Modeling Impact of Weather Conditions on 5G Communication and Mitigation Measures on Control of Automated Intersections

Technology Transfer Activities

by

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TECHNOLOGY TRANSFER ACTIVITIES

1 Summary of Research Study and Findings

In this study, we developed weather impact models for 5G communications among connected vehicles and evaluated them using simulations.

- We extended ns3-Millicar model by adding weather impacts to path loss functions. The code and results of our simulation and implementation details are published on GitHub (https://github.com/ericliujian/ns3-mmwave-weather), our simulation results show that the attenuation of the 5G propagating signal increases when the operating frequency, the concentration of the dust, and the particle size of sand are increased.
- We showed that dust and sand affect the 5G communication channel more than the DSRC channel. This effect is logical because the wavelength λ of the propagating 5G mmwave is short compared to the particle size of dust and sand. Our simulation results also suggest a range of harsh weather of particle size, visibility, and humidity for 5G mmwave.

2 Outputs

At the end of the study, the research goals were accomplished. We shared research results through a conference presentation and published a journal article shortly. Below is the outline plan to disseminate the research results.

2.1 Accomplished Outputs

Journal Article

Abuhdima, E., Liu, J., Zhao, C., Elqaouaq, A., Comert, G., Huang, C.T., Pisu, P. and Nazeri, A.H., 2022. Impact of Dust and Sand on 5G Communications for Connected Vehicles Applications. IEEE Journal of Radio Frequency Identification.

Conference Article Presentation

Abuhdima, E.M., Comert, G., Pisu, P., Huang, C.T., Elqaouaq, A., Zhao, C., Alston, S., Ambrose, K. and Liu, J., 2021, October. The effect of Dust and Sand on the 5G Millimeter-Wave links. In 2021 IEEE International Conference on Wireless for Space and Extreme Environments (WiSEE) (pp. 60-65). IEEE.

Other

Abuhdima, E.M., Comert, G., Pisu, P., Huang, C.T., Qaouaq, A.E., Zhao, C., Alston, S., Ambrose, K. and Liu, J., 2021. The Effect of Dust and Sand on the 5G Terrestrial Links. arXiv preprint arXiv:2108.09226.

Abuhdima, E.M., Qaouaq, A.E., Alston, S., Ambrose, K., Comert, G., Liu, J., Zhao, C., Huang, C.T. and Pisu, P., 2021. Impact of Weather Conditions on 5G Communication Channel under Connected Vehicles Framework. arXiv preprint arXiv:2111.09418.

2.2 Future Output

Peer-Reviewed Journal Article

Currently, we are planning to submit a continuation of our work using the test bed generated from this research collaboration.

Conference Poster and Podium Presentation

The effect of Dust and Sand on the 5G Millimeter-Wave links. In 2021 IEEE International Conference on Wireless for Space and Extreme Environments (WiSEE)

Transportation Practitioners Comments

None

3 Outcomes

The research has produced the following critical outcomes:

3.1 Modeling and Simulation

The study modeled 5G path loss due to weather impact on existing models. These models can incorporate impact and help decision-making robust under extreme weather conditions such as very humid, low visibility, sand storms, or snow storms.

4 Impacts

We expect this study to add knowledge to the transportation community and the public. We anticipate that this research to have an impact on connected vehicles as follows:

(i) *Transportation agencies, enforcement agencies, and public officials:* for safety, we were able to measure what weather conditions can lead to near-collision scenarios for connected vehicles due to communication loss.

(ii) *Transportation professionals:* Analysis shows that 5G communications are impacted due to extreme weather conditions, and different thresholds or guidance is needed under such circumstances.