Position Statement for Detection & Inclusion of Two-Wheelers into the Connected Car Ecosystem

The Problem

As the use of various modes of micromobility within urban areas continues to increase, so do the accidents that occur between automobiles/trucks & cyclists/motorcyclists.

In 2016, bicycle accidents resulted in more than 45,000 injuries and 840[1] killed in the U.S. 30%[2] of all bicycle accidents occur as result of collision with automobiles. With estimates of the Connected Car Market becoming worth $219B USD by 2025[3], VRUs (and specifically, cyclists) become considerably more vulnerable due to a lack of direct-connectivity with these much larger vehicles who have the benefit of safety by speaking amongst themselves.

Motorcycles account for 3% of all vehicles registered in the U.S. yet made up 14% of all traffic fatalities in 2016[4]. Of the top 10 dangers to motorcyclists[5], half of those are directly related to the actions (or, inactions) of drivers, resulting in approximately 2,500 deaths each year in the U.S. alone.[6]

In 2010, motorcycle crashes cost $12.9 billion in economic impacts, and $66 billion in societal harm as measured by comprehensive costs. Compared to other motor vehicle crashes, these costs are disproportionately caused by fatalities and serious injuries.[7]

The U.S. Insurance Industry spend approximately $41B/year as a direct result of automobile collisions with motorcycles & bicycles ($16B: motorcycles[8]; $25B: bicycles[9])

Existing Solutions

Almost all OEMs have some variation of ADAS in their current lineups. It is these technologies that Ridar Solutions can effectively augment through OTA (over the air) integration. ADAS can include Adaptive Cruise Control, Lane Departure Warning

[1] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812507
[2] https://www.peoplepoweredmovement.org/bicycle-accidents-in-the-united-states/
[3] https://www.prnewswire.com/news-releases/connected-car-market-worth-21921-billion-usd-by-2025-673540253.html
[4] https://www.autoinsurancecenter.com/state-of-fatal-motorcycle-accidents-in-america.htm
[5] https://www.cheatsheet.com/automobiles/10-biggest-dangers-to-motorcyclists-on-the-road.html/?a=viewall
[6] https://www.ntsb.gov/safety/safety-studies/Documents/SR1801.pdf
[7] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812013
[8] https://www.autoblog.com/2012/12/06/calculating-the-cost-of-a-motorcycle-accident/
[9] https://www.reuters.com/article/us-health-cycling-accident-costs/medical-costs-of-bike-crashes-on-the-rise-idUSKBN19022J

Systems, Forward Collision Warning Systems, Traffic Sign Recognition Systems, Night Vision & Pedestrian Detection and Parking Assistance Systems.

Newer vehicles are being built with a variety of technology intended to protect it and its occupants from crashing into other automobiles. Specifically, ADAS (Advanced Driver Assisted Systems) use cameras, radar, lidar and other technologies to prevent those vehicles from contacting other vehicles or objects around them. These ADAS solutions work quite well in detecting other vehicles and objects which are within a **clear line of sight** of vehicles so equipped. I emphasize clear line of sight as VRUs are often overlooked by such detection systems, especially when they are hidden by buildings, other larger vehicles, or are simply not detected because they are so much smaller than most vehicles and more difficult to detect.

All of these have one major requirement to function properly: clear line of sight. Because these technologies use cameras, lidar, radar (among other hardware devices), all need to actually 'see' the object nearby from which they are trying to prevent drivers from colliding.

The specific problem with the detection of two-wheelers is that they are a much smaller target for ADAS technologies to acquire but also two-wheelers are frequently blocked from view by other vehicles & infrastructure.

And, because ADAS functionality may vary from one automaker to another, there are inconsistencies in the effectiveness of detections. The IIHS conducted such a test and here are the results. It is quite clear that consistency is not present across OEMs in their ability to detect VRUs. The C/AV (Connected/Autonomous Vehicle) space is one which includes several companies offering as many variations of technologies with no clear standard.

Connected car technologies such as DSRC/ IEEE802.11P (vehicle to vehicle using Dedicated Short-Range Communication) or C-V2X (cellular vehicle to everything) are being developed to allow automobiles to communicate directly with other similarly-equipped vehicles. These will provide prompts directly to the driver in the case of connected vehicles or directly to the autonomous vehicle. With either technology, these solutions exclude two-wheelers.

Ridar Systems

Ridar Systems has developed a cloud-based mobile solution that allows vulnerable road users (VRUs) --bicycles, motorcycles, E-Bikes, E-Scooters, mopeds and, eventually, pedestrians--a means of being connected with and visible to much larger vehicles while sharing the road. Ridar Systems utilizes smartphone technology to connect VRUs to vehicles to speak/communicate with those vehicles who already rely on ADAS (Advanced Driver Assistance Systems) to detect other vehicles, such as VRUs, nearby. The problem is, ADAS does not consistently detect VRUs and, for that reason, Ridar Systems was founded.

Ridar Systems is a passive system and there is no need for drivers to look at their phone while driving as verbal announcements inform drivers to the locations of VRUs.

Similar to V2V requirements of two vehicles requiring the same hardware/technology installed to communicate with each other, Ridar Systems requires both sides of the transportation environment (drivers & riders) to function. The difference with Ridar Systems is that we can utilize existing hardware that is already owned by most commuters: the smartphone.

Ridar Systems' cloud-based mobile solution will help prevent the thousands of injuries & deaths that result from collisions where such VRUs not being visible to drivers or C/AVs (Connected/Autonomous Vehicles). By allowing VRU's smartphones to serve as the hardware/software needed to generate a beacon based upon their location, direction of travel, and speed, Ridar Systems' mobile solution allows them to communicate this information directly to nearby drivers and predict where those VRUs will intersect with the driver, before an accident takes place.

Our goal is to grow a network of two-wheelers who can utilize our mobile solution using only their smartphones as a means of sharing their projected path of travel to much larger vehicles. As these larger vehicles will also need to have the Ridar Systems technology running on either their smartphones or built into the vehicle's infotainment system, we expect to work with OEMs and automobile insurers to encourage downloads by means of insurance premium discounts. We also see an opportunity to connect with existing ADAS systems by means of OTA (over the air) updates to incorporate our solution as well as augmenting existing commercial driver telematics solutions.

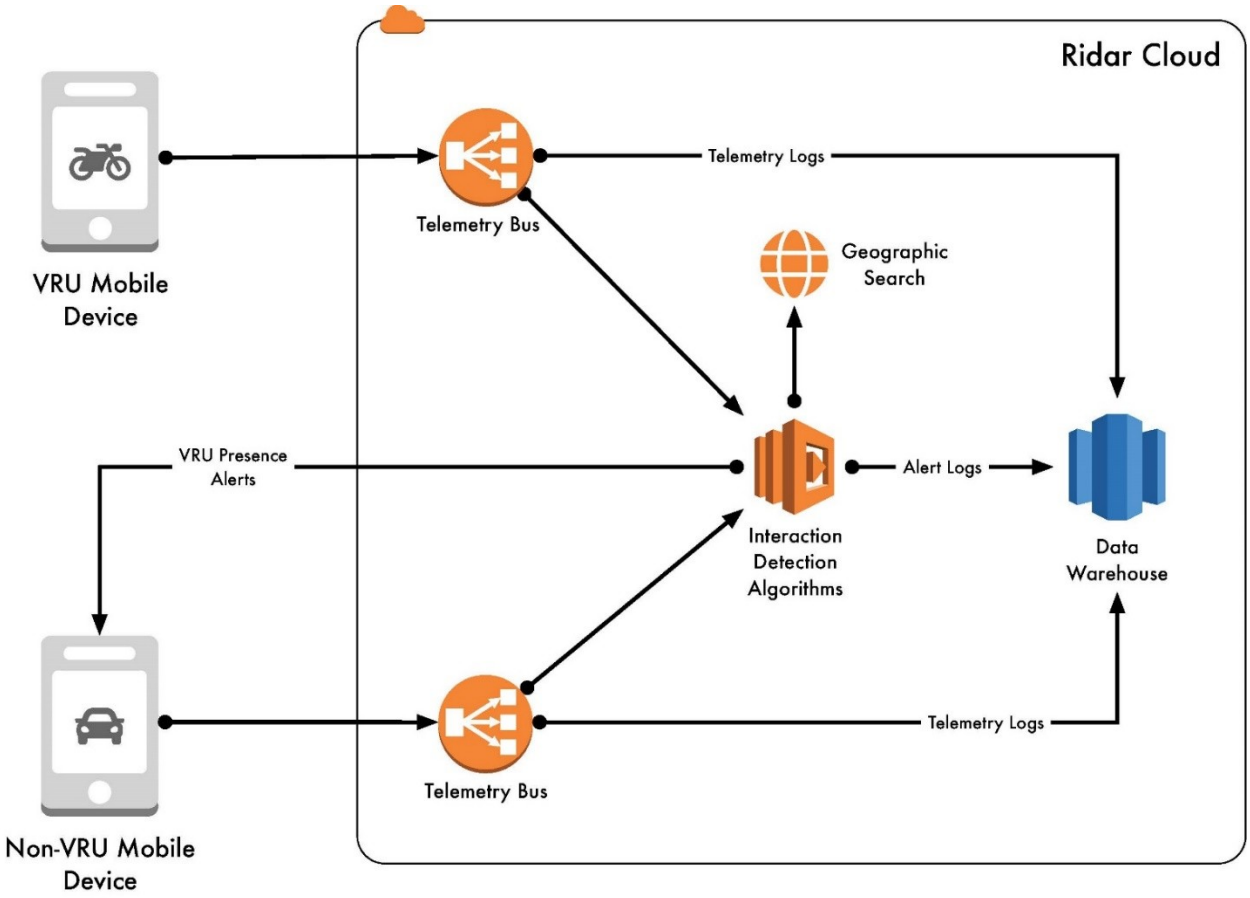
How Ridar Works

Ridar Systems, LLC develops a cloud-based mobile solution which allows two-wheelers (and, potentially pedestrians), some of the most vulnerable road users (VRUs), to be connected to vehicles in order to allow those vehicles to better see or detect such participants in the commuting environment before an accident occurs.

Our mobile solution utilizes existing cellular smartphone technology to create a beacon for VRUs in order to predict their path of travel and notify drivers when they are soon to interact with said VRU.

The software developed for Ridar Systems consists of a front-end (UX) for the smartphone as well as a cloud-based architecture which contains all of the predictive algorithms and data collection. When Ridar determines that a rider is heading towards the same geographic location as a driver (and, potentially posing a hazard for accident), a notification is sent to the driver in the form of an audible or verbal prompt. If an embedded navigation system is being used by the driver, Ridar can overlay a visual notification/representation of a rider onto the IVI (in-vehicle Infotainment) navigation system.

Data Model



Telemetry Delivery

VRUs and non-VRUs both send the same telemetry payload to Ridar via MQTT messaging. MQTT topic is based on unique device identifier and trip mode (VRU vs. non-VRU).

Here is what the payload for telemetry should look like:

```
{
        “id”: <unique identifier for device>,
        “latitude”: <vehicle latitude in decimal degrees>,
        “longitude”: <vehicle longitude in decimal degrees>,
        “speed”: <vehicle speed in decimal km/hr>,
        “heading”: <vehicle heading relative to true north in decimal degrees>,
        “updateTime”: <telemetry timestamp in integer milliseconds since UNIX
epoch>
}
```

Notifications

Notifications are delivered to non-VRUs via subscription to MQTT topic or via mobile device push notification (implementation dependent).

The payload of a notification is:

```
{
	"bearing": <bearing from non-VRU to VRU in decimal degrees>,
	"rangeKm": <range from non-VRU to VRU in decimal km>,
	"targetId": <unique identifier for VRU device used to filter redundant detections>,
	"notificationTime": <detection timestamp in integer milliseconds since UNIX epoch>
}
```

Ridar's v2 will incorporate map-matching in order to minimize false positives which can be prevented by minimizing notifications when a driver and rider have a physical barrier preventing interaction or if one happens to be driving overhead of the other on an overpass, bridge, etc. This next version will also incorporate an auto-start functionality which will allow the technology to start automatically for both a driver and rider. In addition to that, the rider will be further identified as being on a motorcycle (body lean angle, gyroscopic functionality & GPS) or a bicycle—all native elements of smartphones. If coupled with eBicycle/eScooter sharing, the technology incorporated into those rides and/or the mobile app used to rent the ride can be used to further identify the type of rider the driver is soon to encounter: "Bicycle Right", "Scooter Left", "Motorcycle Ahead".

Plus, when there are multiples of the same rider type, we have the capability to announce a plurality: "Motorcycle***s*** Behind", "Scooter***s*** Ahead", "Bicycle***s*** Right", etc. And, when two-wheeled traffic becomes so heavy that multiple notifications to the driver may become a nuisance, Ridar Systems can automatically adjust the algorithm to recognize the heavier, two-wheeled traffic and adapt to a more acceptable, "Many Riders Nearby—Use Caution".
Because a cellular signal is required, we will also incorporate a notification when a signal has been lost: "Signal Lost. Watch for Riders" as well as when the signal has been regained: "Ridar On".

As the cellular industry moves from 3G & 4G/LTE to 5G, Ridar Systems will be able to capitalize on that technology which promises faster speeds plus larger amounts of data—a larger data pipeline, if you will. While our mobile solution currently has a latency of ~225ms to ~325ms, we have incorporated a predictive algorithm which takes into consideration the speed, location & direction of travel of both a driver and a rider. It is this predictive element that allows us to anticipate when & where a driver and rider will meet. When the cellular speeds are increased with 5G, we will continue to utilize our predictive algorithm but can now provide more advanced

“time critical” messaging which are more in line with the 5ms-10ms latencies expected of ADAS and Connected Vehicle technologies.

Conclusion

With the increasing use of connected car technology on the roads, OEMs are preparing to include connectivity between automobiles so that they do not crash into each other. There are two camps around this connectivity, both using the same bandwidth assigned by the FCC (here in the U.S.): V2V (or, DSRC) and C-V2X. They both utilize additional hardware to make them work effectively along with roadside units (RSUs).

Even with these technologies and their ability at allowing vehicles to talk to each other, they still do not talk to nor listen for two-wheelers.

That is the solution we are creating: A method for two-wheelers who may never have a means of participating in the connected car conversation to at least announce to those connected vehicles their location and anticipated path of travel. This would provide drivers with yet another tool to avoid accidents with smaller, more vulnerable vehicles.

By allowing one’s own smartphone to allow their ride to be safer, we eliminate the need to build anything onto a motorcycle, bicycle or scooter. And, because Ridar Systems (on the cyclist-side of the solution) is a ‘headless unit’, there is no UX until their ride has been completed. As such, there is no need to place/mount the smartphone in a manner that requires the rider to have visual access during their ride.