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Distributed Framework for Pothole Detection and Monitoring Using Federated Learning

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Abstract : Transport service monitoring and upkeep are essential components of smart city initiatives. The main risks to the relevant departments and authorities are the ever-increasing vehicular traffic and the conditions of the roads. In India, the economy is greatly impacted by the road transport sector. In 2021, the Ministry of Road Transport and Highways Transport, Government of India, produced a report with statistical data on traffic accidents. The data included the number of fatalities, injuries, and other pertinent criteria. This study proposes a distributed infrastructure for the monitoring, detection, and reporting of potholes to the appropriate authorities. In a distributed environment, the nodes are the edge devices, and local edge servers, and global servers. The edge devices receive the initial model to be employed from the global server. The YOLOv8 model for pothole detection is used in the edge devices. The edge devices run the pothole detection model, gather the pothole images on their path, and send the updates to the nearby edge server. The local edge server selects the clients for its aggregation process, aggregates the model updates and sends the updates to the global server. The global server collects the updates from the local edge servers, performs aggregation and derives the updated model. The updated model has the information about the potholes received from the local edge servers and notifies the updates to the local edge servers and concerned authorities for monitoring and maintenance of road conditions. The entire process is implemented in FedCV distributed environment with the implementation using the client-server model and aggregation entities. After choosing the clients for its aggregation process, the local edge server gathers the model updates and transmits them to the global server. After gathering the updates from the regional edge servers, the global server aggregates them and creates the updated model. Performance indicators and the experimentation environment are assessed, discussed, and presented. Accelerometer data may be taken into consideration for improved performance in the future development of this study, in addition to the images captured from the transportation routes.

Keywords : federated Learning, pothole detection, distributed framework, federated averaging
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