Capstone Project

Computer Vision Project

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Definition

Project Overview

Due to presence of potholes in the road many accidents happens every year. .So, if we make a model which can detect the potholes of any road and can give a pre warning to the riders it can minimize the chances of accidents..But only detecting them is not enough ,so we need to track the location of the potholes so that we can send the exact location to our municipality to take appropriate action to fix them..This was the inspiration for our project..It can also be used as a feature for self-driving vehicles..

So, in this project we have created a pothole detection model using yolov4(tiny- for real time detection) architecture with the mix of our self annotated data and few pre-annotated Roboflow data..

Problem Statement

Firstly, the goal is to create a better model which can detect the potholes in the road in real time without compromising with the accuracy..

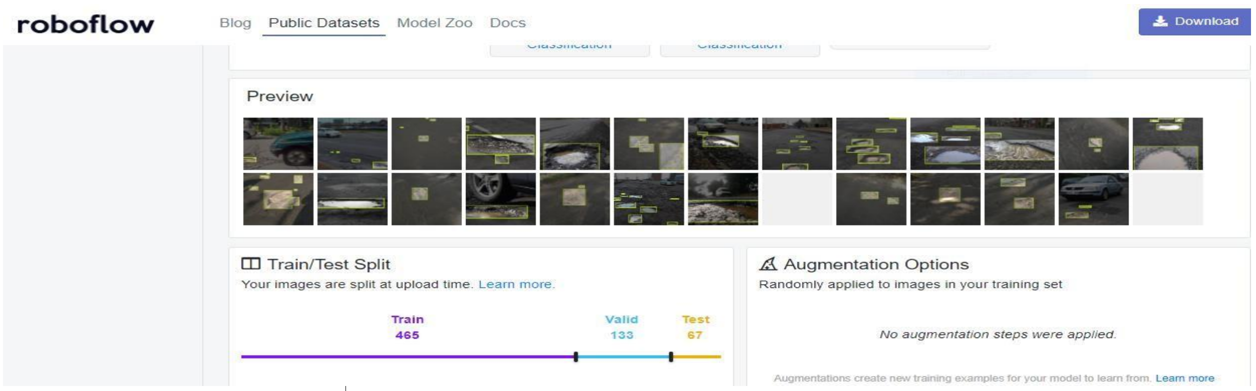
1. Make proper dataset for better accuracy…
2. Train the model with any detection architecture for real time detection..
3. Test the model on local server..
4. Deploy the model using opencv on Flask Api…
5. Finding out the location of the potholes (here we have used the latitude & longitude of any location based on the
   camera location)…
6. Add the pothole location into a Database to keep the record for municipality or other sources…

The final model is expected to be useful for finding the potholes with their proper location, alongside generating the warning for the riders also and keeping the generated data in a proper database for fair use..

Analysis

Data Exploration

At first, we had taken only the Roboflow dataset and trained it with large YOLOv4 model (width=512,Height=512)..It has around 665 images originally shared by Atikur Rahman Chitholian as part of his undergraduate thesis and was originally shared on Kaggle.. Originally it wasn't divided into train, valid & test but Roboflow have re-shuffled the images into a train-valid-test split for various Usage.

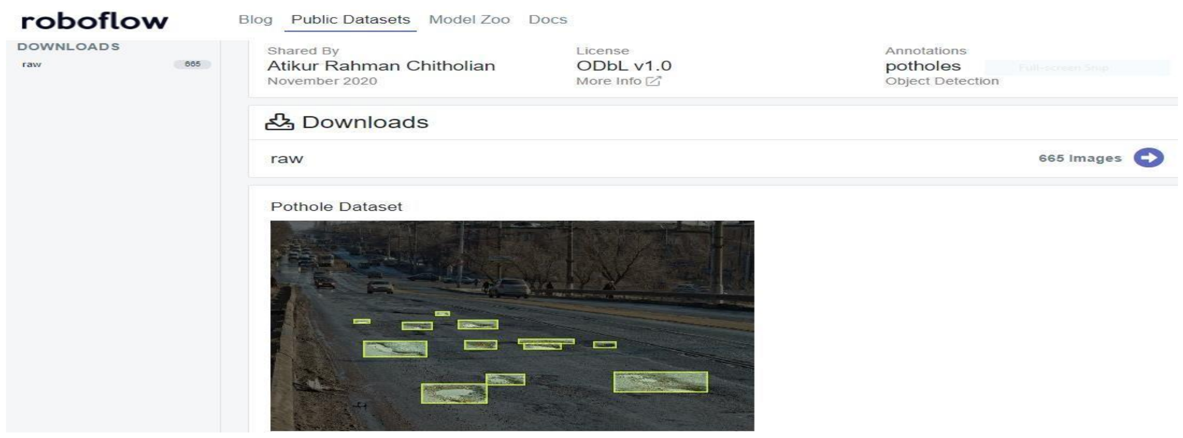


Train/Test Split
Your images are split at upload time. Learn more.
Train 465
Valid 133
Test 67

Augmentation Options
Randomly applied to images in your training set
No augmentation steps were applied.
Augmentations create new training examples for your model to learn from. Learn more

Fig 1:- Roboflow Image

The dataset was originally taken for the worst scenarios in city areas so that those could be fixed faster.



Shared By: Atikur Rahman Chitholian, November 2020
License: ODbL v1.0, More Info
Annotations: potholes, Object Detection
raw 665 Images

Fig 2:- Roboflow Pothole Image Example

This model was having lower mAP & precision with higher latency..So, we decided to train our model once again and this time we use a local video of approximate 1 hour from which we have taken the timestamps where the potholes are present and scrapped the frames from those clips and annotated them using labelimg tool manually.. Now we got around "850" annotated images along with Roboflow Data..Total around 1500 labeled images..

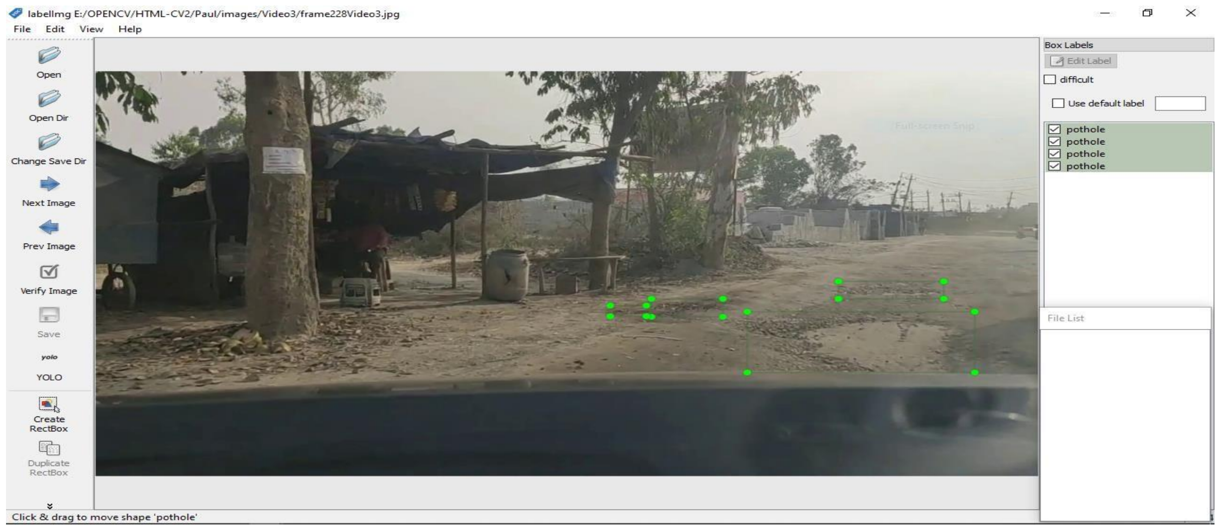


Fig 3:- Annotated on Labelimg

The text annotations of the dataset have the following fields:

- ❖ utf8_string: the text itself (string)
- ❖ bbox: a bounding box around the text, in the form of [x, y, width, height] (integers)
- ❖ legibility: the readability of the text; either "legible" or "illegible" (string)
- ❖ area: the area of the bounding box (float)
- ❖ class: pothole(0)
- ❖ image_id (integer)
- ❖ id (integer)

Algorithms and Technique

Here we are using YOLOv4 model for training.. It is an one stage detection model which use basically "VGG 16" Convolutional Neural Network architecture for training and Softmax function for classification on darknet-53..But in this algorithm before starting the training on VGG16 it takes around 80 frames from the whole image to understand where the real object is present and this way it is able to detect any object more accurately with lower latency...

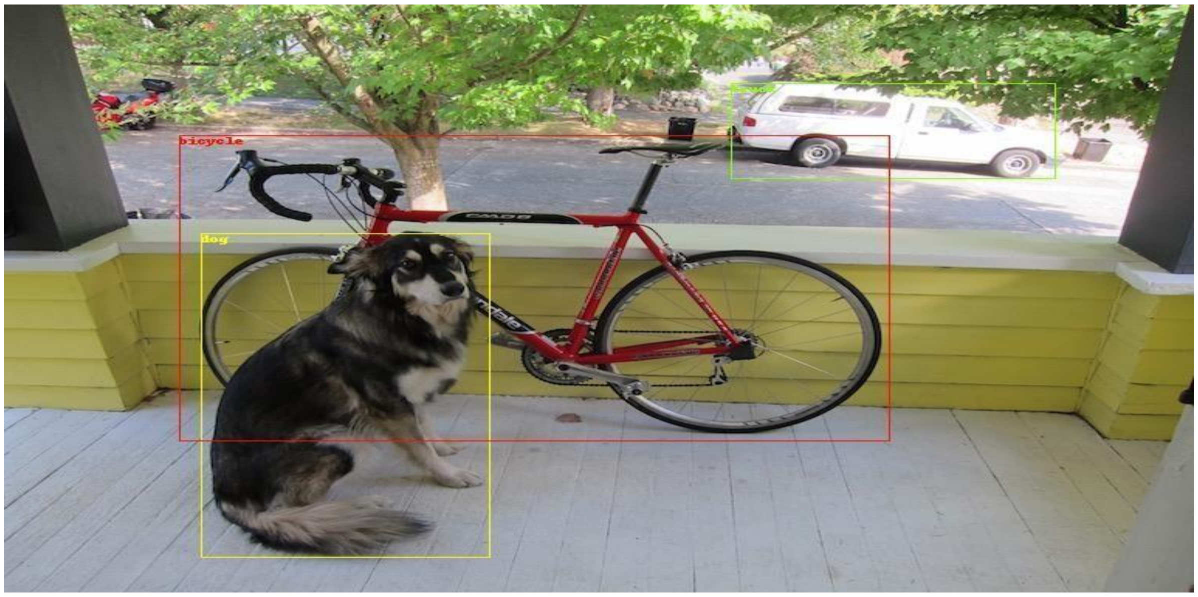


Fig 4:-Here YOLO model is detecting different objects

Training on colab

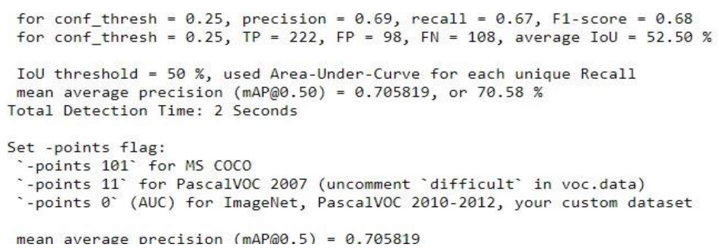
After making the data we have trained it on yolov4 tiny using our google colab with GPU..

❖ Training parameters are:

- ➢ Width = 416, Height = 416.
  - ➢ Max-batches = 6000.
  - ➢ Steps = 4800, 5400.
  - ➢ Batch-Size = 4.
  - ➢ Class = 1.
  - ➢ Filter = 18.
  - ➢ Subdivision = 64.

It took around 4-5 hours to train completely and we got the following result:-

precision = 0.69, recall = 0.67, F1-score = 0.68 TP = 222, FP = 98, FN = 108, average IoU = 52.50%, mean average precision (mAP@0.50) = 0.705819, or 70.58 %



```
 for conf_thresh = 0.25, precision = 0.69, recall = 0.67, F1-score = 0.68
 for conf_thresh = 0.25, TP = 222, FP = 98, FN = 108, average IoU = 52.50 %

 IoU threshold = 50 %, used Area-Under-Curve for each unique Recall
 mean average precision (mAP@0.50) = 0.705819, or 70.58 %
Total Detection Time: 2 Seconds

Set -points flag:
 `-points 101` for MS COCO
 `-points 11` for PascalVOC 2007 (uncomment `difficult` in voc.data)
 `-points 0` (AUC) for ImageNet, PascalVOC 2010-2012, your custom dataset

 mean average precision (mAP@0.5) = 0.705819
```

Fig 5 :- The mAP, precision & recall

Testing & Deployment

After Training we first test on colab with some image & then deploy on Flask using open-cv in my pycharm interpreture..

```
In [51]:   1  imShow('predictions.jpg')
```

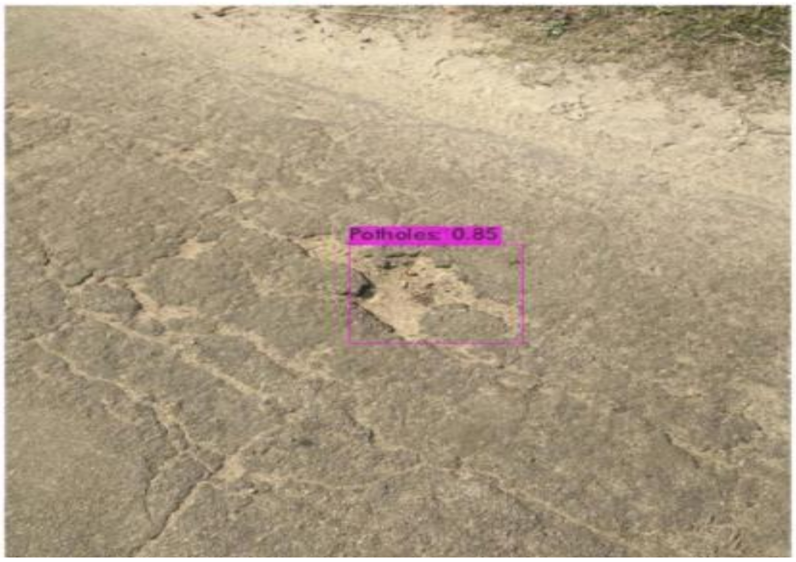


Fig 6:- Tested on colab

After doing the testing we downloaded our weights and cfg files and deployed on our local-server on a random video using OpenCV, Flask & HTML in our pyvchrm interpreter.. Then, we added a function (called geocoder()) which is made to calculate the latitude & the longitude of every pothole based on our camera location.. After calculating that we stored all the information in the database MongoDB in a intent called "Pothole" with current timestamp so that, we can get the detailed information for further usage and at the same time it is also calculating the area of the pothole based on the bounding box.

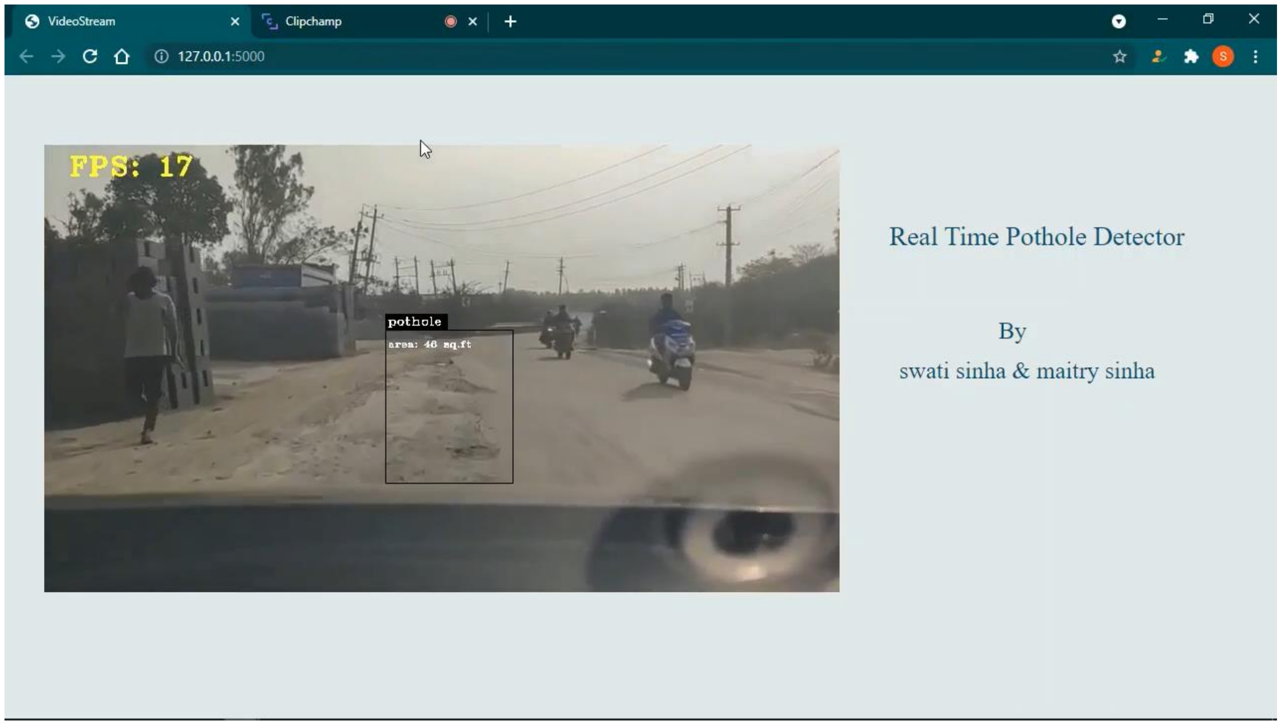
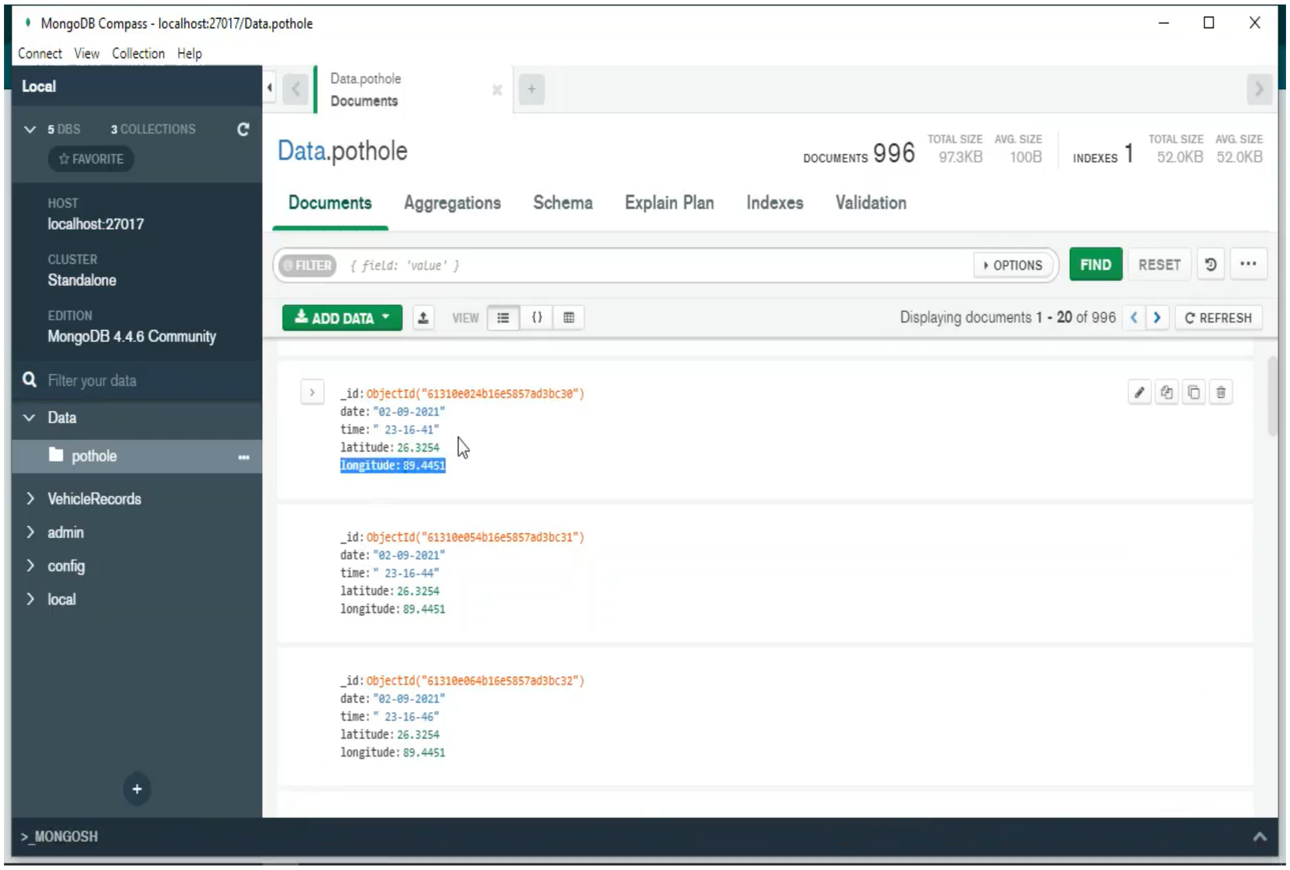


Fig7:- Pothole Detection Example



```
_id: ObjectId("61310e024b16e5857ad3bc30")
date: "02-09-2021"
time: " 23-16-41"
latitude: 26.3254
longitude: 89.4451

_id: ObjectId("61310e054b16e5857ad3bc31")
date: "02-09-2021"
time: " 23-16-44"
latitude: 26.3254
longitude: 89.4451

_id: ObjectId("61310e064b16e5857ad3bc32")
date: "02-09-2021"
time: " 23-16-46"
latitude: 26.3254
longitude: 89.4451
```

Fig 8:- Storing the data in the Database Example.

<u>Future Note:-</u> we can host this project in different cloud-platforms and also can make a good GUI for more handy usage of the project in future.