is placed on top of the structure facing downward and objects are placed under the camera for analysis. The computer model and working hardware is shown below:

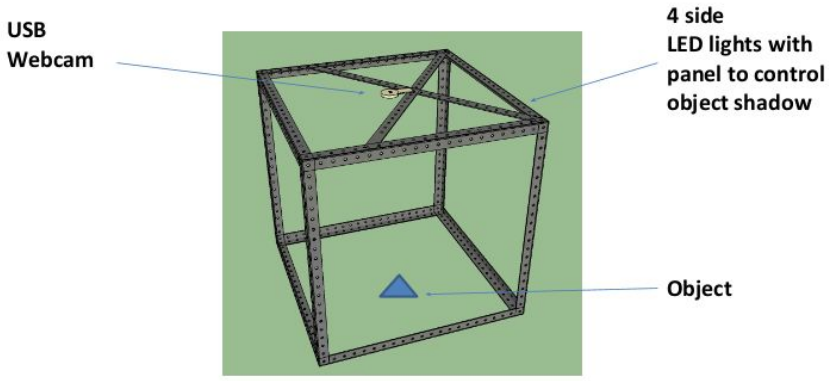


Figure 2 : Computer model of CV Cube

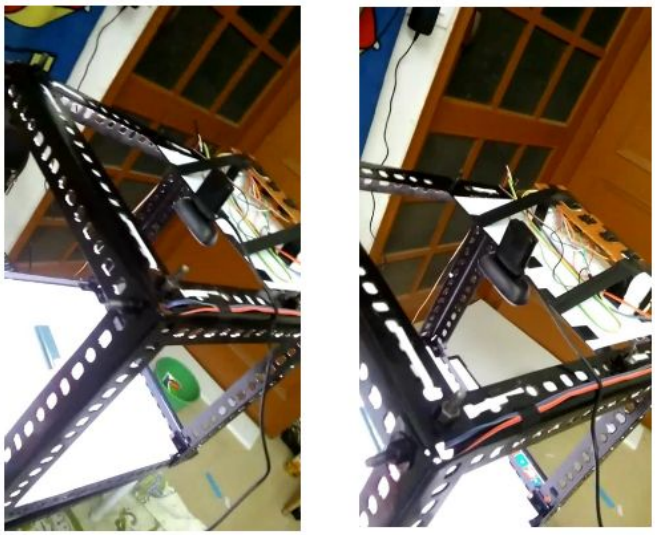


Figure 2 : Hardware of CV Cube

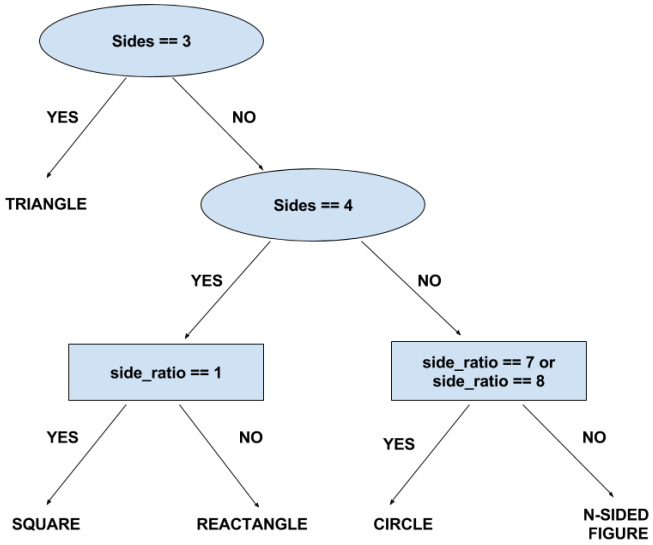
Algorithms

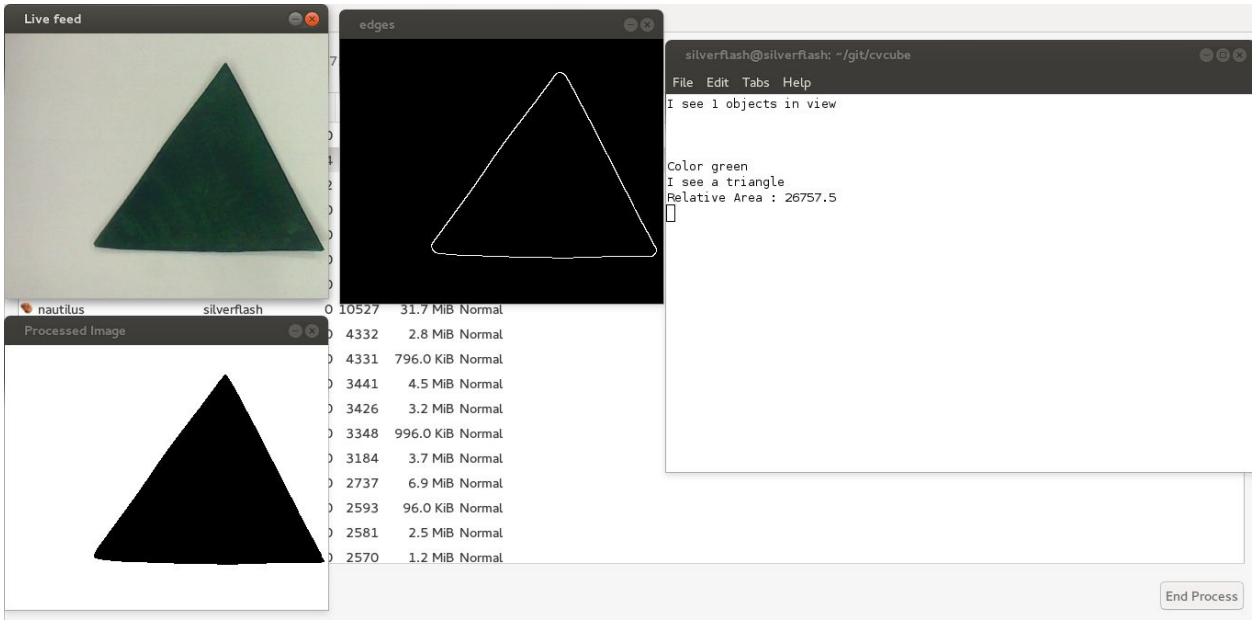
Following algorithms have been used in the software of CV cube.

Purpose	**Description**
Shape detection	Based on number of sides in a contour
Colour detection	Based on maximum number of pixel in RGB model
Relative size	Based on number of pixels in a contour
Learning	Supervised learning : Classification

Results

The system generated following decision tree for classification:





Future Scope

In future, we can add more features to make the range of object detection much wider. We will also add the following:

- Shadow analysis
- 3D shape analysis
- Angle analysis

CV Cube can be used for real life application such as automatic surveillance of CCTV or weapon detection in luggage security system

Reference

- Books : Computer vision Algorithms and Techniques
- OpenCV Docs