Asaf Cohen

201376761

Hackathon 2 Report

Wireless Optical Communication

**Phase 1: Ray Matrices – ABCD Matrix**

1. ABCD Matrix of the system:

For an input beam with vector , we get an output beam:

2. Matrix of propagation through a slab of thickness and index of refraction :

3. For a series of N thin lenses, at a separation distance of from each other, where

, the exit beam height and angle as a function of N is as follows:

****

We can see that for a low number of lenses, the beam height and angle are approximately periodic, and change sign according to the number of extra lenses we add. This is because is so low, that for low numbers the lenses are places approximately in distance apart. But as we can see with increasing numbers, there are fluctuations in the heights and angles, because of the added effect of the is bringing the image out of focus.

**Phase 2: Spatial Propagation**

1. The Gaussian profile beam given in , assuming , appears in the graph:



2. Drawing the spot size as a function of propagation distance, given in:

And assuming: , appears in the graph:



3. For a Gaussian beam with ,we get the following values:

4. For , the spot size after 1km will be:

5. Graph of accumulated power of Lambertian light source, with m = 1, as a function of viewing angle :



**Phase 3: Beam Expander and Concentrator**

1. Designing an expander with , we chose the f-number to be

, and we got that for each of the cases, the expander is feasible, and the foci of the lenses will be:

Where in the Keplerian case we use +1 and the Galilean case we use -1.

2.For given parameters:

The approximation of the spot size, assuming a Gaussian beam, after 1km will be:

Where we calculate from , and the corresponding formulae.

**Phase 5: The Communication Link**

1. Given the parameters of aerosols with concentration , and cross section

, the attenuation of the signal as a function of distance is:



2. The atmospheric index of refraction for air pressure , and temperature

, is given by:

3.

4. The total background radiation from the sun, according to internet sources is

**Phase 6: Filter**

1. The approximated transmission of an interference filter with one layer with and thickness , as a function of the incident angle, and assuming (meaning we take a phase difference of ) look as follows:



We can see that for each incident angle, we get a different wavelength that has the maximum transmission for this specific filter.

**Phase 7: Link Budget**

**Phase 8: Detector**

1. Assuming all the resistors of the SPM are the same, we will get an output voltage in the range of , since each of the elements adds another parallel resistor to the voltage divider. In this case, we have 3400 values that we can output, and for this amount we must have 12 bits in order to read it.

2. Using the approximation of the SNR of the APD,

**Phase 9: Ideal Receiver**