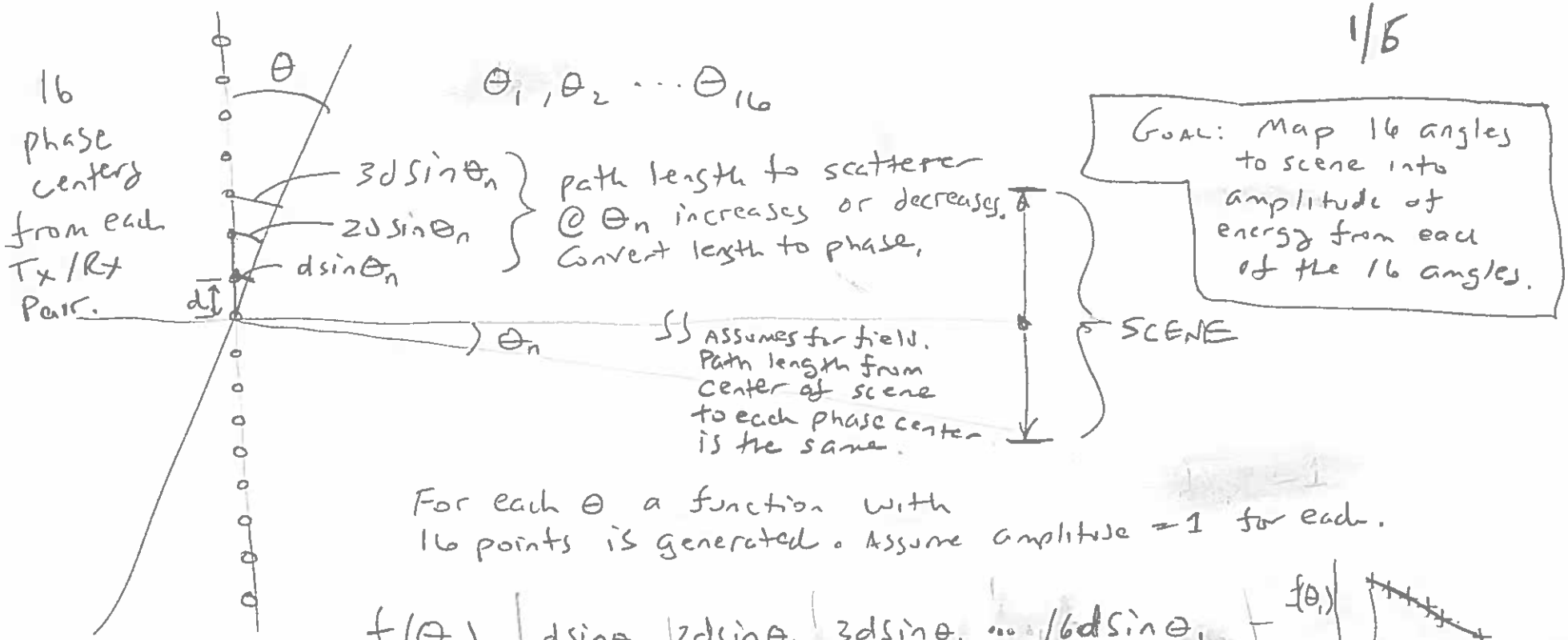
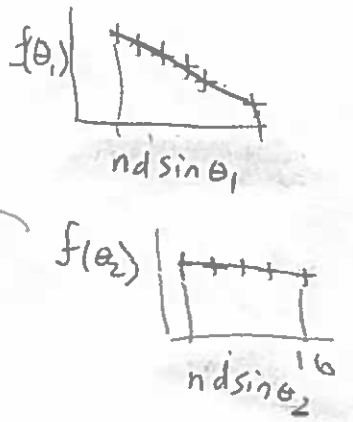
IMAGE FORMATION PROCESSING APPROACH

10/30/14



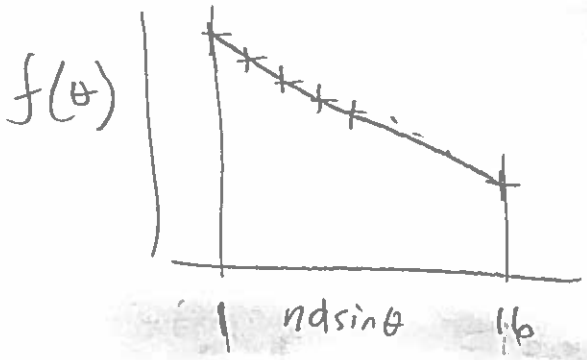
For each θ a function with 16 points is generated. Assume amplitude = 1 for each.

$f(\theta_1)$	$d\sin\theta_1$	$2d\sin\theta_1$	$3d\sin\theta_1$ ···	$16d\sin\theta_1$
$f(\theta_2)$	$d\sin\theta_2$	$2d\sin\theta_2$		
⋮	⋮			
$f(\theta_{16})$	$d\sin\theta_{16}$	$2d\sin\theta_{16}$		$16\,d\sin\theta_{16}$



Each $f(\theta_n)$ generates a linear phase slope versus frequency. Evaluate in EXCEL

Then take each $f(\theta_n)$ and break into Real and Imag Parts.



$n = 1$ to 16

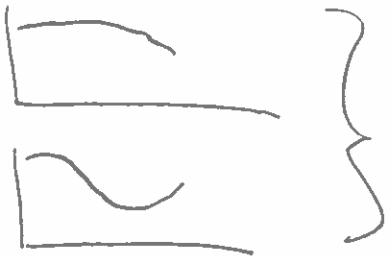
REAL

$$\begin{matrix} 1\cos(d\sin\theta_1), & 1\cos(2d\sin\theta_1) & \cdots & 1\cos(16d\sin\theta_1) \\ 1\cos(d\sin\theta_2, & 1\cos(2d\sin\theta_2) & \cdots & \cos(16d\sin\theta_2) \\ \vdots & & & \\ 1\cos(d\sin\theta_{16}), & 1\cos(2d\sin\theta_{16}) & \cdots & 1\cos(16d\sin\theta_{16}) \end{matrix}$$

Each row will plot out as a sinusoidal function of different freq

IMAG

$$1\sin(d\sin\theta_1), \quad 1\sin(2d\sin\theta_1) \cdots \sin$$
$$\vdots$$



These will be 90° out of phase with IMAG.

Plot these in excel

The real and imag function become basis functions and they will be stored in the VHDL Code. (Pat will) Need to convert from decimal to Fixed Point so they can be operated on.

We have: ($R_1\cos\theta_1$, $R_1\sin\theta_1$) from before.

$$\text{REAL}\begin{bmatrix} R_1\theta_1 & R_2\theta_1 & \cdots & R_{16}\theta_1 \\ \vdots & \vdots & & \vdots \\ R_1\theta_{16} & R_2\theta_{16} & \cdots & R_{16}\theta_{16} \end{bmatrix}$$

$$\text{IMAG}\begin{bmatrix} I_1\theta_1 & & & \\ & \ddots & & \\ & & & \end{bmatrix}$$

The hardware provides 16 I and Q values based on measured data from each of 16 phase centers

This generates 16 I's and 16 Q's

REAL IMAG

These are Real and Imag from the hardware data.

"data"

$$\begin{bmatrix} I_{1d} \\ I_{2d} \\ \vdots \\ I_{16d} \end{bmatrix} \quad \begin{bmatrix} Q_{1d} \\ Q_{2d} \\ \vdots \\ Q_{16d} \end{bmatrix}$$

These are analog voltage values that represent real and image part of measured return from scene.

5/6
updated
11/11/14

Next look at case for one angle θ
where we calculate the image energy at θ.

Will explain why this is negative later.

$$\underbrace{\left[\left(R_{1,\theta_1}\right) - j\left(I_{1,\theta_1}\right)\right]}_{\text{Basis Function for } \theta_1} \times \underbrace{\left[\left(I_{1d}\right) + j\left(Q_{1d}\right)\right]}_{\text{Data}} \rightarrow \text{sum real parts, sum imag parts,}$$

$$\sqrt{R^2 + I^2} = A_1$$

This is mag of energy @ θ_1

Repeat this calculation 16 times with all θ's, using the same data. set in simulation as typical response.

Simplify using $(a-jb)(c+jd) = ac + bd + j(-bc + ad)$
and calculate real part and imag part seperately

$$\underbrace{(R_{1,\theta_1})(I_{1d})}_{a\ c} + \underbrace{(I_{1,\theta_1} Q_{1d})}_{b\ d} + j\underbrace{(R_{1,\theta_1} Q_{1d})}_{a\ d} - \underbrace{(I_{1,\theta_1} I_{1d})}_{b\ c}$$

Suggested tasks to generate simulation:

1) Build 16 basis functions in EXCEL (1/6).
   Should plot as 16 lines with different slopes

2) Convert these to REAL and IMAG parts (2/6)
   This will yield 32 functions, 16R, 16I that
   should graph as sinusoids.

3) Set up the data function I and Q. (4/6)
   Since there is no data we would make these look like
   one of basis functions at a particular θ.

4) Do the complex multiply (5/6)
   and generate 16 amplitudes each
   corresponding to one of 16 angles.

5) Plot the 16 amplitudes versus the 16 θ's.