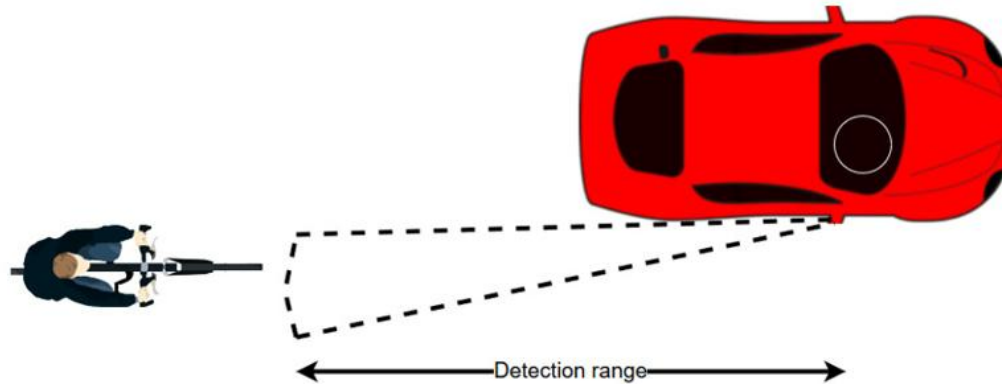




ASSISTED CAR EXIT (ACE)



Assisted Car Exit using RADAR

Saranya Das(Analog Devices (ADI)), Sriram
Madavswamy(Analog Devices (ADI))



The Motivation

- ▶ Car Dooring is when the door of a car is carelessly opened and it hits an incoming vehicle and this is serious problem for which automotive companies are looking for a solution
- ▶ This type of sudden crash may eject the rider from their bike and lead to fatal injuries



[1]



[2]

We confirmed this using available accident data and user survey.
And this problem if solved would have a significant societal impact.

Incidents reported across the globe

German in depth Accident Study (GIDAS) estimated these accidents have a share of 3% of all bicycle accidents in Germany, 2015 [5]

“Dooring” was responsible for 474 accidents across the UK in 2015, according to the Department of Transport (DfT) [6]

Diplomat kills cyclist in Berlin by opening car door too quickly [7]

APRIL 27, 2017, 5:00 AM

More than 300 cases of cyclists crashing into open car doors on the streets of Chicago — deemed America’s Best Bike City — were reported in 2015, an almost 50 percent increase from the previous year. [4]

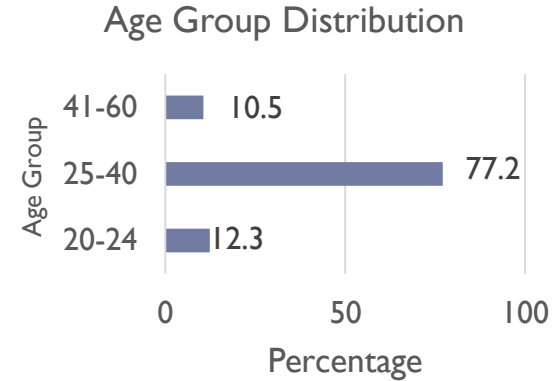
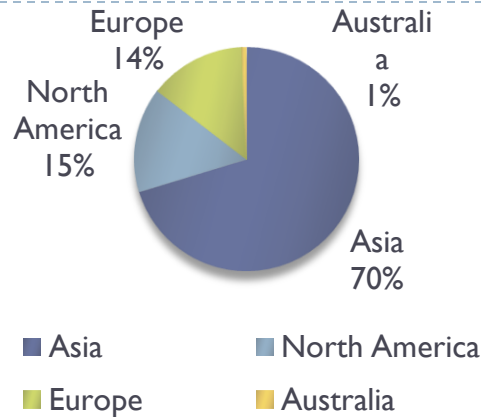
Sudden opening of car doors caused 98 accidents in Nanjing in 10-day period [8]

Truck runs over bikers in Punjab, all because of a car door [9]

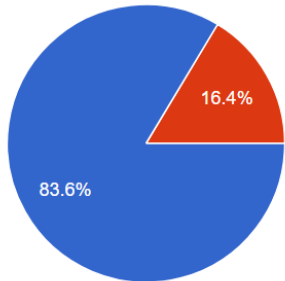
SINGAPORE - A motorcyclist died after crashing into a car door which opened without warning in a road accident on Wednesday (Feb 22). [10]

Cyclist ‘car-doored’ before being killed by passing truck in Melbourne [11]

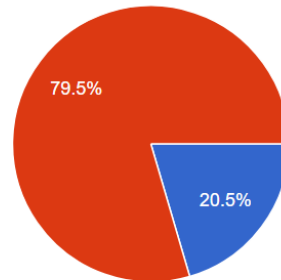
Survey Demographics (Sample Size – 200)



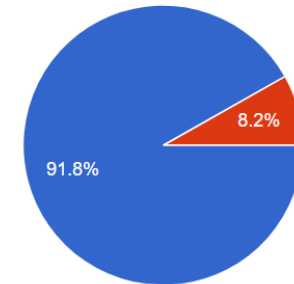
Are you aware of accidents due to sudden opening of car door ?



Have you been a victim while you are standing or walking when the door of a car suddenly opens ?



Do you think it would be convenient if there was a mechanism to indicate that the door of the car was safe to open?



● Yes
● No



Problem Statement

- ▶ Detect incoming vehicle within a range whose velocity is greater than a certain threshold

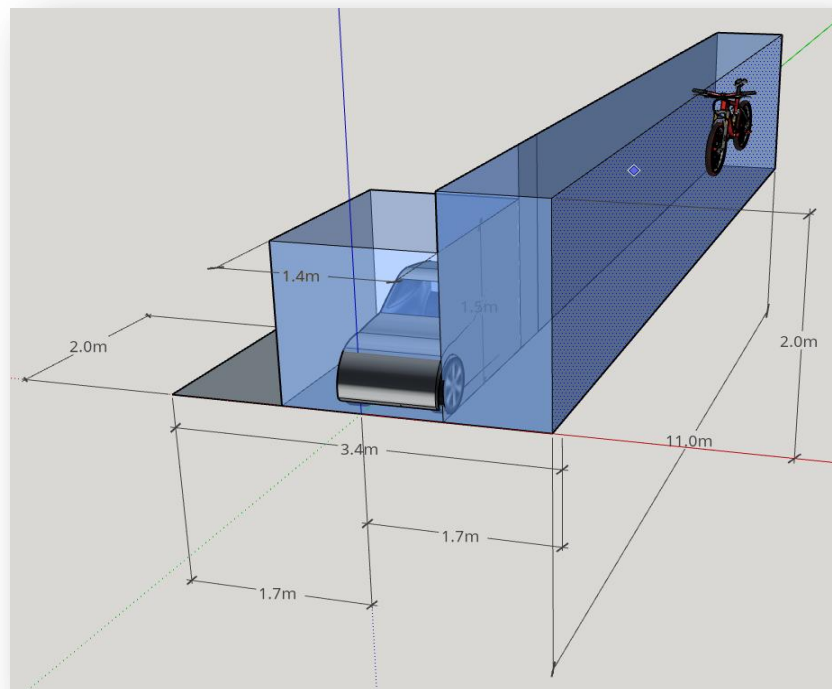


Figure shows a bicycle at a 11m range from the car. This provides 2sec reaction time if the object is travelling at a velocity of 5.5m/s

If the object / bicycle enters the field of view with a velocity greater than 5.5m/s, the system should alert the car user.

Existing Technologies and why RADAR?

	APPLICATION	WEAKNESS
Computer Vision	<ul style="list-style-type: none"> Object Detection & Classification 	<ul style="list-style-type: none"> Night/Low Light Bright Sun Fog, Rain, Snow
RADAR (Radio Detection and Ranging)	<ul style="list-style-type: none"> Object Detection (evening, bad weather) Possibly Classification 	<ul style="list-style-type: none"> Non reflective surfaces (e.g. glass) System noise limited
LIDAR (Light Detection and Ranging)	<ul style="list-style-type: none"> Precise Object Detection & Classification Image/Laser Stabilization 	<ul style="list-style-type: none"> Reflective particulates Fog, Rain, Snow

Comparison of different technologies

	LIDAR	RADAR	CV
Accuracy	10	8	5
Robustness	7	10	6
Cost	5	10	5
Ease of integration	8	7	10
	30	35	26

Evaluation Parameters

Based on the above parameters, RADAR is the best technology to go with.

Proposed Solution and Advantages

Radar transmits electromagnetic waves which hits the object and the sensor then receives the reflected wave.

The received data is processed to detect range and velocity of the object.

Figure 2 indicates the RADAR detection system.

- Two antennae, each for transmit(TX) and receive(RX)
- Sensor to sample and filter the data
- Digital Signal Processor (DSP) chip for data processing
- Power Supply IC
- Uses 28nm technology which helps in packaging more digital system.
- Reduced power due to integration of components like Analog Front End, Phase locked loop into a single sensor IC
- *PCB:Printed Circuit Board*

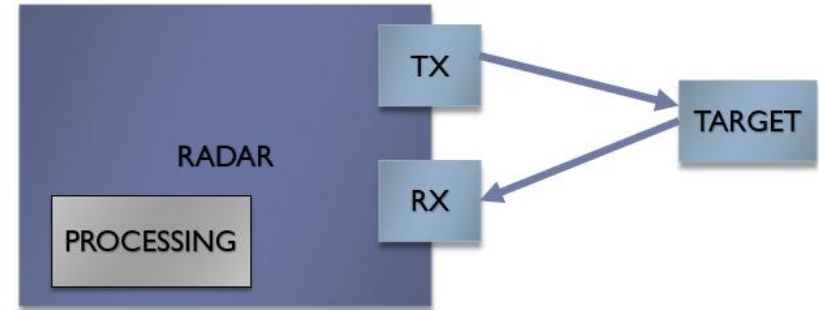


Figure 1: RADAR Block diagram

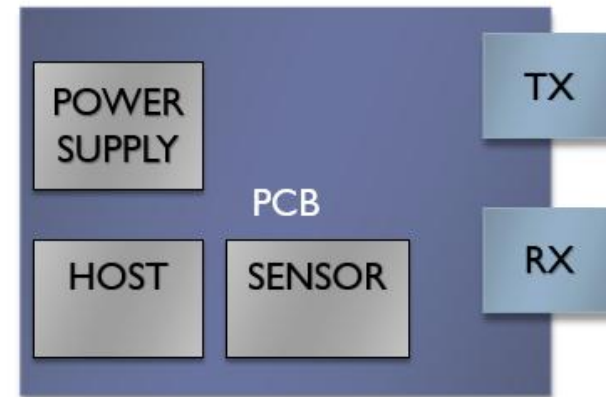
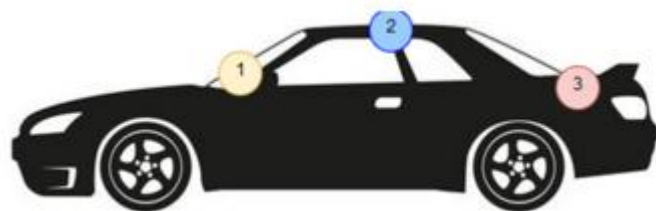


Figure 2: RADAR module



Radar Sensor Placement



Position	1	2	3
Damage prone	5	10	7
Target Scan	8	9	10
Aesthetic	10	6	8

Table I indicates parameters used to determine the RADAR placement

- As shown in Table I, there are three positions where the sensor can be placed
- Going by the parameters mentioned, both positions 1 and 2 can solve the problem.
- But there are some added advantages of placing the sensor in position 2 like B-pillar crash alert/protection



Evaluation Platform

ADI's evaluation platform – Demorad: 24GHz Radar Solution (Part number EV-DEMORAD24G)

The Demorad uses ADI's 24 GHz, multichannel radar solution.

The sensor consists of

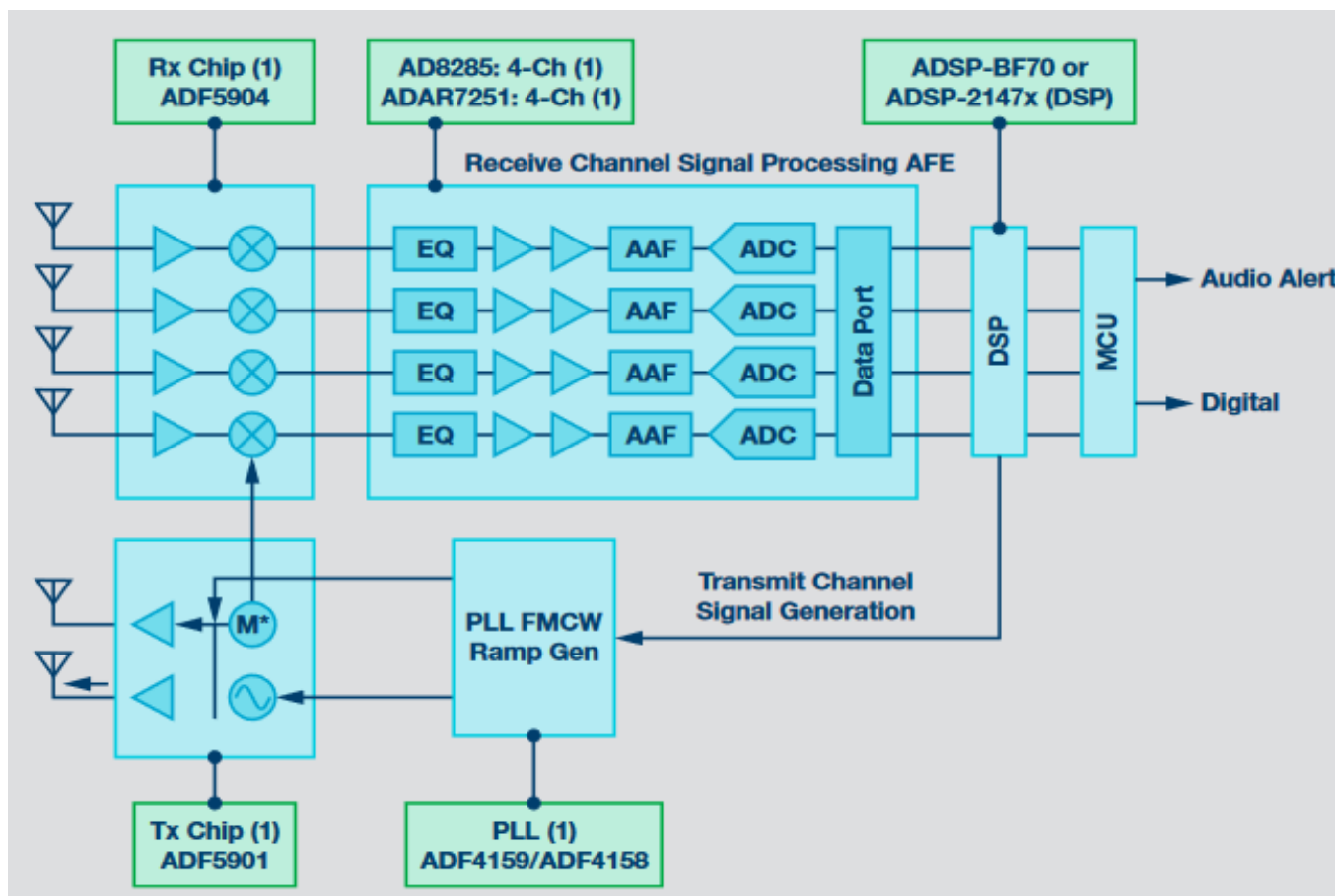
- ▶ a single PCB with 2 transmitter/4 receiver antennas on the front side connected to the 24 GHz RF chipset
- ▶ data acquisition Analog to Digital Converters(ADCs) and DSPs on the reverse side



[12]



Signal Chain

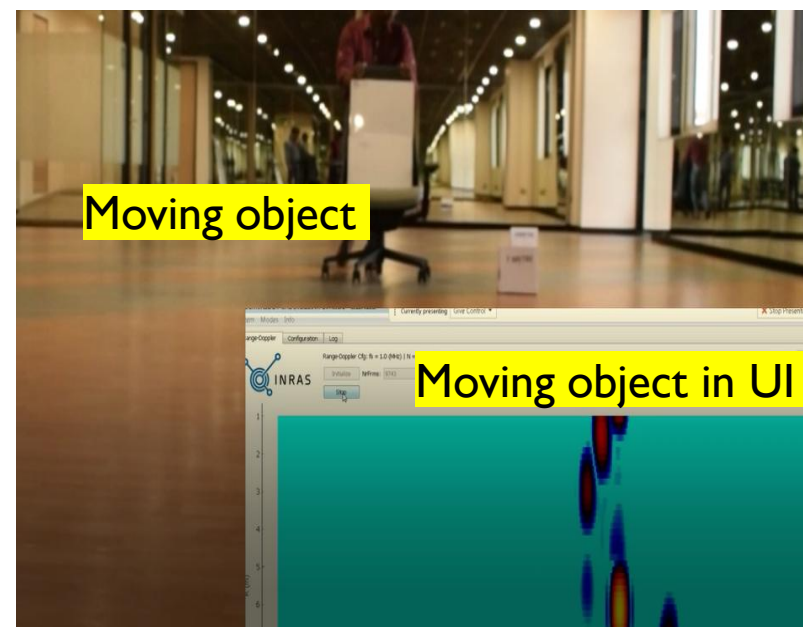
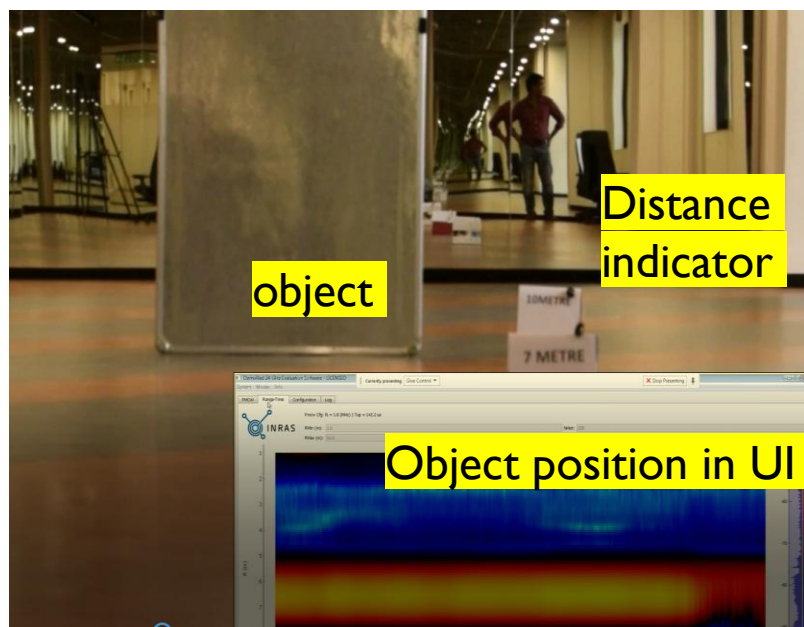


[13]

The above figure is the signal chain of Demorad containing Ramp Generator, Transmitter, Receiver, Analog Front End and Digital Signal Processor.



Range and Velocity Evaluation

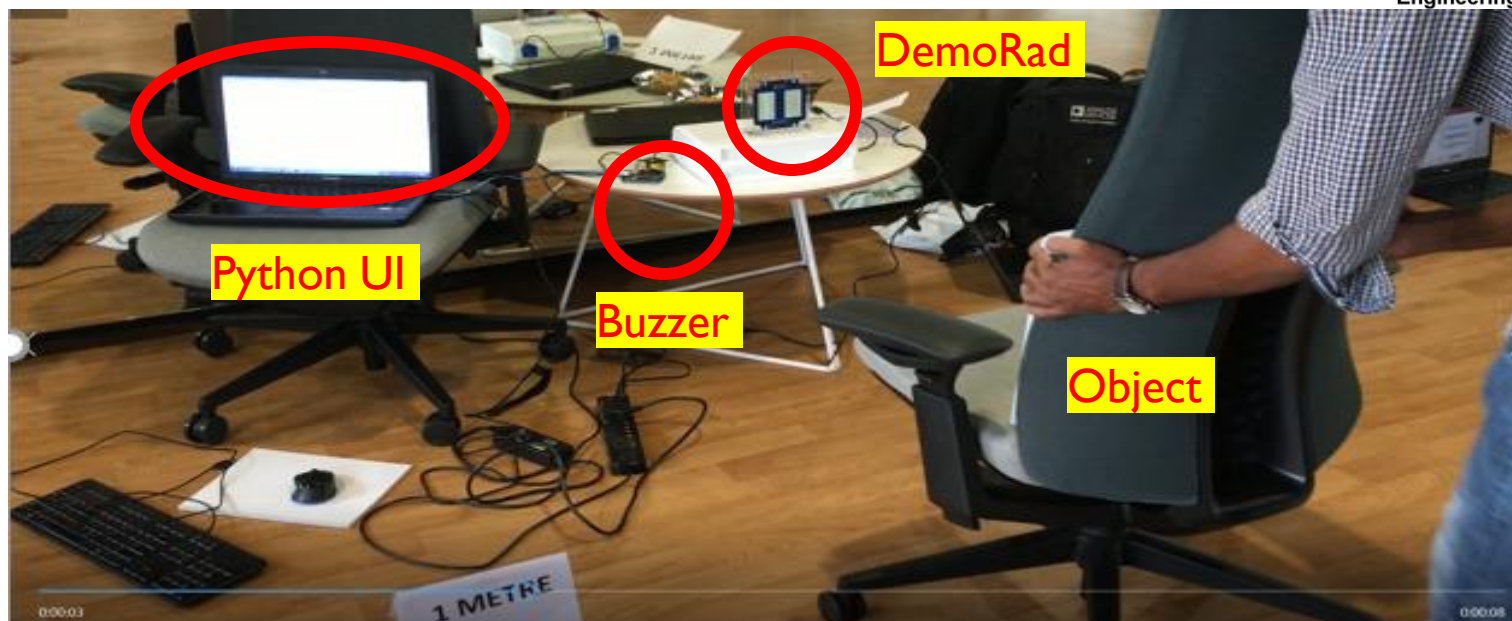


The above setup indicates an object placed at different distances to see that Radar system detects it. The yellow bar indicates the object's position.

Here, the setup indicates an object being moved to see that Radar system detects motion. The blue/yellow dots indicate the moving objects.



Snippet from Demo



In the above setup, Demorad is connected to PC and configured to detect objects within 1 meter range. Received data is processed in python and fed to the Arduino which beeps if the processed data is higher than the threshold.

Here we demonstrate how

1. When an object is brought within 1 meter range, the system alerts the user by sending a beep.
2. When an object is in motion, the system alerts the user by sending a beep.

This is an evaluation setup. In a real vehicle, any other forms of activation can be used to alert the user. The actual range to be detected is 11 meters as indicated in slide 5.



Work to be done..

- ▶ In this demo, a white metal object was used for better reflectivity. However for actual systems, there is a need to do study with real objects with different radar cross-sections.
- ▶ Though the technology is robust, it might pose a design challenge from aesthetics point of view for the car. But looking at the future trend of autonomous vehicles being the norm, this might not be a real problem where safety comes before aesthetics.
- ▶ As we go higher in frequency i.e. from 24GHz to 77GHz, the antennae size reduces which in turn reduces the size of the overall system, making RADAR a better choice compared to other technologies.



Conclusion

- ▶ With future of automotive industry moving towards autonomous vehicles, safety becomes important. RADAR helps in developing robust solutions to these problems.
- ▶ Assisted Car Exit attempts to solve one such problem using RADAR and this can be extended to other use cases of Automotive safety where ranging and detection are required.



References

- ▶ J. Morrissey, P. Walsh, <http://www.analog.com/en/technical-articles/integrated-24-ghz-fmcw-radar-transceiver-chipset.html>
- ▶ <http://www.analog.com/media/en/news-marketing-collateral/product-highlight/Demorad-24-GHz-Radar-Sensor-Platform.pdf>
- ▶ <http://www.inras.at/en/products/radarbook.html>



References of images and news

▶ Slide 1

[1] <http://www.dailymail.co.uk/news/article-2291625/600-cyclists-year-injured-knocked-open-car-doors.html>

[2] https://www.123rf.com/photo_98169147_angry-young-bicyclist-shouting-while-swerving-for-avoiding-dangerous-collision-with-the-open-door-of.html

▶ Slide 2

[3] <https://templates.office.com/en-us/Map-pins-infographic-Depth-theme%2c-widescreen-TM00001073>

[4] <http://www.chicagotribune.com/news/ct-chicago-dooring-cyclist-report-met-20170426-story.html>

[5] http://www.ircobi.org/wordpress/downloads/irc15/pdf_files/11.pdf

[6] <https://www.telegraph.co.uk/travel/news/the-dutch-reach-how-opening-car-door-like-the-dutch-could-save-lives-cycling/>

[7] <https://www.thelocal.de/20170615/cyclist-killed-after-crashing-into-diplomatic-car-in-berlin>

[8] https://www.youtube.com/watch?v=VVR79_EGmbNM

[9] <https://www.cartoq.com/truck-runs-over-bikersall-because-of-a-car-door/>

[10] <https://www.straitstimes.com/singapore/motorcyclist-dies-after-crashing-into-car-door-which-opened-suddenly-at-traffic-light>

[11] <http://www.abc.net.au/news/2015-02-27/cyclist-car-doored-before-being-killed-by-passing-truck/6270058>

▶ Slide 9

[12] <http://www.analog.com/en/design-center/evaluation-hardware-and-software/evaluation-boards-kits/eval-demorad.html>

▶ Slide 10

[1] <http://www.analog.com/media/en/news-marketing-collateral/product-highlight/Demorad-24-GHz-Radar-Sensor-Platform.pdf>