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| **MEETING MINUTES – Sponsor & Team Meeting** |
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| OWNER: Julia Kim |

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Present: Matt Cammuse, Patrick Delallana, Julia Kim, Malcolm Harmon

Time 5:10 p.m. – 6:00 p.m.

Pete informed us that he would definitely be coming in on October 21st, and he wanted to be sent information on Tallahassee, such as airport and school directions.

Question: In order to determine the gain of each of the horn antennas, you have to have the elevation and the azimuth beam width angle. But for each antenna, do we want the elevation angle to be the size of an average person or is that going to be a lot shorter based on putting the whole system into an array?

We want each one of the antennas to illuminate the scene to the extent that you want to image. Imagine the horn is a flashlight and you want the beam of light that is going to be the same for each antenna and that’ll illuminate the area, the scene you care about. So ideally it’ll illuminate a person. The critical dimension is the azimuth, the width of a person. The height is somewhat secondary at this point. The gain is equal to 26000/beam width.

Matt determined the azimuth angle to be about 15 degree, and he was trying to determine what the elevation angle should be. Pete said to look at what horns are available online and that should give an azimuth beam width and an elevation beam width. So we could look at one that had an azimuth beam width of about 15 degrees to see what the elevation is. It also depends on how the horn is oriented.

How far is the azimuth scene extent; what is the elevation of the scene extent we’re looking at? That’s up to us, but we would generally just have to look at the torso since weapons are generally hidden around the torso area, not the head or feet. So each individual horn’s elevation beam width angle would be an average person’s torso.

When you have a rectangular horn and in the aperture that’s radiating, the long dimension is horizontal and the short dimension is vertical. You have more aperture in the horizontal (azimuth) direction and you’ll have a narrower beam in elevation. If you have a rectangular horn and orient it with the long dimension (horizontal), that’ll give you a narrower beam in azimuth and a wider beam in elevation, which is what you want for a person scene. So you can look at the dimensions separately with what happens with the beam width. With a rectangular horn, you can look at the azimuth with 15 degrees and in elevation, you can have the dimension of the horn to get a wider beam width in elevation to have more of a person’s body. Matt will research different horn antennas and send Pete some of the options.

The key thing is the size of a horn opening, the radiating face of the horn, and the spacing between the horns. So there would be three dimensions really: the horizontal, the vertical, and the spacing in between. The first two are the dimensions of a horn that’ll illuminate the target, the scene area you want to image. Next thing will be put a horn next to that one and evaluate what’ll happen. So the concept to understand are array factor and how you’re getting the antenna pattern when you take an array factor and multiply it by the individual pattern will give you the total patter of the array.

For the FPGA programming: Patrick talked to the lab manager but he would not give us access to any of the labs with FPGAs here. He asked around to see if any of the faculty had a spare FPGA but the only one he could find was not 100MHz. Pete told us to just order one. He recommended a Digilent one that had TMod. Pete told us we want the switching edge to be like 10ns. So if we had a clock at 10ns, we could switch things every 10ns which is 100MHz. If we hit an edge and there’s a pulse that goes out, and 20ns later, the leading edge of the pulse is hitting our target 20ft away. We want to be able to switch to receive by the time the leading edge of that pulse comes back to our antennas. So basically when the leading edge hits the target, the trailing edge is just coming out of the transmitter. So that’s why we want to switch over to receive so that the transmit pulse goes to 0, and now you have 20ns until the return from the target comes back to the receiver. There should be a margin of time for the pulses, for example if you have 20ns, then leave a margin of time and do it in 5ns or 10ns.

Anytime you switch something between on and off, it doesn’t happen instantaneously. There is a rise time and then there is a settling. If you have a really sharp rise time, that corner when it turns on causes whatever the load is to have some ringing. You want to have a settling time allocated so that your level is stable. If you have a 100MHz clock, you can switch every 10ns to another state and that includes the rise time. In VHDL code, there is a rising edge syntax, and based on the rising edge, that’s when you switch. Ultimately the switching speed will be the rising time plus the settling, which can be 6 or 7 ns in this case. If you pick something in the FPGA that will only switch at the 20ns rate, that means you can’t get two rising edges that are less than 20ns because that’s the fastest you can switch. You have to pick a clock that is smaller than the switching speed that you really need. If you have a 100MHz clock, you can get a rising edge every 10ns, and if you can switch a switch between transmit and receive in 10ns, and you need to do it in less than 20ns, then you’re in pretty good shape.

One of the things that can be done is to generate a timing diagram where you draw all the switching signals. Since there are multiple switching signals, you can do a timing diagram for each one on top of each other, and zero can be the reference edge. In VHDL, by using a counter you can generate different pulse widths. The switch between transmit and receive has to be at a 100MHz rate, and the switch that goes to the antenna that switches between antenna can happen a lot slower. The switches could be done manually as a backup. In the diagram, there are other switching signals that come out, which should be straightforward. There are a lot of parallel signals that are coordinated in time to do different functions. We are going to want to transmit and receive through one horn multiple times, where only that horn is what switch and receive. Then we are going to want to switch to the next horn and then go through to the transmit/receive cycles. We are transmitting out of the one horn and receiving through the other horn multiple times, and then we switch to another receive horn and repeat the same thing. So we would switch between the receive horns at a slower rate than do the transmit and receive.

Pete asked how the order process works and we explained the process through FAMU Foundation as we understood it. So we are trying to have all the most urgent components needed figured out by next week. Pete also said that we could go over the list while he’s here in two weeks.

Pete also mentioned that as a challenge for the mechanical engineers, they could try to figure out how to build the horn antennas themselves with raw materials since it would be cheaper as an alternative. This would be a real-life application to learn from.

Pete also asked about the radar equations, but since Josh is working on them, we didn’t have a definite answer for him except that he’s working on it.

Pete went through the system characteristics and the only thing we need to derive are the antenna parameters and the radar equations in order to figure out the transmit power and the receiver parameters. What we really care about is the signal to noise of the transmit/receive path, and that can be calculated with one equation by understanding what each value is. As the gain goes up in the antenna, the signal-to-noise would also go up.

Pete asked what our schedules were like for October 21st, especially the ECE people so that he could work with us. As far as for Patrick, Matt, and Julia, they are free after 2 p.m. We weren’t sure exactly how Joshua’s schedule would work out, so we couldn’t vouch for him.

Malcolm mentioned that the mechanical engineers were discussing whether to use pyramidal or conical horns, and how to place the horns on the antennas. Once they get the dimensions from the ECE people, they can start branching out more. They would have to coordinate with Matt in order to figure out whether to use pyramidal or conical for beam width and all that. And the ME people would have to figure out how to hold them and how to grab onto them in the cross-configuration for the design. They also have to figure out how to point them at the same point and have some adjustability. They also have to work on the precision and alignment of the system, which can be done through use of lasers.