How to use CUED LaTeX template

Using the CUED template

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This work is submitted for the requirements of the
First year report

Darwin College April 2019

Declaration

This report is the result of my own work whilst at Ph.D. candidate at the University of Cambridge and includes nothing which is the outcome of work done in collaboration. No part of this report has been submitted for full or partial fulfilment of the requirements any other degree or diploma at this or any other university or institute of learning.

CSSA
April 2019

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Blah blah blah

Abstract

This paper .... Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

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Chapter 1

Introduction

This chapter .... 我来写写中文， 这个中文环境有点傻逼啊，不推荐使用。

1.1 Heading 1

Big section

1.1.1 Heading 2

Heading 3

List:

- aa
- bb
    - sub list

Numbered list:

1. aa
2. bb
    (a) sub enumerate list

1.2 Heading 1 with references

aa [1][2]

Chapter 2

Equations, images and algorithms

This chapter shows you how to write complex equation and position complicated images.

2.1 Image with tikz label

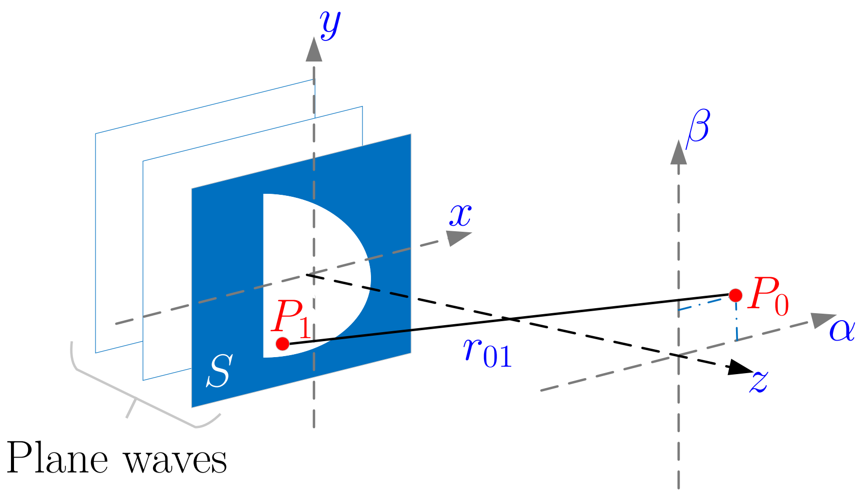


Figure 2.1: The coordinate system for analyzing different diffraction regimes

2.1.1 Equation 1

Consider the geometry shown in Figure. 2.1, coordinates (x, y) and (α, β) locates at the aperture plane and the observation plane respectively. Setting r_{01} as the distance between P_0 and P_1, the Rayleigh-Sommerfeld relationship becomes:

$$U(\alpha,\beta)=\frac{z}{j\lambda}\iint_{\Sigma}U(x,y)\frac{\exp jkr_{01}}{r_{01}^2}dxdy \tag{2.1–1}$$

where, $r_{01}=\sqrt{z^2+(\alpha-x)^2+(\beta-y)^2}$. The complexity of r_{01} suggests further assumptions to simplify Equation. 2.1–1. Assume P_0 and P_1 are reasonably coaxial, then r_{01} in the denominator approximates to z. However, it is the fact that small perturbation in the exponential function might lead to huge changes. The simplification of the distance term requires other approach. Binomial expansion is therefore adopted on r_{01} to eliminate the square root.

$$r_{01}\approx z\left\{1+\frac{1}{2}\left[\left(\frac{\alpha-x}{z}\right)^2+\left(\frac{\beta-y}{z}\right)^2\right]\right\} \tag{2.1–2}$$

Substitution Equation.2.1–2 into Equation.2.1–1 yields the Fresnel diffraction integral:

$$U(\alpha,\beta)=\frac{e^{jkz}}{j\lambda z}e^{j\frac{k(\alpha^2+\beta^2)}{2z}}\iint\left\{U(x,y)e^{j\frac{k(x^2+y^2)}{2z}}\right\}e^{-j\frac{2\pi}{\lambda z}(\alpha x+\beta y)}dxdy \tag{2.1–3}$$

The above equation suggests a significant conclusion: the diffraction pattern is the Fourier transform of a quadratic phase modulated aperture, multiplied with a scaling factor.

2.1.2 Cross reference equations and images

Fraunhofer diffraction deals with light propagation in the far field. In this regime, the quadratic phase term in Equation.2.1–3 can be dropped to make the whole equation even simpler:

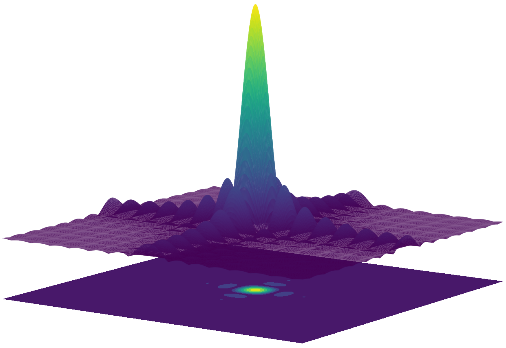
$$U(\alpha,\beta)=\frac{e^{jkz}}{j\lambda z}e^{j\frac{k(\alpha^2+\beta^2)}{2z}}\iint U(x,y)e^{-j\frac{2\pi}{\lambda z}(\alpha x+\beta y)}dxdy \tag{2.1–4}$$

Normalizing above equation, and letting $u=\frac{k\alpha}{2\pi z}$, $v=\frac{k\beta}{2\pi z}$ [3], the final relationship becomes:

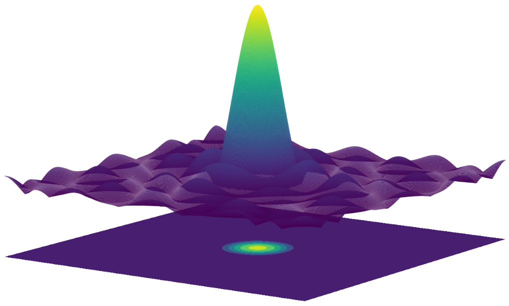
$$U(u,v)=\iint U(x,y)e^{-j2\pi(ux+vy)}dxdy \tag{2.1–5}$$

Figure 2.2a and 2.2b visualized a plane wave traversing a cubic or a circular aperture respectively.

2.2 Two images in the same row

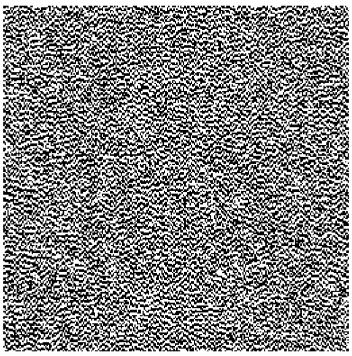


(a) cubic aperture

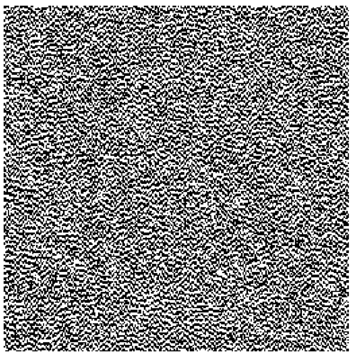


(b) circular aperture

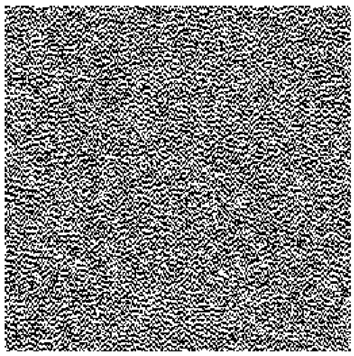
2.3 3 images in the same row



(a) Place holder 1



(b) Place holder 2



(c) Place holder 3

Figure 2.3: Example of position 3 figures

2.4 Algortihm

Algorithm 1: Direct binary search

Data:

$\mathbf{T}$: Target replay field

$\boldsymbol{C_{0,1}}$: Cost function

$\boldsymbol{H_{0,1}}$: Replay field after flipping one pixel

Input:

N: Number of iterations

Output: Optimized phase

```
Define the target replay field, T Random flip one pixel, and calculate its replay
  field, H_0
for k < N do
    Take the difference between T and H_0, calculate the first cost function C_0;
    Random flip one pixel, then calculate its replay field, H_1;
    Take the difference between T and H_1, then find the second cost function
      C_1;
    if C_0 < C_1 then
        Reject the flip and turn it back;
    else if C_0 > C_1 then
        Accept the flip and update the old cost function C_0 with the new one C_1;
    k = k + 1
end
```

Chapter 3

Tables and more equations

This chapter .... table

3.1 Simple table

Table 3.1: General comparison among CPU, GPU and FPGA [4]

	Number of cores	Development time	Clock frequency	Power consumption
CPU	Low	Short	High	Average
FPGA	High	Long	Low	Low
GPU	High	Average	High	High

3.2 Equation with bracket

$$\theta_H(x_{\alpha j}, y_{\alpha j}, z_j) = kR_{\alpha j} = 2\pi \left(\underbrace{\frac{z_j}{\lambda}}_{\theta_Z} + \underbrace{\frac{p^2}{2\lambda z_j}(x_{\alpha j}^2 + y_{\alpha j}^2)}_{\theta_{XY}} \right) \tag{3.2–1}$$

3.3 Aligning equations

$$\theta_{XY}(x_{\alpha j} + d, y_{\alpha j}, z_j) = \mathrm{mod}[\frac{p^2}{2\lambda z_j}(x_{(\alpha j} + d)^2 + y_{\alpha j}^2)] \tag{3.3–1}$$

$$= \mathrm{mod}[\theta_{XY}(x_{\alpha j}, y_{\alpha j}, z_j) + \Gamma_d] \tag{3.3–2}$$

Table 3.2: Comparison of computation time [5]

	Direct computes	Fresnel approximation	Recurrence algorithm
Time(s)	603	118	25

3.4 Another table

Table 3.3: Result comparison between Verilog and MATLAB fft function

Input data (s)	Verilog			MATLAB
	Binary real part	Binary imaginary part	Decimal	Decimal
1	9'b011111111	9'b000000000	255	255
2	9'b000110000	9'b010100101	48+j165	48.6396 + j166.0660
4	9'b111001101	9'b001100110	-51+j102	-51 + j102
8	9'b110110010	9'b000101101	-78+j45	-78.6396 + j46.0660
16	9'110101011	9'b000000000	-85	-85
32	9'b110110010	9'b111010011	-78-j45	-78.6396 - j46.0660
64	9'b111001101	9'b110011010	-51-j102	-51 - j102
128	9'b000110000	9'b101011011	48-j165	48.6396 -j166.066

References

[1] D. Gabor. A new microscopic principle. *Nature*, 161(161):777–778, May 1948.

[2] H. Kim, Y. Kim, H. Ji, H. Park, J. An, H. Song, Y. T. Kim, H. Lee, and K. Kim. A single-chip fpga holographic video processor. *IEEE Transactions on Industrial Electronics*, 66(3):2066–2073, March 2019.

[3] T. Wilkinson. Lecture notes 4B11 phtonics systems, October 2015.

[4] T. Shimobaba, T. Kakue, and T. Ito. Review of fast algorithms and hardware implementations on computer holography. *IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS*, 12(4):1611–1622, 2016.

[5] T. Shimobaba and T. Ito. An efficient computational method suitable for hardware of computer-generated hologram with phase computation by addition. *Computer physics communications*, 138:44–52, July 2001.

Appendix A

Project plan

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Appendix B

Title

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