

TRACTS-Net: An Intelligent Road Damage Detection System using 5G Integrated Team-forming Network

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Abstract—In the era of fifth generation of cellular communication (5G), connected vehicles are expected to play a crucial role in transportation and road safety. Every year, road accidents cause numerous injuries and deaths all over the world. One of the various reasons for these accidents is the damaged roads. However, recent technological advancements have provided us with the opportunity to overcome these challenges and mitigate the number of accidents drastically. Thus, in this manuscript, we developed a cost-effective IoT device to capture information of potholes on the roads and alert the authority through gateways with the aid of our proposed architecture which integrates 5G networks. Experimental investigations have been carried out to test the performance of our model and our findings demonstrate that the proposed device performs significantly well in the testbed with an accuracy of little less than cent percent in team-forming network.

Index Terms—IoT, team-forming network, road damage detection.

I. INTRODUCTION

Roads are one of the mediums of communication and play a crucial role to the economy of a country. Countries like USA, Japan, UK are the leading examples of extraordinary transportation systems due to their well-constructed roads. In a contrary, developing countries are still suffering from having a better transportation system. Roads are not well maintained developing countries and thus they face a lot of difficulties including major accidents as discussed in [1] and [2]. Roads can be damaged due to several reasons such as geographical position where rain occurs frequently, constant transition of heavy weight vehicles, negligence in maintenance [3] and so on. Most of the issues are unavoidable due to its nature. Moreover, manually monitoring the condition of highways is a tedious and inefficient task. Even if we consider it as a solution, we need a huge human resources. This will leads to consider the financial aspect and spending huge amounts of funds.

Recently, deep learning and computer vision techniques attracted a significant attention to overcome the challenges towards pothole detection systems. However, these applications require huge computational resources and thus it makes the overall system quite expensive to use in everyday usage. A pothole detection system is developed by Kang et al. in [4]

which is based on 2D LiDAR (two dimensional light detection and ranging) that captures the information of angles and distances. Furthermore, the detection algorithm is constructed upon noise reduction, clustering, line segment extraction etc. Finally, to improve accuracy, different image processing techniques are applied. In [5], multiple USB cameras are utilized for capturing real time images. Disparity map is visualised with the aid of different parameters obtained from USB camera calibration and checkerboard to inform the driver about the potholes in real time.

A popular deep learning based algorithm called you only look once (YOLO) is proposed by the authors in [6] has been implemented in several pothole detection systems. In [7], authors implemented YOLO algorithm to detect potholes and used several image processing techniques to measure the dimensions of potholes. A computer vision based pothole detection system is presented by the authors in [8] which is designed on small single-board computer Raspberry Pi. The processing of the data is done on the input video to identify potholes using computer vision techniques. A machine learning based pothole detection system is presented in [9], that gathers data by monitoring the vibration of a car and its location through global positioning system (GPS). The potholes are identified by analysing the data using machine learning algorithms. A real-time pothole detection system is proposed by Kashish et. al. in [10], which is based on internet of things (IoT) sensors to identify irregularities on road surface using machine learning algorithms. A global road damage detection scheme based region based convolutional neural networks (R-CNN) is presented in [11] which is expected to detect and classify the road damages. Unlike the aforementioned solutions and solutions presented in [12] which have cost constraints, we have developed a low-cost IoT device which automatically detects the road damage using team-forming network. More specifically our contributions are listed as follows:

- Network Architecture is designed to help the authorities to monitor and repair the damaged road on the map.
- An intelligent pothole detection system is proposed exploiting the team-forming networks to collect data by