Case Study

Stopped Vehicle Detection (SVD)
M6 Motorway (England)

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This case study describes a long-term trial of the Ogier Electronics SVD radar prototype on the M6 motorway in the UK over a two-year period: 2018-2020. The purpose of the trial was to demonstrate the performance of radar under heavy traffic loads in all weather conditions. The radar performance exceeded expectations and the knowledge obtained was used to modify the basic Scan-360 hardware to produce the higher-performance SVR-500 radar, as well as enhance our software simulation models to better model a live road environment.

Background

A large number of vehicles break down or run out of fuel on motorways every day. In cases where radar is not used to detect stopped vehicles, the response time can be extremely slow, leading to increased risk of collisions with other vehicles.

In 2016 a Highways England report showed breakdowns on all-lane-running sections of the M25 took an average of 17 minutes to be detected. We decided we could improve this situation by using our radar expertise to develop a Stopped Vehicle Detection (SVD) radar product that would dramatically reduce response time from minutes to seconds. Rapid detection is important in most situations, but especially on Smart Motorways where there may not be a hard shoulder.

Smart Motorways can use radar alarm data to automatically control variable speed limits and electronic signage to alert other road users to the location of the obstruction, thus reducing collisions and improving road safety.

Our Solution

Our SVD radar was developed from our existing field-proven Scan-360 product.

Scan-360 was designed for security applications to locate moving targets and ignore stationary targets, so we inverted the processing technique to detect stationary targets instead.

We used computer simulations to confirm the software routines would behave as expected before undertaking some basic tests on roads near our offices to confirm the theory. We undertook a series of high-speed measurements on a disused runway to confirm we could detect stranded vehicles in the presence of other vehicles.

To demonstrate the equipment's suitability a long-term trial was undertaken. The initial deployment used a modified version of our Scan-360 radar with new software to identify stopped vehicles. The system was configured to monitor the lanes on all carriageways, covering a total of 400m of roadway, including adjacent slip roads and hard shoulders.

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Location of Trial Site

Our radar was set up on the M6 motorway close to the busy Coleshill interchange to the east of Birmingham. This location was ideal to evaluate performance under heavy traffic conditions where it would be more challenging for the signal processing routines.

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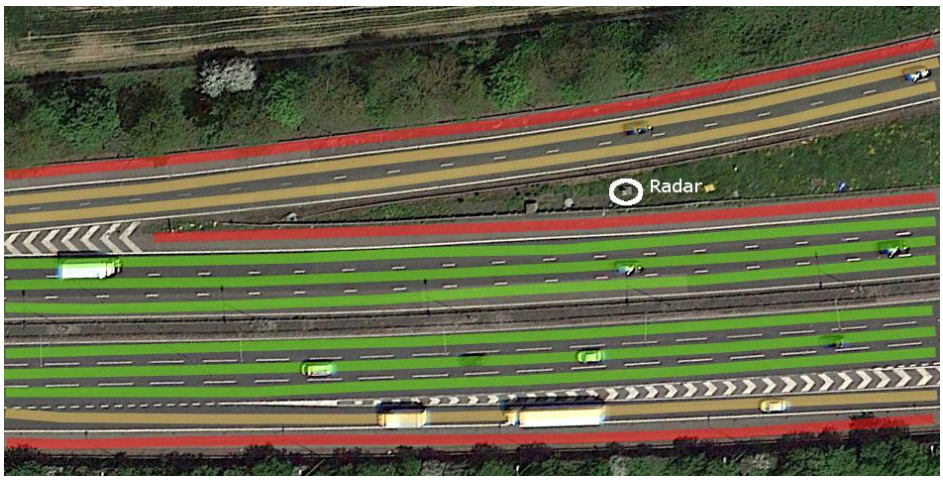
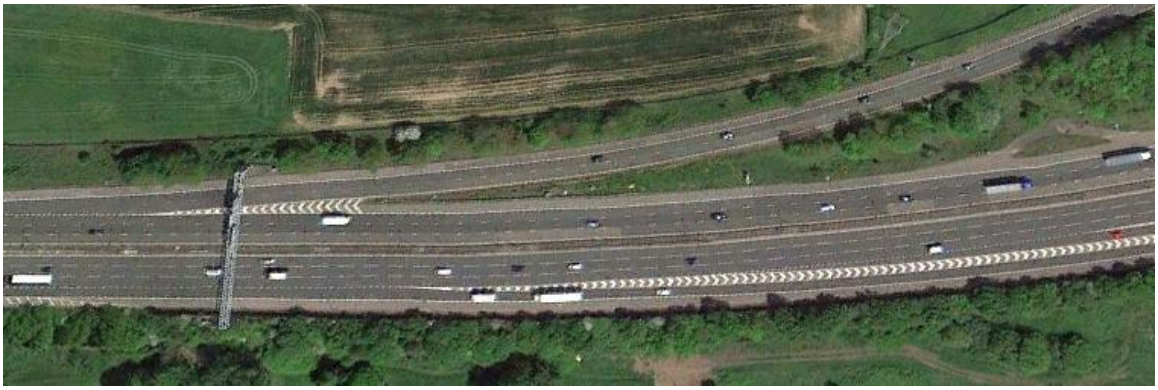
Site Details

The radar was positioned so that a large number of lanes would be monitored at once, as shown below. This presented the radar with a very high number of vehicles within the field of view to make the detection algorithms work hard to highlight if there were any flaws in our approach. There were three hard shoulders (red), three slip roads (yellow) and six running lanes (green), giving a total coverage of 12 traffic lanes for a single radar sensor. The radar location is circled in white:



The approximate coverage area is shown below. Since this early trial used Scan-360 hardware rather than SVR-500 the range was limited to 400m, rather than the full 500m of the production SVR-500.



A number of large trees were next to the hard shoulder and allowed us to evaluate how the system would work when vehicles stopped next to the trees. A large gantry was situated around 130m from the radar and allowed us to evaluate the radar's ability to ignore very large static objects in the environment.

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Radar equipment was mounted very high to improve coverage by eliminating obscuration by high-sided vehicles. The image below shows the radar equipment offset to the left hand side of the pole.

To aid analysis, two PTZ cameras were positioned on top of the pole so radar detections could be confirmed against video footage. The radar automatically pointed one of these cameras toward the stopped vehicle so we could judge false alarm rate by observing the recorded footage.

In addition to video footage, large amounts of raw radar data were saved to allow the detection algorithms to be fully evaluated and refined using "real world" data.

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Radar Performance

The long-term testing showed that our standard Scan-360 radar hardware with SVD application software had good performance in a real motorway environment. There were a surprisingly high number of stopped vehicles observed during the test period, which gave us ample opportunities to observe radar performance.

The ability of the radar to slew a PTZ CCTV camera proved to be invaluable and produced lots of footage to demonstrate the system performance in a variety of road and weather conditions. Footage from this trial is available on our website.

Many stopped vehicles were identified correctly and rapidly, with minimal false alarms, demonstrating the suitability of our solution. The radar was able to detect stopped vehicles at long ranges as well as almost directly underneath the sensor.

The essential requirements for stopped vehicle detection could be met using our 24GHz radar technology. All processing was undertaken within the radar itself; no external signal processors or additional hardware was needed and the radar could operate correctly with low bandwidth networks.

Throughout the trial period we utilised the firmware update facility of the radar to check that changes to the detection routines modified the real world performance as predicted by our theoretical understanding and simulations. This aspect of the trial gave us great confidence that we could accurately predict the radar performance based on our simulations and confirmed to us that we had a good understanding of the nature of stopped vehicles in a live environment.

Enhancements Based on Trial Data

During the trial many gigabytes of raw radar data were recorded. After careful analysis of the many weeks worth of data, we identified the key areas where the Scan-360 radar hardware could be improved. With our new insights we re-designed the equipment to increase the detection range and the sensor resolution, which would both help to further decrease false alarms. The resulting SVR-500 radar is better suited to Smart Motorways where the traffic density is very high and the false alarm rate needs to be low enough for automation with minimal human intervention.

SVR-500 is an evolution of Scan-360 hardware, rather than a revolution. The majority of the sub-systems are identical, which keeps costs down due to economies of scale. By using proven circuitry and techniques, SVR-500 inherits low-risk and reliable designs.

SVR-500 is the same height as Scan-360 and is only 84mm wider, so the size is still comparable to a typical PTZ CCTV camera. Radar installation is typically no more difficult that a CCTV camera since the radar uses the same mounting arrangement and a single cable provides both power and data interface.

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Conclusion

SVD radar is a key technology to improve road safety because it is able to operate in all weather conditions with a low false-alarm rate. Our long-term trial has shown that using our 24GHz radar technology we have a SVD solution with good performance and a high detection probability in a challenging environment.

Our hardware is robust and reliable, with straightforward configuration, low power consumption and simple network requirements, making it ideal for use on remote roadside areas with limited infrastructure.

Throughout the trial the radar hardware was our standard perimeter security radar, Scan-360. Despite being un-optimised for this application the results were still very encouraging, especially compared to the performance of other sensor systems such as video analytics that struggle in some weathers.

Our radar automatically detects stopped vehicles and controls PTZ cameras to point at the incident. It can also be integrated easily with third-party equipment to send the vehicle co-ordinates, so could, for example, be used to activate electronic road signs to quickly alert other drivers to the hazard.

Please visit our website to discover more about our radar solutions and to discover why roadside SVD radar is superior to other technologies, including radars fitted to vehicles themselves.

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