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Arba Shkreli

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1 Project Pivoting

Not having enough familiarity with the topic, my initial attempt at seeing whether combining receiver data in the naive, additive way could yield something was, as expected, not particularly interesting and not correct. Furthermore, combining the data in the first place may not be a very useful approach.

There may not be added benefit when attributing this many receivers to one transmitter in the configuration, at least not without further study of the problem. One technique that is applied in GPR surveys is the repetition of a source pulse and the collection of the corresponding return signals. The returned data undergoes a process called stacking in order to increase the Signal-to-Noise Ratio (SNR). In my initial approach, I wanted to see if stacking could be performed in this other way. However, this becomes difficult and perhaps even intractable with differently placed receivers because of the asymmetries in radiation patterns that naturally would take place in different positions. So, even if one were to combine the data trying to compensate for the differences in receiver positions, that combination still would not be correct. Therefore, attributing one receiver to a transmitter (or coinciding them) appears to be the best alternative for the time being.

Having realized this, this leaves me to consider another kind of configuration altogether. With the goal being to get a better idea of the 3D geometry of the underlying object, another approach I am considering is having multiple transmitter-receiver pairs that each obtain A-scan data (or small B-scan data) in their respective locations, and with that we can try to interpolate the 3D C-scan between the pairs, without exhaustively taking a lot of data points. In other words, a sparse 3D survey of the ground. If this were to work with tractable amount of computation, and further research were to be done for the hardware realization of having so many transmitter-receiver pairs, then this would make surveys looking for certain kinds of objects faster.

Intuitively, it seems that sparse interpolation with spread out 1D or 2D data should be possible with varying results. This is because we know the relative distance between the transmitter-receiver pairs. One idea that comes to mind is taking the convex hull of the data somehow, but selectively since we would need to make a reasonable guess that there in fact is an object beneath the array, and the object may only be within the purview of a *part* of the overall array. We could also use triangular meshes, as done in computer graphics. Therefore, what really remains the challenge is to determine the points that are indicative of structure to then draw a 3D geometric fitting.

2 Technical Breakdown of Next Step

For the next data collection, I will have transmitter-receiver pairs spread out equidistantly over a small section of soil, some of which will have objects underneath the soil, and others not. In order for reasonable interpolation to take place, adjacent pairs will not be more than 3 cm apart. This does not mean that in a real implementation that we need a lot of redundant hardware that is spread out everywhere, but would most likely take advantage of a moving platform and localization technology.

To be continued...