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REAL TIME DETECTION AND REPORTING OF ROAD POTHOLES USING GPS

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Abstract: Pothole is a depression in the normal surface of the road. Lack of bond between the bituminous surfacing and the base course below due to improper application of prime coat and track. Larger potholes sometimes cause breath holding accidents and loss of lives as they are not visible at night. Pathetic condition of roads is a boosting factor for traffic congestion and accidents. The driver must manually look for potholes on the road while driving sometimes, the driver encounters many risks such as he will be at a constant speed and suddenly there will be a pothole on the way. At these times, the risks of accidents are more. To ensure road surface quality it should be monitored continuously and repaired as necessary. Thus, we have developed a proposed design using Deep learning. Here, we have used image processing to detect the road potholes. The process is done by proposing an image - processing to detect potholes from satellite images. By using the algorithm mentioned above, the system can detect whether the road has potholes or not. Once the system finds the potholes, the system will send the data to micro controller received on the GPS location and it is sent via mail and SMS.

Keywords: Potholes, Transportation safety, Deep Learning, Image Processing, GPS

I. INTRODUCTION

The major challenges faced in the road transportation sector are: The roads are narrow, not of good quality and the road maintenance is low funded. The road vehicle handling capacity is also low, but the vehicle density on road is increasing. India, the most populous Country in the World and a fast-growing economy, is known to a gigantic network of roads. Roads are the presiding means of transportation in India today. Most of the roads in India are narrow and congested because of poor road maintenance. Roads have been flooded with the vehicular traffic. It has become difficult to manage this traffic.

The prime motivation is to make a vehicle intelligent enough to aid driver in various aspects. Over the last decades, there has been an enormous increase in the vehicle population. Pathetic condition of roads is a boosting factor for traffic congestion and accidents. One of the increasing problems the people facing are worsened road conditions. Because of reasons like rain, wear and tear makes the road difficult to drive and causes the expansion and contraction of ground water under the pavement.

When water freezes, it expands the proliferation of vehicles has led to problems such as traffic congestion and increase in the number of road accidents. Unexpected hindrances on road may cause more accidents and also because of the bad road conditions, fuel consumption increases. It actually focuses on building a user-friendly device that specializes in detecting potholes. As a result, the roads deteriorate and increase the users cost of transportation. This had led to road accidents. The other reason for traffic jams and accidents is the poor condition of roads. Potholes are formed due to heavy rains and dense movement of vehicles on the poorly constructed roads. Pothole formation has given rise to accidents and loss of human lives. Various methods like image and video analysis, and laser-based techniques have been proposed to detect pothole and also to provide information in terms of their shape, size, depth and volume, so that an appropriate maintenance measure can be taken.

ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI), sometimes called machine intelligence, is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans.

Leading AI textbooks define the field as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals. Colloquially, the term "artificial intelligence" is often used to describe machines (or computers) that mimic "cognitive" functions that humans associate with the human mind, such as "learning" and "problem solving".

Artificial intelligence (AI) is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans. Some of the activities computers with artificial intelligence are designed for include:

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- ✓ Speech recognition
- ✓ Learning
- ✓ Planning
- ✓ Problem solving

ARTIFICIAL INTELLIGENCE, MACHINE LEARNING, AND DEEP LEARNING

Artificial Intelligence is the simulation of human intelligence by computer systems. AI can include hardware and software systems and it focuses on 3 cognitive processes: learning, reasoning, and self-correction. As a society, we're currently at the base-form of AI — Artificial Narrow Intelligence. This essentially means that AI is mainly a phenomenal pattern matcher for complex, unstructured datasets and due to this, its most common applications are natural language processing, computer vision, and speech recognition.

Machine Learning

Machine Learning often referred to as a subfield of AI, Machine Learning is the practice of learning from examples seen in data. It takes examples with answers and learns the rules (patterns) that yield those answers given the data. ML models are built on top of a foundation of statistics, ML optimizers (how they learn those patterns) are built on calculus, and efficient ML programming is built on linear algebra.

Deep Learning

Deep Learning is a subfield of Machine Learning and is the practice of constructing Neural Networks with multiple layers. Common use cases of deep learning are image classification, time series forecasting, and fraud detection. Note that Deep Learning just represents a set of methods related to Neural Networks for complex datasets; they are not a silver bullet for ML and will not be the best modelling choice in every scenario.

II. LITERATURE REVIEW

1. DESIGN AND DEVELOPMENT OF AN INTELLIGENT SYSTEM FOR POTHOLE AND HUMP IDENTIFICATION ON ROADS

AUTHOR – Shivaleelavathi YEAR - 2021

Country's economy depends on well – maintained roads as they are major means of transportation. It becomes essential to identify pothole and humps in order to avoid accidents and damages to the vehicles that is caused because of distress to drivers and also to save fuel consumption. In this regard, this work presents a simple solution to detect potholes and humps and hence avoid accidents and help drivers. Potholes are detected using Image Processing Technique and Ultrasonic Sensors are used to detect humps. Controlling device used is Raspberry Pi. The system acquires the geographical position of potholes using Wi-Fi and transmits it to authorities to take corrective measures. This project aims at identifying the potholes using image processing technology with the help of a camera.

2. ROAD DAMAGE DETECTION BASED ON UNSUPERVISED DISPARITY MAP SEGMENTATION

AUTHOR – RuiFan YEAR - 2020

This article represents a novel road damage detection algorithm by minimizing an energy function with respect to stereo rig roll angle and road disparity projection model. Instead of solving this energy minimization problem using non-linear optimization techniques, we directly find its numerical solution. The transformed disparity map is then segmented using Otus's thresholding method, and the damaged road areas can be extracted. The pixel-level road damage detection accuracyis approximately 97.56%.

3. SMART POTHOLE DETECTION USING DEEP LEARNING BASED ON DILATED CONVOLUTION

AUTHOR – Khaled YEAR – 2021

Roads make a huge contribution to the economy and act as a platform for transportation. Potholes in roads are one of the major concerns in transportation infrastructure. A lot of research has proposed using computer vision techniques to automate pothole detection that include a wide range of image processing and object detection algorithms. There is a need to automate the pothole detection process with adequate accuracy and speed and implement the process easily and with low setup cost for real-time with adequate accuracy.

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III. BLOCK DIAGRAM

HARDWARE

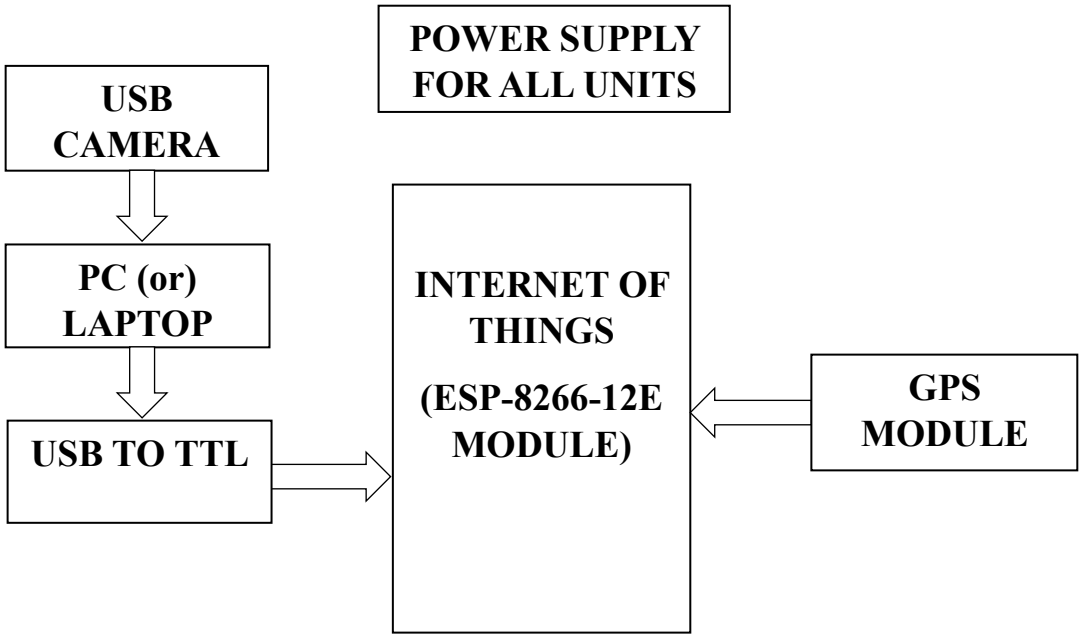

Fig 1 Hardware-Block Diagram of Proposed System

SOFTWARE

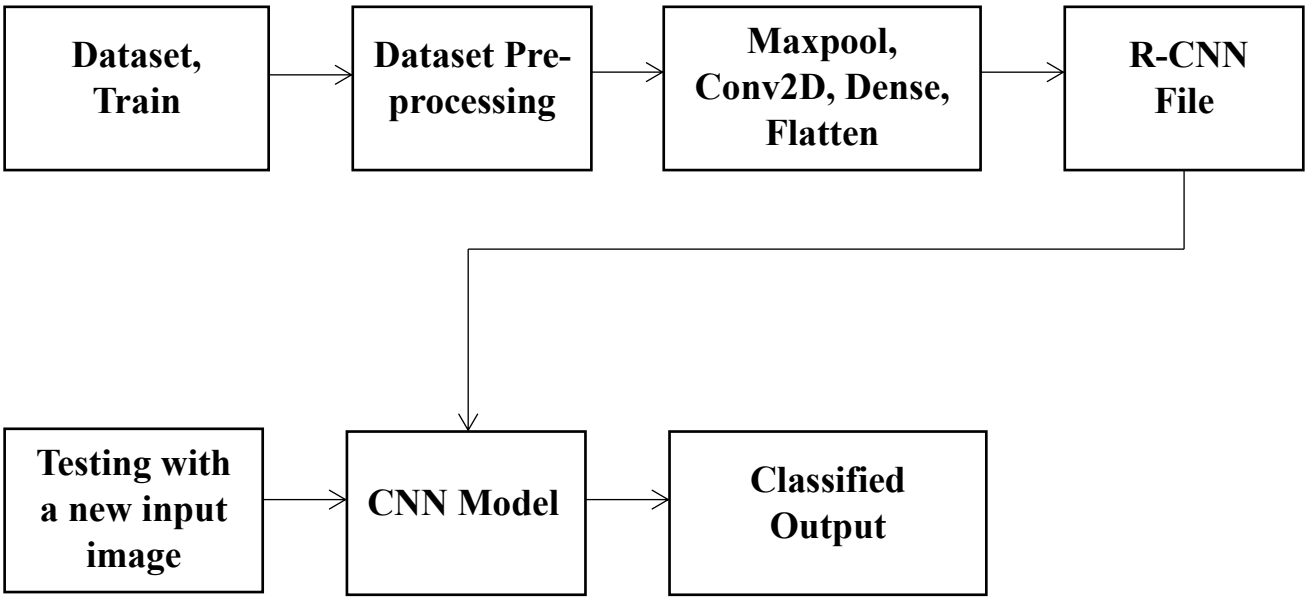

Fig 2 Software-Block Diagram of Proposed System

IV. PROPOSED SYSTEM

The system proposed is a simple and cost-effective solution to detect potholes. The aim of the proposed system is to detect potholes before the vehicle crosses the pothole so that damage to the vehicle and the potential risk of accidents can be reduced. The simplest method to detect potholes is collecting photos of road damage and hazards taken by the

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participants and uploading them to a central server. An automated approach to detect potholes with little or no human interaction is more promising. It is accomplished by Image processing. It captures the pothole and it is been expressed in some forms of code in python. So, in that case detecting the potholes and sending the location of that pothole using GPS to the higher authorities (For e.g. Municipal office) via email with attached image file. This can make them to know that pothole is located here and it needs to be emended.

SOFTWARE NEEDED

- ✓ PYTHON
- ✓ PYTHON NUMPY
- ✓ OPEN CV
- ✓ TENSORFLOW
- ✓ CONVOLUTIONAL NEURAL NETWORK(CNN)

HARDWARE NEEDED

- ✓ POWER SUPPLY
- ✓ TRANSFORMER
- ✓ REGULATOR
- ✓ INTERNET OF THINGS(IoT)
- ✓ ESP 8266 – 12E NODE MCU (IoT Module)
- ✓ GLOBAL POSITIONING SYSTEM
- ✓ USB TO TTL

IV. RESULTS AND OUTPUT

Hardware-Schematic

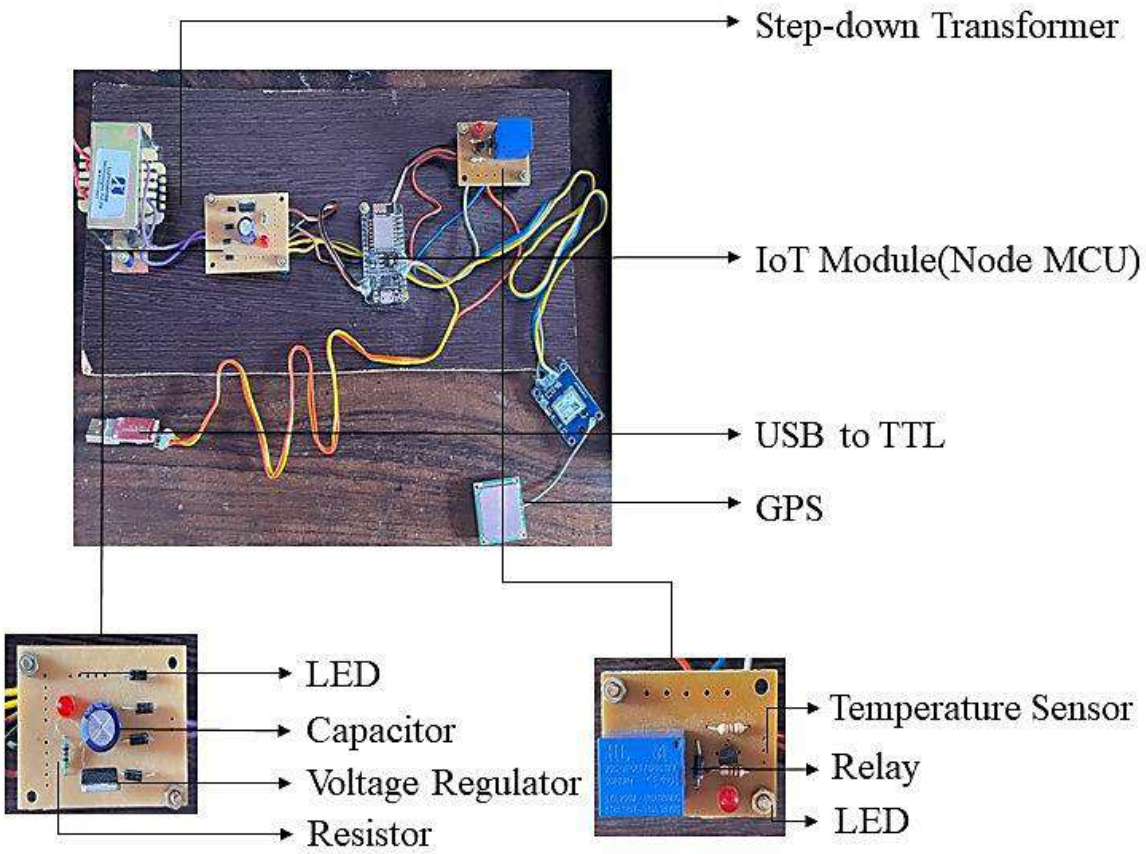

Fig 3 Hardware Representation

The schematic representation of Hardware setup is shown in figure 3

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Input Image

Fig 4 Input Image for Detection

The input image of the pothole is shown in figure 4

Output for Input Image by Detecting Potholes

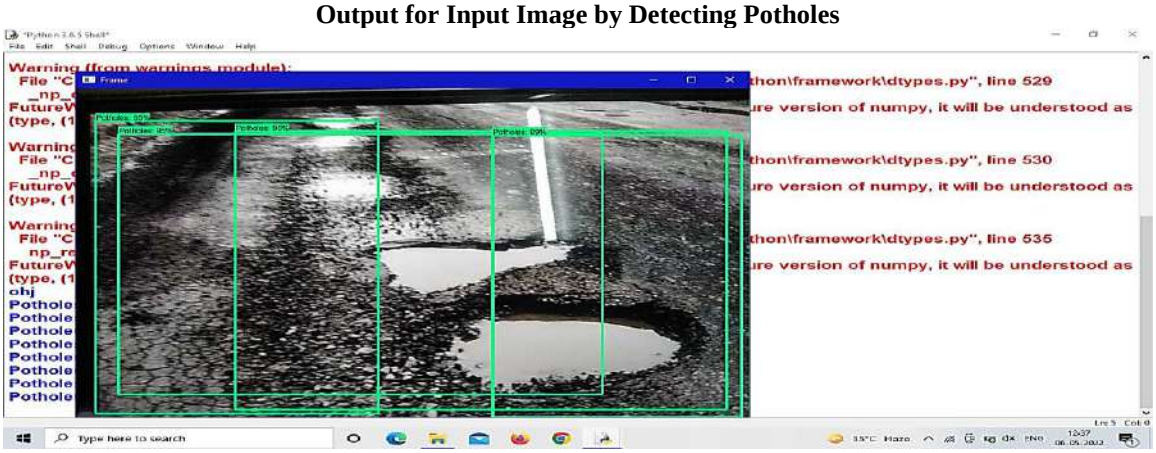

Fig 5 Pothole Gets Detected by AI in Python

The window which depicts the detection of potholes in python shell using AI is shown in figure 5

SOFTWARE OUTPUT IN PYTHON-SHELL ALONG WITH THE HARDWARE SETUP

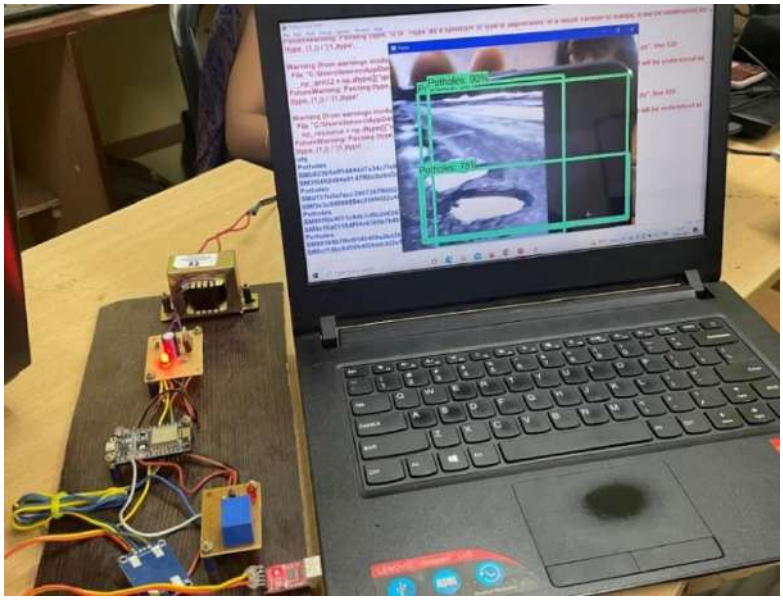

Fig 6 Software and Hardware Output

The setup of hardware and software along with output is shown in figure 6

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LOCATION SHARED BY GPS THROUGH CAYENNE

Fig 7 Location which is Tracked by GPS (Location showed – SBECW)

The location of potholes viewed in CAYENNE site is shown in figure 7

NOTIFYING THE POTHOLES BY MAIL AND SMS

Message Via Mail

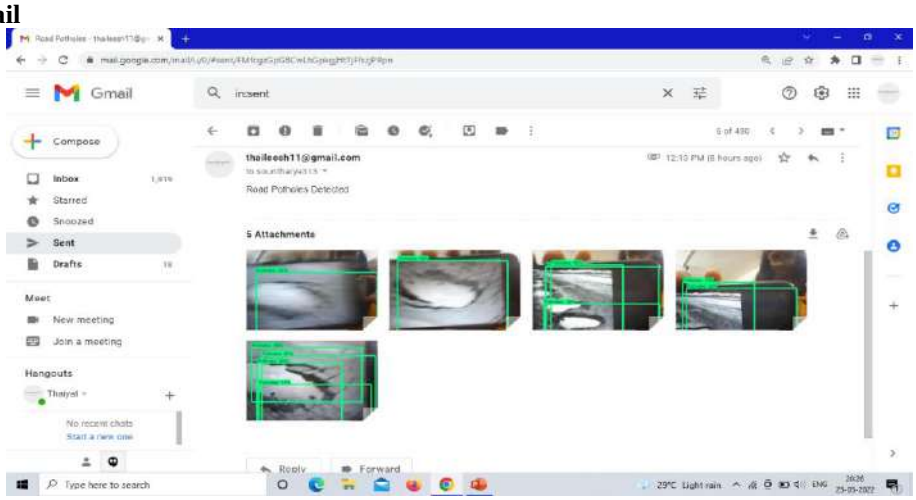

Fig 8 Captured Pothole Images Gets Received to Registered Mail

The pothole images which are sent to the user by the server by mail is shown in figure 8

Message Via SMS

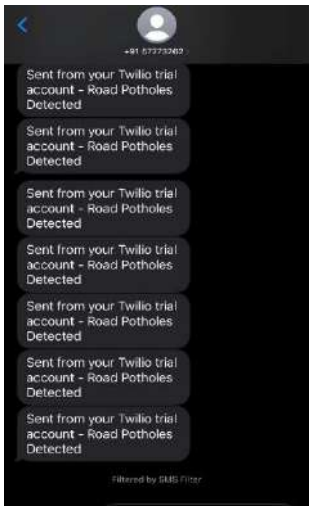

Fig 9 Pothole Detected Information is Received by SMS.

The information whenever a pothole gets noticed is sent to the user by SMS is shown in figure 9

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V. APPENDIX

```
import numpy as np
import sys
import tensorflow as tf
from distutils.version import StrictVersion
from collections import defaultdict
from object_detection.utils import ops as utils_ops
# This is needed since the notebook is stored in the object_detection folder.
sys.path.append("..")

if StrictVersion(tf.__version__) < StrictVersion('1.9.0'):
  raise ImportError('Please upgrade your TensorFlow installation to v1.9.* or later!')
from utils import label_map_util
from utils import visualization_utils as vis_util
MODEL_NAME = 'inference_graph'
PATH_TO_FROZEN_GRAPH = MODEL_NAME + '/frozen_inference_graph.pb'
PATH_TO_LABELS = 'training/labelmap.pbtxt'
detection_graph = tf.Graph()
with detection_graph.as_default():
  od_graph_def = tf.GraphDef()
 with tf.gfile.GFile(PATH_TO_FROZEN_GRAPH, 'rb') as fid:
 serialized_graph = fid.read()
 od_graph_def.ParseFromString(serialized_graph)
  tf.import_graph_def(od_graph_def, name='')
category_index = label_map_util.create_category_index_from_labelmap(PATH_TO_LABELS, use_display_name=True)
def run_inference_for_single_image(image, graph):
    if 'detection_masks' in tensor_dict:
        # The following processing is only for single image
        detection_boxes = tf.squeeze(tensor_dict['detection_boxes'], [0])
        detection_masks = tf.squeeze(tensor_dict['detection_masks'], [0])
        # Reframe is required to translate mask from box coordinates to image coordinates and fit the image size.
        real_num_detection = tf.cast(tensor_dict['num_detections'][0], tf.int32)
        detection_boxes = tf.slice(detection_boxes, [0, 0], [real_num_detection, -1])
        detection_masks = tf.slice(detection_masks, [0, 0, 0], [real_num_detection, -1, -1])
        detection_masks_reframed = utils_ops.reframe_box_masks_to_image_masks(
            detection_masks, detection_boxes, image.shape[0], image.shape[1])
        detection_masks_reframed = tf.cast(
            tf.greater(detection_masks_reframed, 0.5), tf.uint8)
        # Follow the convention by adding back the batch dimension
        tensor_dict['detection_masks'] = tf.expand_dims(
            detection_masks_reframed, 0)
    image_tensor = tf.get_default_graph().get_tensor_by_name('image_tensor:0')

    # Run inference
    output_dict = sess.run(tensor_dict,
                           feed_dict={image_tensor: np.expand_dims(image, 0)})

    # all outputs are float32 numpy arrays, so convert types as appropriate
    output_dict['num_detections'] = int(output_dict['num_detections'][0])
    output_dict['detection_classes'] = output_dict[
        'detection_classes'][0].astype(np.uint8)
     output_dict['detection_boxes'] = output_dict['detection_boxes'][0]
    output_dict['detection_scores'] = output_dict['detection_scores'][0]
    if 'detection_masks' in output_dict:
        output_dict['detection_masks'] = output_dict['detection_masks'][0]
    if output_dict['detection_classes'][0] == output_dict['detection_scores'][0] > 0.70:
      print('Potholes')
    return output_dict
    import cv2
cap = cv2.VideoCapture("road.mp4")
#cap = cv2.VideoCapture(0)
try:
    with detection_graph.as_default():
        with tf.Session() as sess:
```

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```
            # Get handles to input and output tensors
            ops = tf.get_default_graph().get_operations()
            all_tensor_names = {output.name for op in ops for output in op.outputs}
            tensor_dict = {}
            for key in [
              'num_detections', 'detection_boxes', 'detection_scores',
            ]:
                tensor_name = key + ':0'
                if tensor_name in all_tensor_names:
                    tensor_dict[key] = tf.get_default_graph().get_tensor_by_name(
                  tensor_name)
while True:
                ret, image_np = cap.read()
                # Expand dimensions since the model expects images to have shape: [1, None, None, 3]
                image_np_expanded = np.expand_dims(image_np, axis=0)
                # Actual detection.
                output_dict = run_inference_for_single_image(image_np, detection_graph)
                # Visualization of the results of a detection.
                vis_util.visualize_boxes_and_labels_on_image_array(
                    image_np,
                    output_dict['detection_boxes'],
                    output_dict['detection_classes'],
                    output_dict['detection_scores'],
                    category_index,
                    instance_masks=output_dict.get('detection_masks'),
                    use_normalized_coordinates=True,
                    line_thickness=8)
                cv2.imshow('Frame', cv2.resize(image_np,(800,600)))
                if cv2.waitKey(1) == ord('q'):
                    cap.release()
                    cv2.destroyAllWindows()
                    break
except Exception as e:
    print(e)
    cap.release()
```

VI. CONCLUSION

The system presented in this paper provides solution for intelligent detection of potholes to aid transport vehicle or car drivers in avoiding accidents and provide information to the Higher officials (Municipal office) to take action of maintenance of roads. The system uses web camera to detect the potholes. The detected pothole is been captured and sent to the officials along with their picture via mail and SMS. For mailing SMTP is used and for SMS purpose GSM(Twilio) is used, where it gets received to the registered mobile numbers. It makes use of the GPS for sending the location of potholes. (Node MCU) is used forgetting the pictures and for transferring via cloud using Wi-Fi-module. In advanced, drivers also get intimated by some other stopping-sensors which gets attached to the braking system, so that it makes the vehicle to stop automatically whenever the potholes are found.

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