2019 UDOT RESEARCH PROBLEM STATEMENT

**** Problem statement deadline is Feb. 6, 2019. Submit statements to UTRAC@utah.gov. ****

Title: Fast and Reliable Prediction of Pedestrian Crossing Intention and Movement at Intersections **No. (Office Use):** 19.03.12

Written By: Ziqi Song and Xiaojun Qi **Organization:** Utah State University **Email:** ziqi.song@usu.edu **Phone:** 435-797-9083

Submitted By UDOT Employee: Blaine Leonard **Email:** bleonard@utah.gov **Phone:** 801-547-5937

UDOT Champion (if different): **Email:** **Phone:**

Select ONE Subject Area ☐ Materials/Pavements ☐ Maintenance ☒ Traffic Mgmt/Safety ☐ Structures/Geotech ☐ Planning ☐ Perf Mgmt/Data Analytics ☐ Public Transportation ☐ Other

1. Describe the problem to be addressed:

According to the 2017 Utah Fatal Crash Summary, 15.4% of pedestrian accidents occur at intersections since pedestrians tend to pass the crosswalk quickly without pushing the crosswalk buttons or paying attention to the crosswalk traffic signals. As a result, developing a fast and reliable pedestrian crossing intention and movement prediction system at intersections is essential to significantly reducing the number of pedestrian fatalities. In addition, such a prediction system can be integrated into current traffic signal timing systems and can provide drivers with timely information to take immediate actions. This system could play a crucial role for connected and automated vehicles (CAVs) to avoid collisions, as the presence of CAVs on our roadways increase in the near future.

A fast and reliable pedestrian crossing intention and movement prediction system should possess the following characteristics:

- Responding in a timely manner to notify the drivers or CAVs to take actions immediately.
- Handling the high agility and unexpected movements of pedestrians to reduce the false alarms.
- Providing long-term predictions to ensure smooth and safe maneuvers of vehicles.
- Predicting the intention of individual pedestrians and/or group of pedestrians within a crowd to alert the drivers.
- Handling different weather and lighting conditions to be a practical tool for any situations.

We propose to develop a fast and reliable pedestrian crossing intention prediction system, which can be utilized at intersections to provide drivers with timely information to take immediate actions to avoid a potential collision. We will deploy multiple sensors (i.e., high-resolution cameras and 16-beam miniature LiDAR unit) at intersections and collect a large amount of data from those sensors for a certain timeframe under different weather and lighting conditions. We will construct a Deep Recurrent Neural Network (DRNN) to learn pedestrian intention and movement using the data collected from multiple sensors and employ the learned DRNN to provide a fast and reliable pedestrian crossing intention and movement prediction at intersections.

2. Write the project objective (25 words or less):

Develop a fast and reliable pedestrian crossing intention and movement prediction system using deep learning techniques.

3. Explain why this research is important:
(In response, consider addressing specific UDOT goals, applicability in Utah or other states, etc.)

A fast and reliable pedestrian crossing intention and movement prediction is crucial for better pedestrian-vehicle interaction and safer transportation. The proposed research will help UDOT achieve zero crashes, zero injuries and zero fatalities, one of the UDOT strategic goals. The developed system can be integrated into current traffic signal timing systems and CAVs to avoid collisions at intersections.

4. List the major tasks:

1. Conduct a comprehensive literature review of pedestrian crossing intention and movement prediction using data collected from different sensors.
2. Collect a large amount of data from multiple sensors (e.g., videos and LiDAR data) that will be deployed at intersections for a certain timeframe under different weather and lighting conditions.

3. Develop labeled data (e.g., whether the pedestrian intends to cross the intersection and whether the pedestrian intends to change his/her moving trajectory) from collected data for deep learning model development.
4. Develop a Deep Recurrent Neural Network (DRNN) to learn pedestrian crossing intention and movement using the data collected from multiple sensors and employ the learned DRNN to provide a fast and reliable pedestrian crossing intention and movement prediction at intersections.
5. Perform extensive experiments on the publicly available datasets and our collected datasets.
6. Evaluate the effectiveness of the prediction system under different weather and lighting conditions in terms of the accuracy and the computational time and fine-tune some parameters of the DRNN for multiple rounds of evaluations.

5. List the expected deliverables (reports, manual, specification, design method, training, etc.):

1. Data collected from multiple sensors.
2. Training data developed from the labeled field information.
3. The trained Deep Recurrent Neural Network (DRNN) that learns pedestrian crossing intention and movement using the data collected from multiple sensors.
4. Interim reports of different stages of the work.
5. Final report.

6. Describe how the research results will be implemented:
(In response, consider addressing UDOT leader support, process or standard improvement, etc.)

If successful, the developed fast and reliable pedestrian crossing intention and movement prediction system can help UDOT reduce the number of fatalities by avoiding pedestrian collisions at intersections. This can be accomplished through integration into current traffic signal timing systems and deployment into CAVs. The developed system can be tested and implemented on the Redwood Road CAV project and similar corridors.

7. Requested from UDOT: $50,000 **Other/Matching Funds:** $50,000 **Total Cost:** $100,000
(or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates:
The proposed research work will be carried out in a period of 12 months with an estimated start date of July 1, 2019. The project will follow the schedule below:

- Literature review: 1 month.
- Data collection and labeling: 3 months (at different seasons).
- Pedestrian crossing intention and movement prediction development: 4 months.
- Initial performance evaluation: 1 month.
- Fine-tune parameters and comprehensive performance evaluation: 2 months.
- Report preparation and writing: 1 month.