Personal Note

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Task: Making Basic design Flow, Research Parts, PCB design, Order, Soldering, Test design, Advice Coding, Writing Reports. (I did almost everything, I wish we have someone who understand radar concept)

What was the first step for designing a good radar?

Decided frequency range.

The very first step for our project was deciding frequency range of the radar. There were two options. One was that using a frequency range 2.4GHz which we were experienced in quarter 1. Two was that using higher frequency to increase radar resolution. Each frequency range has own advantage. If I choose 2.4GHz frequency range, I could choose IC parts and design PCB board easily because I already had some experience. Moreover, 2.4GHz frequency range has less noise problem on FR-4 PCB board. Also, I could find a well-designed antenna. Therefore, I don't need to spend time to design out own Antenna. 24GHz frequency range has some benefit also. There is single IC which has most necessary parts in it. Therefore, the size and weight of the radar would be considerably smaller than frequency range 2.4GHz. Moreover, 24GHz frequency range is used for industrial application. Therefore, I would learn something related with work-based skills.

Overall, I decided to use frequency range 2.4GHz. The reason was following: (1) we didn't have enough time to study new frequency range and a complicate IC chip. We only had 10 weeks to finish the senior design project. We didn't have confidence to finish all works during one quarter. (2) we were not fully understand concept of antenna from 134A course. (I can't work everything by myself.) It would be better to understand basic radar design instead of studying the advanced topic.

How to draw Block Diagram?

The block diagram was designed with following sequences.

1. Mixer - Splitter - VCO

- Local signal power was the starting point. I could use passive mixer or active mixer. I chose active mixer. Splitter is simply divided VCO signal by half. VCO choose for provide

enough local signal power after splitter. Fortunately, I could find perfect VCO. So I didn't need to use amplifier for LO signal.

2. RF Amp
   - RF Amp used to boost RF signal to antenna. Ideally, strong power is better anyway. However, I decided to use only one RF Amp due to power consumption. (Also it was hard to find high input power tolerant amp.) For receiving part, I am going to use 3 RF amp which has by-pass mode. Therefore, I could make receiving RF signal power strong enough for the mixer even if distance of object is keep changing.
3. Antenna
   - Directional antenna with high gain is good.
4. IF module: a. VGA, b. LPF
   - VGA makes IF signal voltage by Vp-p 1V even receiving RF signal is low. After VGA, LPF, that has gain 4.5 and 10 KHz cutoff frequency, clean noise up. DSP need Vp-p greater than 3.5V to processing signal. Therefore, this set up is good to use.\

(RF/IF IC Selection Guide 2014 from ANALOG DEVICES was really helpful to choose part)

PCB design

Base on Block diagram, I designed PCB board. To design LPF, I used TI software. It was useful because it is automatically design circuit with various option. The most challenge was that minimizing circuit. Since I didn't have enough confidence about soldering, I wanted to build independent module for each part. Unfortunately, we didn't have enough time to test those system. Therefore, I should put all IC part in 2 PCB board. It turn out to be hard to debug. However, it was fun to think about optimal design of PCB. Design flow was simple, just place all part into the board. After that, I move around part until I got good looking trace line.

PCB manufacturing

PCB manufacturing was hardest task in this project. Since I want a PCB as small as possible, I choose small IC part and minimize all signal line. The problem was that I don't have enough skill to solder those small IC part on PCB. Especially, RF Amp and mixer was huge problem. Those two ICs has connection legs behind of chip. Therefore, it is hard to tell it is properly soldier or not. The worst part was those IC is for RF signal module. Only way to debugging RF signal module is

that designing PCB board individually such as RF Amp, Mixer and Splitter. However, it was impossible to do that. Fortunately, I could manage to solder all part in quarter 3. I learn how to use hot-plate, heat gun, and heat tip properly now. However, still there was some problem on overall circuit soldering.

Advice Teensy Code

I think about using Arduino at the beginning. However, I realized that Arduino has limited power for DSP and triangle signal generation. Moreover, Arduino PCB board is huge compared to our PCB. Therefore, I decided to use Teensy 3.1. Teensy 3.1 had four benefits compared with Arduino. One is its processing power. Two is its size. Three is that it has powerful libraries for DSP. Four is that it has built-in DAC. The library we used for DSP was not Fourier Transform. The library used timer and interrupter. ADC detecting 0V point and count number from there. Since its process frequency around 100MHz, it should count input frequency is pretty well. Also this coding is relatively simple compare to other method. LCD displaying library is Hitachi HD44780. It is easy to use.