The Future of Radar and Advanced Driving Assistance

John Quain (00:00):

Welcome to The Smarter World Podcast, where we'll be focusing on the technology and issues behind today's connected world. I'm your guest host today, John Quain. In this episode, we're going to discuss the rise of radar as one of the most important advanced driving assistance technologies around today.

(00:25):

New car assessment programs across the world are calling for automotive radar to be used in a variety of safety applications, from things like blindspot detection, collision avoidance, self-parking systems, and obstacle detection systems.

(00:41):

So how did radar become such an important part of this ADAS landscape? And how are car makers approaching the technology? And what does the future hold for radar? These are some of the questions we'll explore today with Matthias Feulner. He's the director of marketing for ADAS at NXP Semiconductors. Welcome, Matthias.

Matthias Feulner (00:59):

Thank you, John.

John Quain (01:00):

I guess the first thing is just to get people started rolling and understanding where we are. I cover automotive, I know who NXP is, but maybe you can explain how NXP came into these advanced driving systems, and it's strength in radar in particular.

Matthias Feulner (01:15):

No, absolutely. So as a matter of fact, ADAS is at the center of NXP's automotive commitment, and it is leveraging our strength to automotive safety and automotive quality. And ultimately, it supports our vision of making zero road fatalities a reality.

(01:36):

Now, we did indeed invest into ADAS technologies very early on, allowing us to take a lead. And that did involve, on the one hand, an investment into tailor-made radar microcontrollers, as well as [inaudible 00:01:54] based radar sensors, which today are used in 10 out of 10 OEM car platforms.

(02:01):

On the other hand, we did early on invest into V2X communication technology, which has been used among others in the world's largest rollout of Retrax technology with Volkswagen Golf eight model. Going ahead, looking into the future, we are looking forward to enabling the car

architecture of the future, whatever it may be, and that which involve our complimentary building blocks. For example, what we call central compute, the brains of the car, if you wish, as well as vehicle networking that is a means of connecting all these smart subsystems that are a part of the vehicle today.

John Quain (02:48):

And that radar, when you talk about those platforms is something that's easily plugged into most of them today, I would assume.

Matthias Feulner (02:56):

Yes, indeed. So radar, as we said before, is one of the mainstream sensors in the car today next to cameras. And as level of autonomy increases with cars, where level of autonomy is ranging from level zero, no automation, to level five with fully automated driving, radar actually is the mainstream sensor next to cameras. And as the demand for autonomy increases, more sensors are getting added since there isn't any single sensor that does meet all the requirements of a given configuration.

John Quain (03:51):

And I guess a lot of people are wondering too that the... Which we have to pay attention to is because of the worldwide pandemic that we are in a different environment now than we were just five months ago or six months ago. How has that changed in terms of your perspective on those new companies coming along that want to be AV companies and the traditional OEMs who are trying to catch up and electrify more vehicles, how is that market looking right now?

Matthias Feulner (04:23):

That's an interesting question, John. So a matter of fact, it's an exciting environment in every respect that we're in right now. But if you take a step back and look at this from a 10,000 feet level, the market really consists of two main segments.

(04:42):

On the one hand, there are the disruptors, the mobility companies, the autonomic strivers, if you will, which are looking to deliver full mobility, and among others, there are concepts like robotaxis, there are concepts like home delivery, which as you mentioned, the pandemic certainly do get quite an uplift in this environment. And they are really the ones looking to enable the fully autonomous driving experience, leveraging a multitude of sensors in parallel, leveraging enhanced algorithms that can deal with just any given situation you might just think of, or even with the unthinkable.

(05:32):

On the other hand, there are the more traditional car manufacturers that have been in the industry for a while. And for them, the challenge is actually a different one, because many of them, they've got a broad model portfolio, a broad brand portfolio, and they need to cater to

the needs of the entire portfolio, starting from the entry level cars with very basic functionality, to their very premium brands that would require support for a fully autonomous driving experience.

(06:13):

Now, the way they go about that is that they are applying a so-called platform approach, whereby they develop a scalable platform that spans across their entire brand and model portfolio, where the capabilities of the basic sensors, they are expanded by more performance sensors that are built on top and still reuse that same basic architecture, such that car manufacturers can reuse their investment into hard and software to a large extent, thereby accelerating their time to market, as well as reducing the cost of such development.

John Quain (07:01):

We talk about things like automotive grade in terms like that, and what we usually mean is this has to be reliable in the sense that, "I've done this before, I've used this technology before, and I know what its parameters are." I think that is a big advantage to those companies producing tens of thousands of cars, right?

Matthias Feulner (07:22):

Well, true. Very true, actually. And this is what actually speaks for radar. That is it's maturity. We've been going through 20 plus years automotive radar now, and before that, radar has had a long history in military applications. Consequently, it's been going through a lot of innovation cycles already. And today, that allows radar sensors to really be delivered in a highly integrated fashion that allows for a very small form factor on the one hand, as well as a very cost-efficient manufacturer on the other hand.

John Quain (08:07):

I can't even remember what it was like before. I'm trying to recall what it was like to drive for hours and hours and have to be paying so much attention, whereas now I rely on radar so much for that without even thinking about it.

(08:25):

Going forward with this is like how it fits in with other components and whether I can use... I mean, I picture it as I've got radar on my car and it's just one sensor, but it's not really, it's actually several different radars in these vehicles.

Matthias Feulner (08:43):

Yeah, indeed. Of course some would wish you would have the one size fits all, but in reality, there are quite a variety of different requirements for ADAS sensors that are constantly evolving. So on the one hand, there are the front radar use cases for highway pilot or for automated emergency braking. Then there are corner radar use cases for lane change assist and for cross-traffic alert, for example.

(09:19):

And then there as well, the side-facing radars, the ones that prevent the door bends when you open the door and there's an obstacle outside you didn't see, or as well, the ones that are used in cabin monitoring to detect children left behind on the backseat, as well as monitoring driver's vital signs.

(09:43):

And eventually, there is what's been labeled as the high definition radar or the imaging radar, which gifts a very, very precise representation of the car's environment that does allow to really get a much more precise map that would allow to tell different cars from one another on a crowded road, that would allow to detect vulnerable road users, children stepping out between two parked cars, that would allow to tell static objects, bridges from moving objects, vehicles, or would allow to detect the dimensions reliably of static objects like bridges, so you can see whether it's safe to pass through under a bridge.

John Quain (10:39):

I think most people have seen the information and data over the past few years about those front-facing radar systems and used in auto breaking, and emergency braking systems and technologies, we know those are effective, and those are reducing accidents. Is there something that you guys see on those other imaging uses of radar that you think that's the next place where we can either save lives or reduce accidents etcetera?

Matthias Feulner (11:11):

I think there are different underlying drivers, as we said before. And that is that sense that the adoption of these basic sensor functions are driven by regulation for car safety, for both vulnerable road user safety, as well as passenger safety through regulatory efforts like NCAP, the New Car Assessment Program, or through the United Nations regulations.

(11:45):

So these are driving a lot of these basic sensors, which now we're seeing widespread adoption across the car industry. As we said, the case for higher levels of autonomy, which requires really the interplay of different sensor modalities and much more performance sensors involving high-definition radar, also known as imaging radar, as well as LIDAR, these are driven by higher levels of automation. And that is a different model because that is really driven by these disruptors in the marketplace that are aiming for business models like robotaxis, or home delivery, which is a different approach.

(12:41):

So we see different dynamics and certainly the mass adoption of these basic NCAP sensors, it's happening right now across different regions of the world. The case for full autonomy, there is promise, and of course there's a lot of goods technology development going on, but the adoption of full autonomy may be a little further out in time than we thought previously.

John Quain (13:12):

Is there more recognition, speaking of those disruptors? I don't know how to put this, but a few years there were people thought, "I'm just going to do all this in software. I don't need these sensors, I can just do it all with AI, I can do all this in software and fix it all." And it seems to me, there's now a recognition. That's probably not going to be the solution and maybe we need more and better sensors, and so you're seeing more demand from people for more sensors?

Matthias Feulner (13:39):

That is actually an interesting question. And to answer to that, I think there's actually two parts to this. So on the one hand, and if we were to stick with imaging radar as an example, there is a question of improving the sensor as such, and the way imaging radar does it is that it is adding a large number of antennas compared to standard radars, which is essential to improving resolution, which is what allows you to tell one object for the other so you get more data points, you get a denser point cloud, if you wish.

(14:24):

But now that you've got a much increased amounts of data available, there's as well a cognitive dimension, meaning you need to interpret that data you obtained and make sense of it. And that does significantly drive processing requirments for such systems. And as you said before, may involve artificial intelligence, may involve increased algorithmic work, which this far, has actually been the main obstacle for widespread adoption of these types of sensors. Because even though there's been a lot off demonstrators out in the marketplace, and a lot of the startups have been trying to bring emerging technology to the market, it's not been ready for prime time yet, it's not been ready for large scale commercial adoption because these more complex systems, more complex sensors, and more demanding processing requirements have had an impact on the cost of such sensors and that has not allowed really widespread adoption this far.

(15:43):

Now, we have made significant progress in the past years. And I do believe, when it comes to imaging radar, technology we've got coming up right now will be enabling true commercial adoption of imaging radars in the next one to two years.

John Quain (16:04):

That's really interesting. I think people forget too, I mean, just by point of comparison, video cameras used in cars, yes, they're used to identify different objects on the road, but that is actually based on manual human labor that has sat people literally sitting there and identifying things in pictures. It's not because there's some magical AI program doing that.

(16:32):

And so, I think of radar as the same way, the reason it works so well. It's been, as you said, 20 years or so, being used in the automotive industry. And so, yes, where reliability's pretty good. That comes back to the kind of raw data that you're dealing with. They are very different from

each other. One piece of equipment from another and sort of what you are saying is look, “I’m using the same data and I can incorporate that into the decision making that goes out in the car”, correct?

Matthias Feulner (16:59):

Well, in some sense, we like to talk about our scalable radar architectures. So scalability, as we've said before, is where you really expand the capabilities of one architecture towards higher performance use cases, more demanding use cases, but the car makers, they get to benefit from reuse of software they've done before already for the basic version of a sensor as they've scaled towards that higher performance sensor.

(17:34):

So in that sense, if we talk about this scalable radar sensor platform that we are driving for, then that gives that reuse, and that in turn has all the benefits you would be thinking about like accelerated time to market and less resource investment for R&D. Whereas if you add LIDAR on top, it's a very different kind of sensor and you don't get to leverage these synergies.

John Quain (18:04):

Well, also I'm using the cars I test, and just to test a lot more before the pandemic, but still continue to test now.

Matthias Feulner (18:14):

So which one is your favorite one from the cars you've tested this year?

John Quain (18:17):

Oh, gosh. Well, I mean, there are some very reliable, actually, from FCA, and BMW, and Volvo in terms of what I think of as advanced driver assistance systems with their adaptive cruise control. I'm extremely confident in those vehicles. I drive, and I'm paying attention, but I let the car, I'm assuming it will slow down and stop and do those things that it's supposed to do.

(18:50):

And that's all relying on radar primarily. There are camera systems that supplement them, but a lot of these guys are relying on radar. So they're used to letting that basically control the car, whereas there's no LIDAR right now that you would allow it to break the car or anything. And not that I can think of, is there?

Matthias Feulner (19:10):

Once again, that comes back to what we said before, and undoubtedly, LIDAR will have its use cases, but as technology, both on camera, as well as radar has been evolving, and as their capabilities have increased over the years, the case for LIDAR that was very strong two or three years ago, it does not seem to be all that clear anymore today. And within that timeframe of one to two years, that I indicated earlier, if we are to deliver commercial grade imaging radars that

really meet all the requirements, the cost targets that meet the requirements with respect to the integration level, then I'm very confident that radar will expand its footprint next to camera as the dominant ADAS sensor.

John Quain (20:07):

The other thing I think I just wanted to mention is distance. So the earlier warnings, we talk about E-horizons and technology like that, where we have the infrastructure vehicles, everything, connections, but we don't have those yet, and we're not going to have it for a while clearly. But radar does give us more distance too, it gives a little earlier warning and chance to see things down the highway, correct?

Matthias Feulner (20:33):

Right. So long range capability, as we said before, is one of the key advantages of radar. And today long range radars are getting to 100 to 150 meters range. Tomorrow's long range radars, which is one of the goals clearly, they might be ranging beyond 200 meters of range towards 300 meters. And then, as you already pointed out, there is this vehicle to vehicle communications feature, which is actually supported by our V2X technology, which we usually like to call an ability of seeing around corners.

(21:20):

So beyond the reach of radar, now you've got this added capability that cars can actually directly communicate with each other up to 500 meters of distance or more, or they can communicate with the roadside infrastructure that would allow them to bridge even larger distance to be warned about an accident or a traffic jam that is building up around the corner, maybe a mile away.

(21:50):

So this is where things actually play together. And as we said initially, while we have a very large investment radar, our ADAS investment is more than that. And the vehicle to vehicle communication aspect plays along with that, and certainly holds a lot of promise in getting capability to reach further and to make driving the car even safer going forward.

John Quain (22:20):

Yeah, I think that's important. We talked about vulnerable road users earlier on, and mentioned them that making the car is safer for those around the cars too, just not the people in the cars.

(22:33):

One last thing I did want to mention though, speaking of people in the cars, because you mentioned it in passing, is that in-cabin use of radar, which I don't think people are aware of. But in the United States, there are various advocacy groups for the... There are these hot car deaths, unfortunately that happen every year with children. And also looking forward with autonomous vehicles, there's going to have to be some monitoring of people in the car. So maybe you could explain a little bit about how radars used in the cabin as well, or could be used.

Matthias Feulner (23:08):

So as you did mention a very rightfully, there are advocacy groups and there is regulation progress, not just in the United States, but as well in other regions of the world, which are aiming to prevent these tragic events when little children or even animals get left behind in the car in a hot summer weather.

(23:32):

And towards that, and what's interesting with radar and what is an added benefit on top of, for example, a camera-based detection that is the ability of radar to look through a blanket, for example. Say if your little child is covered by a blanket on the back seat of the car, then radar would actually be in a position to see through that blanket and detect the presence of a human being.

(24:05):

The other interesting feature that is being considered for radar in the cabin of the car that is vital signs monitoring, because there's a possibility with radar to detect very small displacements of your chest, for example, and consequently, you can detect the status or the vital signs of the driver and really anticipate any passing out of the driver. If a person gets unconscious, or if a person is not feeling well, there might be warning going on, your 911 call system might trigger an emergency call.

(25:52):

So there are a lot of interesting use cases that are once more aimed at really driving towards the vision of zero fatalities. And I think this is what's driving really the adoption of ADAS sensors going forward. And this is what I find most exciting beyond the technology itself, that there is this potential to really improve road safety by applying or fascinating technology.

John Quain (25:25):

So now that we have that experience with a regular radar, if you will, in the vehicle, all I kept hearing and all I keep hearing about the last couple of years is this imaging radar, 4D, 3D radar. Maybe you could explain what the relevance of that is and more of the details about how that works, how it's different from the radar that's being used now.

Matthias Feulner (25:49):

Oh, yes, absolutely. Now, imaging radar actually is quite exciting, and certainly it's been in the spotlight quite a bit in the press and at trade shows in these past years. Radar, it's a relatively mature sensor on the one hand, and that is why it's seen widespread adoption, it's got its technical advantages, which do involve the capability to operate at long range, which involve its tolerance to bright daylight, which does involve its ability to operate under adverse weather conditions.

(26:36):

But on the other hand, there are as well limitations for radar sensors, and these are in particular with respect to resolution and with respect to sensing altitude. And what that results in, there are shortcomings with respect to object classification and object separation. And that in turn does provide you with difficulty when you want to distinguish different vehicles on a crowded road, when you want to detect vulnerable road users, say a child is stepping out from in between two parked cars, or when you want to distinguish static objects, say bridges from moving objects, say vehicles, or if you want to really tell the dimensions reliably for these static objects and want to determine whether it's safe to pass through under a bridge.

(27:43):

So that is why in the previous years for those use cases that require that higher resolution, LIDAR has actually been seeing a lot of attention. Two, three years ago, LIDAR was all over the place and it was assumed that LIDAR would be assuming a lot of the relevance for those use cases.

(28:12):

Now we've seen quite a bit of progress in terms of radar capabilities, to the point that our CTO, Lars Reger, he actually labeled imaging radar as the LIDAR killer, which would drive through overcoming these limitations that we just talked about. It would replace LIDAR in quite many of the use cases.

John Quain (28:40):

So it might seem obvious, but with LIDAR, even with a MEMS technology, there's some vulnerability there when you're talking automotive, that radar just doesn't have, right?

Matthias Feulner (28:50):

Right. Certainly, LIDAR has come a long way from the days of the rotating $70,000 LIDARs to MEMS-based solid state LIDARs today. But then again, even MEMS, they have certain moving parts, even though at a microscale, which an automotive environment requires qualification. And in contrast, certainly radar is a sensor like camera without any moving parts, without any mechanical parts that would be prone to mechanical failure.

(29:30):

So in that sense, as we said before, on the one hand, radar is the safe bet. It's relatively mature, having been around for more than 20 years in automotive applications, lots of experience gathered. But on the other hand, it's as well evolving. There's a lot of innovative work being done with radar sensors, both in improving the sensor itself, as well as on the algorithmic side to actually do a better job in interpreting that data that we are receiving from the radar sensor.

John Quain (30:06):

Well, that's great. I really appreciate the walkthrough of the imaging radar. I think that gives me a much better understanding of how it works and its importance.

Matthias Feulner (30:15):

It was a pleasure.

John Quain (30:16):

Thank you so much, Mathias, for today-

Matthias Feulner (30:18):

Thank you, John.

John Quain (30:19):

... and all your help. I hope people enjoy the podcast and learn more about radar and where things are going in the future. For The Smarter World Podcast, this is John Quain, have a great day.