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Detecting Potholes Using Deep Learning

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Abstract

The road is a human need that is very important for us as human beings who do activities, the road is access to the destination that we want. Seeing the growing population of Indonesia so that the use of roads is very important to note. One of the problems that are often encountered by motorists in Indonesia is potholes, this is due to the increasing number of motor vehicles passing by. With the presence of potholes cause activities disrupted to cause accidents. In this final task, a system will be designed to detect potholes. This is done using a yi cam camera placed on the hood of a car with a height of 70cm facing the road. Data obtained in the form of video and from video will be extracted into images, this is a process of data acquisition. Making bounding boxes is the next step after the data acquisition process is done. From the collected images will be labeled according to the hole and will be continued with the training process. The result that will be obtained after the processes are done is video detection of hollow roads. The video shows there will be bounding boxes as a sign that there is a hole in the road. **Keyword** : Android application, GPS, PDAM, Record Meter.

Abstrak

Jalan merupakan kebutuhan manusia yang sangat penting bagi kita sebagai manusia yang beraktifitas, jalan merupakan akses menuju tujuan yang kita inginkan. Melihat jumlah penduduk Indonesia yang terus bertambah sehingga penggunaan jalan sangat penting untuk diperhatikan. Salah satu masalah yang sering dihadapi pengendara di Indonesia adalah jalan berlubang, hal ini disebabkan semakin banyaknya kendaraan bermotor yang lalu lalang. Dengan adanya lubang menyebabkan aktivitas terganggu hingga menimbulkan kecelakaan. Pada penelitian ini dirancang sebuah sistem untuk mendeteksi lubang. Hal ini dilakukan dengan menggunakan kamera yi cam yang ditempatkan pada kap mobil dengan ketinggian 70cm menghadap ke jalan. Data yang diperoleh berupa video dan dari video akan diekstraksi menjadi citra, hal ini merupakan proses akuisisi data. Pembuatan bounding box merupakan langkah selanjutnya setelah proses akuisisi data dilakukan. Dari citra yang terkumpul akan diberi label sesuai dengan lubangnya dan akan dilanjutkan dengan proses pelatihan. Hasil yang akan didapatkan setelah dilakukan proses adalah video deteksi jalan berlubang. Video tersebut memperlihatkan akan ada kotak-kotak pembatas sebagai tanda adanya lubang di jalan tersebut. .

Kata kunci : deep learning, deteksi, lubang, jalan

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I. INTRODUCTION

The development of technology is very fast and its application is a lot and can be done in daily life to facilitate and improve the efficiency of human activities and work. Along with the increasing population, welfare and anonymity of the community, the increasing power of human needs will also have an impact on the community. Especially in the field of transportation both private transportation and public transportation. The higher the activity of the community does not close the possibility of increasing transportation used to help people in activities so it is natural if many roads are damaged and still have

not received attention from the government. The government's lack of responsiveness in dealing with damaged road conditions is very disruptive and dangerous for road users. Cracks and holes in the road are often the cause of accidents that can lead to death. Based on the existing problems, the researchers want to design a device that can detect potholes by utilizing raspberry pi, intel stick and camera as a tool that can process images from those captured by the camera, if there is a hollow road then the buzzer will give a warning, with this detection tool can minimize accidents caused by perforated roads.

II. RELATED WORKS

In the related works sub-chapter, several studies related to this study are explained.

1. Research entitled "Internet of Things Based Pothole Detection System using Kinect Sensor". design perforated road detection tools using IoT-based kinect sensors. This research was conducted to be able to know the hollow roads and see performance tests in the field. This tool is also equipped with GSM module and GPS module where GSM module is used for data transmission and GPS module is used to know the position of the road that is perforated.

2. Research titled " Deep Learning Approach to Detect Potholes in Real-Time using Smartphones". to design a device to detect holes that are monitored in realtime using a smartphone. It uses a camera to capture images of perforated roads as well as accelerometer sensors and gyroscope sensors. The accelerometer sensor and gyroscope sensor here are used to determine whether or not this road is perforated based on the sensor readings that have been performed. The results of the data will be processed using the YOLO method.

3. Research entitled " IoT Based Humps and Pothole Detection on Roads and Information Sharing". Discuss about To acquire data on this tool not from the image but from the depth of the hole. It uses accelerometer sensors and ultrasonic sensors. In this system better monitor the state of the road surface. As we define changes in the road reduces its ability to function as a smooth road and safe driving.

4. Research entitled " Pothole Visual Detection using Machine Learning Method integrated with Internet of Thing Video Streaming Platform". This research is about detecting potholes. This system consists of 2 large parts namely VaaMSN (Vehicle as a Mobile Sensor Network) for edge side and SEMAR (Smart Environment Monitoring and Analytical in Real-time) for server side. VaaMSN consists of 3 parts namely Processing Unit, Wireless Portable Camera, Additional Sensor Device. The processing unit controls and processes all inputs, the Wireless Portable Camera captures the road in front of the car and streams the frame over the wireless network with the imageZMQ library. And for additional information, an Additional Sensor Device connected via the Processing Unit's USB port sends the GPS location and IMU value

III. YOLO OBJECT DETECTION

Yolo (You Only Look Once) is a method used for object detection. This approach is a method that uses neural network and is a development of CNN (Convolutional Neural Network) method. Yolo optimizes the results of the object detection process by making the pipeline of a single neural network process. Yolo optimizes high detection speed and accuracy with simple pipelines rather than detection algorithms and methods using other neural networks.

A. Bounding Box

YOLO, divide input image into S × S grid. If the center of the object is in a grid cell, the grid cell will used to detect the object. Each network cell will B Bounding Box for object detection. The box is boundedby 5 predictive variables x, y, w, h, and confidence score. With

- x and y is the center of detected object
- w,h is the length and width of the Bounding Box relative to the image.

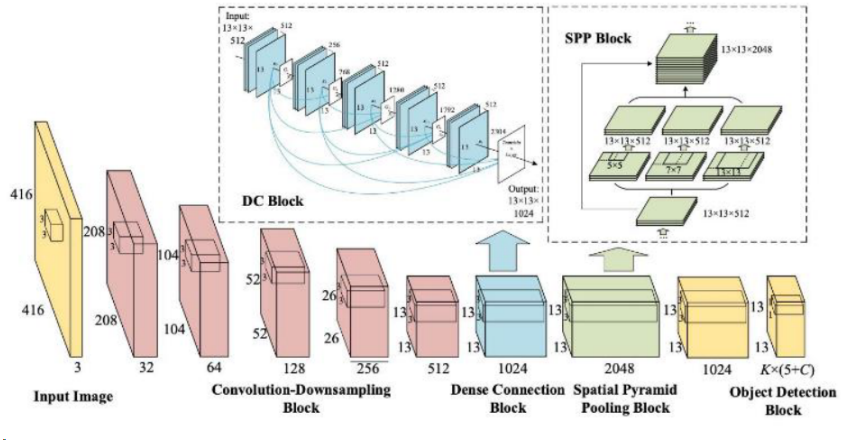

Figure 1: Yolo Object Detection Architecture

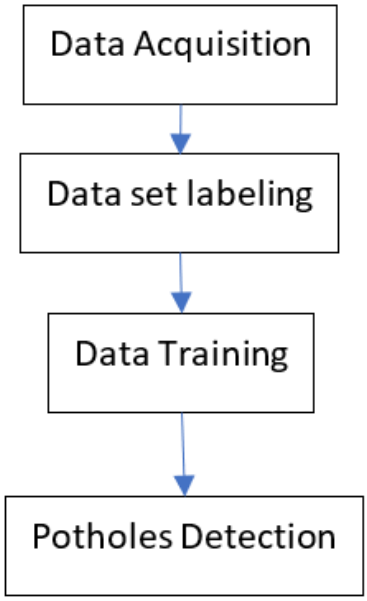

Figure 2: Block research diagram

B. Confidence Score

Confidence Score is a number between 0 and 1 that indicates the probability that the output of a Machine Learning model is correct and will satisfy user requests.

IV. SYSTEM DESIGN

The purpose of this study was to create a perforated road detection system using Deep Learning to alert road users to the state of the road. Based on the diagram on Figure 2, to perform the detection of potholes using yi cam cameras placed on cars with a height of 70cm as a tool for data acquisition. Then from the results of the image will be processed using image processing and identified using Deep Learning and the image will be processed using yolo method.

A. *Data Set*

The data set of pothole image obtained from the yi cam camera. The camera is installed on a car with an angle of 90 degrees to record the potholes. The camera output is video in .mp4 format. Figure 3 shows the placement of the Yi Cam camera on the car.

(a) (b)

Figure 3: Yi cam placement on car (a) Top view and (b) front view

An example of an image resulting from data acquisition is shown in Figure 4.

Figure 4: Data set sample

B. Pothole Detection

At this stage of the video of the pothole that has been taken will be tested to get the detection results in the form of bounding boxes with hole labels.

Figure 5: Perforated Road Detection

V. TESTING AND ANALYSIS

Evaluation of the detection results is done to determine the overall performance of the yolo model used, so that it can be determined whether the model is running well or not. The results of data training conducted using darkflow 6000 times iteration, obtained detection model with average loss and mAP from each iteration. The table above is a model performance testing table where there is 1 class

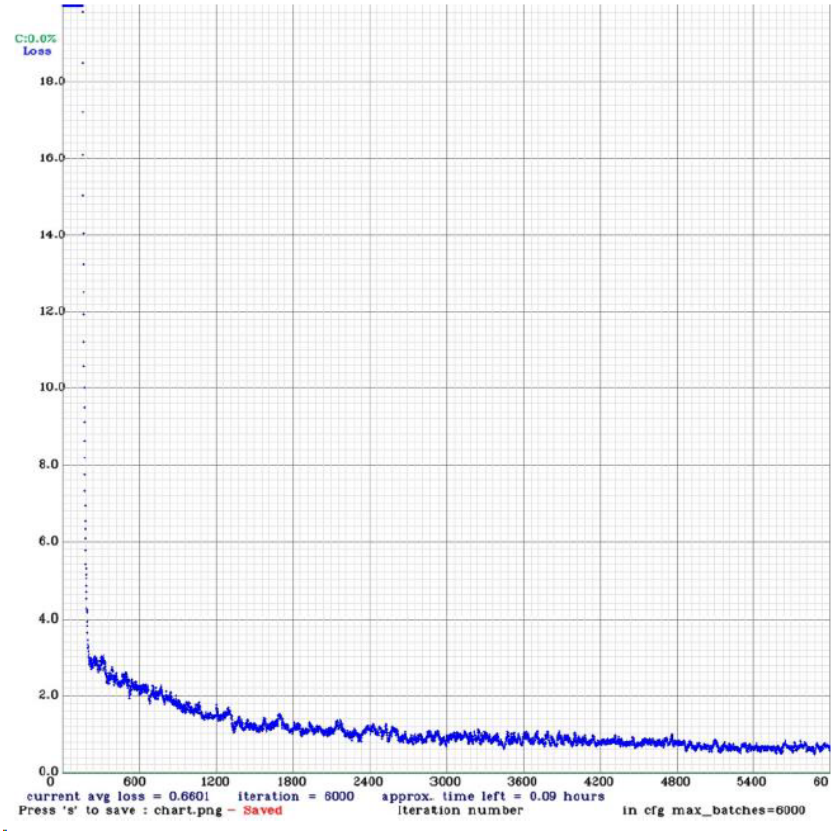

Figure 6: Graphic Loss

detected that is a hollow road but is done with different iterations that are 1000, 2000, 3000, 4000, 5000 and 6000 iterations. The YoloV4 model works well with Precision results of 0.78 at 1000, 0.94 in 2000, 0.97 at 3000, 0.98 at 4000, 0.95 in 5000 and 0.97 at 6000. Recalls amounted to 0.85 at 1000, 0.85 in 2000, 0.85 on 3000, 0.86 on 4000, 0.93 in 5000 and 0.90 on 6000. f1-scores were 0.81 at 1000, 0.89 in 2000,

Table 1: mAP

Load Model	Iteration					
Lubang	1000	2000	3000	4000	5000	6000
TP	170	169	170	172	186	180
FP	49	11	6	4	10	6
FN	30	31	30	28	14	20
Waktu Pemrosesan (s)	3	3	3	3	3	3
Precission	0.78	0.94	0.97	0.98	0.95	0.97
Recall	0.85	0.85	0.85	0.86	0.93	0.90
F1-Score	0.81	0.89	0.90	0.91	0.94	0.93
Average IoU	58.05%	73.07%	79.05%	82.05%	79.47%	82.26%
mAP@0.5	0.881846	0.878109	0.880153	0.876952	0.946235	0.941011

0.90 on 3000, 0.91 on 4000, 0.94 on 5000 and 0.93 on 6000. Average IoU was 58.05% at 1000, 73.07% in 2000, 79.05% in 3000, 82.05% in 4000, 79.47% in 5000 and 82.26% in 6000. 0.881846 at 1000, 0.878109 in 2000, 0.880153 at 3000, 0.876952 in 4000, 0.946235 in 5000 and 0.941011 in 6000. The aP (average Precission) value is the combined value of Precision and Recall based on the interval level. Average IoU is the intersection over union (IoU) average of detected objects. Mean Average Precision (maP) is the average of the aP (average Precission) of each object. Detection is declared accurate When iteration for 6000 by producing maP (Mean Average Precision) of 0.941011 or 94.10

VI. CONCLUSION

In this study, several conclusions can be drawn, among others:

1. The system uses perforated road image input and the system can detect perforated roads.
2. Based on the results of the accuracy test a classification of perforated roads is determined by the division of the number of datasets divided into tests and trains.
3. By using YoloV4 obtained accuracy of 94
4. Based on detection system testing obtained detection results TP, FP and FN.

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