

Lecture S5 Muddiest Points

General Comments

Welcome back from Spring Break! Today, we did graphical convolution of signals. This material is really important, both because we will build on this material, but also because it's useful for increasing your intuition about signals in general.

Responses to Muddiest-Part-of-the-Lecture Cards

(20 cards)

1. *How do you design a “matched filter”?* (1 student) Generally, a matched filter has an impulse response that is equal to the time-reversed signal we are trying to detect. This is not always possible to do exactly, but can often be well-approximated. The flip-and-slide method helps explain why the time-reversed signal is the right matched filter to use.
2. *So then you jam radar by flooding it with signals it sends out?* (1) That's one way, although that approach can be defeated by sending out a random signals. (This is one way GPS prevents jamming or spoofing.) You can also overwhelm a radar by sending out lots of power in the frequency range of the radar, whether or not the signal shape is the same.
3. *How much does Doppler shift affect radar?* (1) For aircraft, not much, but enough (in principle) to detect the speed of the target in the line-of-sight direction.
4. *In lecture, you said that if $u(t)$ and $g(t)$ have the same shape, that the product $g(t - \tau)u(\tau)$ would be level, but shouldn't it be that the graph is symmetrical?* (1) You are correct in general. For the specific case of two exponentials, the graph would be both symmetrical and level.
5. *Is the speed of the radar signal really c , since you are not in a vacuum?* (1) There is a very small change in the speed of light through the atmosphere, not worth mentioning in lecture.
6. *How do you know what the response of the plane is in the radar examples?* (1) Good question! Yes, the plane will have an impulse response as well (i.e., how it responds to the radar pulse), which would then change the shape of the returned pulse a little or a lot. I'm not sure how important this effect is, although radar obviously works.
7. *Is $g(t)$ the response to a delta function or the response to a step function?* (1) $g(t)$ is the impulse response, i.e., the response to a unit impulse.
8. *I think you said, “A signal (impulse) that happened 5 seconds ago and an impulse that happened 10 sec ago would create a $y(t)$ of an impulse 15 sec ago.” Since impulse reactions die out with time, it would seem that 15 second delay would be even weaker.* (1) Two things: First, not all impulse responses die out, so it's a misconception to think of all responses as dying away. For example, if you strike a bell, it rings for a long time. Second, I didn't explain myself very clearly, given your quote of me.

Here was my point: In every impulse response $g(t)$, the time variable t represents how long after an input occurs the effect is felt at the output. In the input signal $u(t)$, t represents the time after some arbitrary fixed time (say, noon today) the signal occurred. In the convolution integral, we can see that it is the sum of these two times that is important. So what I said was that if an input occurs at time $t = 10$ sec, and there is a 5 sec delay through the system, then the output occurs at 15 sec. Of course, any input signal (except an impulse) has nonzero values at many times t , and any impulse response has nonzero values over a range of times. That's why we need a convolution integral — to sum up all those times.

9. *Why is how a mathematician thinks of functions important for us engineers? I thought Engineering and Science were mutually exclusive (or at least different).* (1) No! The sciences (math, physics, etc.) are the foundation for modern engineering. As engineers, we are often sloppy about how we treat functions, and that's OK, when it works. Mathematicians are never sloppy about how they treat functions. The point today was that in order to understand what the convolution means, we first have to really understand what a function is.
10. *No mud. (10)* Great! There were lots of nice comments about the lecture today: *“Radar and graphical convolution are neat! Great lecture.” “Radar talk was cool.”* One person commented, *“Would prefer active learning questions after some lecturing.”* Why? In today's lecture, we had all the info we needed for the active learning question from last lecture.