EECS101: HOMEWORK #2 SOLUTION

2021 Winter

1

According to the problem, we have $\begin{matrix}\mathrm{Var}(N_A)=2, E(N_A)=0\\ \mathrm{Var}(N_p)=S, E(N_p)=0\end{matrix}$

Total noise is

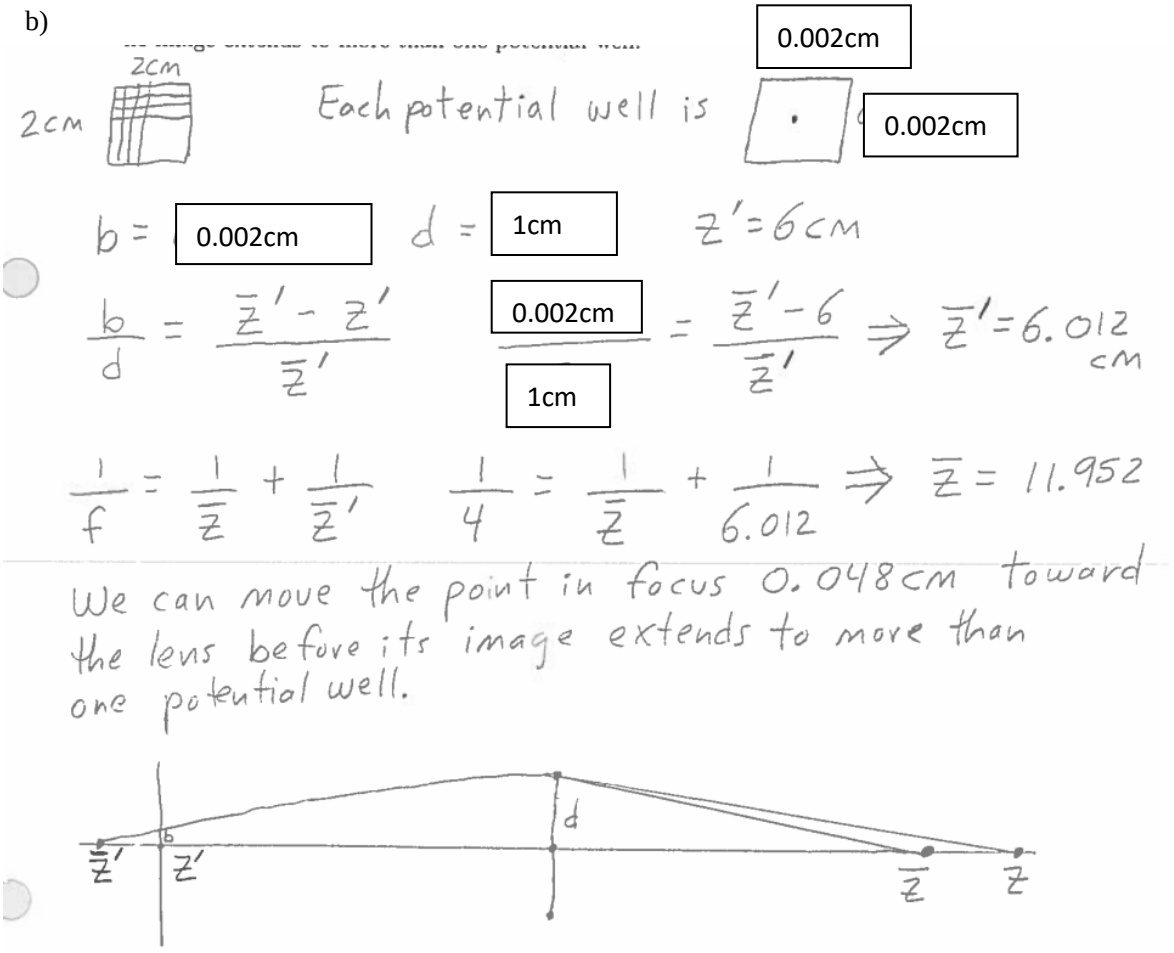
$\mathrm{Var}(C)=\mathrm{Var}((S+N_A+N_p)A)=A^2\mathrm{Var}(S+N_A+N_p)=A^2(2+S)$

$\mathrm{SNR}(C)=\frac{E(C)}{\sqrt{\mathrm{Var}(C)}}=\frac{E((S+N_A+N_p)A)}{\sqrt{A^2(1+S)}}=\frac{\mathrm{AS}}{\sqrt{A^2(2+S)}}=\frac{S}{\sqrt{2+S}}\geq 50\Rightarrow S\geq 2502$

2.

a) 1/4=1/6+1/x, x=12cm

b)



3.

a) $\mu=E((S+N_A+N_P)A+N_Q)=\mathrm{AS}+\mathrm{AE}(N_A)+\mathrm{AE}(N_P)+E(N_Q)=\mathrm{AS}$

$V(D)=V((S+N_A+N_P)A+N_Q)=A^2V(N_A)+A^2V(N_P)+V(N_Q)$

$A^2\sigma_A^2+A^2S+\sigma_Q^2=\mathrm{Au}+A^2\sigma_A^2+\sigma_Q^2$

b) Image1: $\hat{u} = 49.423, \hat{\sigma}^2 = 15.144$

Image2: $\hat{\mu} = 79.479, \hat{\sigma}^2 = 21.493$

Image3: $\hat{\mu} = 110.721, \hat{\sigma}^2 = 26.886$

Image4: $\hat{\mu} = 160.079, \hat{\sigma}^2 = 35.986$

Least square fit is shown in Figure 1 where dots are the data and line is the fit.

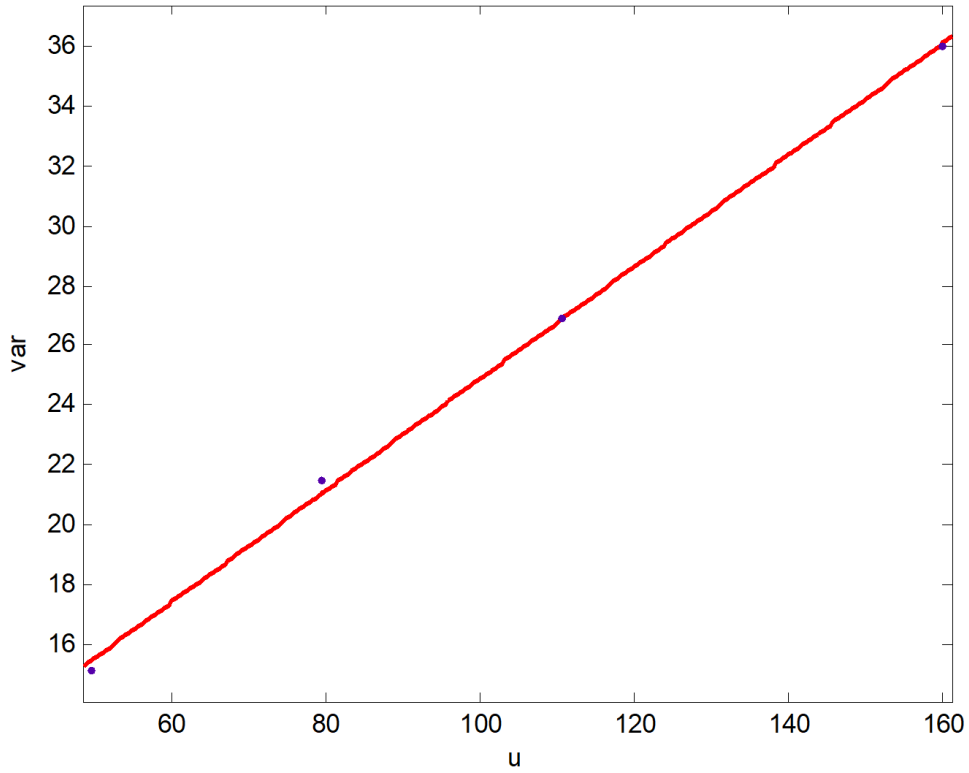


Figure 1

Estimation of A, $\hat{\sigma}_C^2$are

$\bar{A} = 0.187$

$\bar{\sigma}_C^2 = 6.234$