Introduction to LaTeX

Cheng-Han Du

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Outline

How Do You Make A Document?

- You may only think of Microsoft Word or OpenOffice.
- What will you do if your documents have lots of equations or non-English/Chinese letters?
  - Equation editor is really useless sometimes ...
  - Frequent use of "insert" of special letters is really annoying ...
- Does complicating and bad paragraph alignment in Microsoft Word drive you crazy?
- There is a better choice for you ...

Outline

What is LaTeX

- LaTeX is a document preparation system.
  - It is not a word processor like Microsoft Word!
  - That means you may need a LaTeX code editor (we'll talk about this later).
- It is mainly used for scientific and technical documents and publications.
- However, LaTeX can also be very useful to make other kinds of documents.
- So far, the version of LaTeX comes to LaTeX 2_ε. LaTeX 3 is under development.

Outline

Basic Use

- Simply type some words and lines.
- Add some math and “strange” notations.
- Insert a picture.
- . . .

More Variation

- By using different "documentclass," different templates can be generated easily.
- IEEE journals, books, report, etc.
- It can even generate presentation slides like Microsoft PowerPoint.
  - Though special effects are limited, it is quite useful for simple slides.

Example in Beamer

Formulation - Full-Vectorial BPM

From the Maxwell's equations

$$\nabla \times \vec{E} = -\jmath\omega\mu_0\vec{H} \tag{1}$$

$$\nabla \times \vec{H} = \jmath\omega\bar{\bar{\epsilon}}\epsilon_0\vec{E} \tag{2}$$

After proper coordinate transform and considering z-direction as the propagating direction, wave equation can be derived as

$$\nabla^2\vec{E} + \bar{\bar{\epsilon}}k^2\vec{E} = \nabla(\nabla \cdot \vec{E}) \tag{3}$$

where $\bar{\bar{\epsilon}}$ is the dielectric tensor

$$\bar{\bar{\epsilon}} = \begin{pmatrix} \epsilon_{xx} & \epsilon_{xy} & 0 \\ \epsilon_{yx} & \epsilon_{yy} & 0 \\ 0 & 0 & \epsilon_{zz} \end{pmatrix}$$

Extracting transverse components from eq. 3 yields

$$\nabla^2 \vec{E}_t + \bar{\bar{\epsilon}}_{tt} k^2 \vec{E}_t = \nabla_t (\nabla_t \cdot \vec{E}_t + \frac{\partial E_z}{\partial z}) \tag{4}$$

where

$$\bar{\bar{\epsilon}} = \begin{pmatrix} \epsilon_{xx} & \epsilon_{xy} \\ \epsilon_{yx} & \epsilon_{yy} \end{pmatrix}$$

Using Gauss' law

$$\nabla_t \cdot (\bar{\bar{\epsilon}}_{tt} \vec{E}_t) + \frac{\partial \epsilon_{zz}}{\partial z} E_z + \epsilon_{zz} \frac{\partial E_z}{\partial z} = 0 \tag{5}$$

Example in Beamer

Formulation - Full-Vectorial BPM

When simulation device media variation along z-direction is very small, the $\frac{\partial \epsilon_{zz}}{\partial z}$ term in eq. 5 can be neglected. Thus, we can combine eq. 5 and 4 to obtain

$$\nabla_t^2 \vec{E}_t + \bar{\bar{\epsilon}}_{tt} k^2 \vec{E}_t = \nabla_t (\nabla_t \cdot \vec{E}_t - \frac{\nabla_t \cdot (\bar{\bar{\epsilon}}_{tt} \vec{E}_t)}{\epsilon_{zz}}) \tag{6}$$

Using $\bar{k}$ as a reference wavenumber for slowly varying envelope

$$\vec{E}_t = \vec{\Psi}_t \exp(-\jmath \bar{k} z) \tag{7}$$

Paraxial approximation claims

$$|\frac{\partial^2 \vec{\Psi}_t}{\partial z^2}| \ll 2\bar{k} |\frac{\partial \vec{\Psi}_t}{\partial z}| \tag{8}$$

Hence,

$$(\nu_x x + F_x + D_y + T_{xy}) - 2\jmath\bar{k}\frac{\partial}{\partial x})\Psi_x = V_{xy}\Psi_y \tag{9}$$

$$(\nu_y y + F_y + D_x + T_{yx}) - 2\jmath\bar{k}\frac{\partial}{\partial y})\Psi_y = V_{yx}\Psi_x \tag{10}$$

where

$$F_u = \frac{\partial}{\partial u}[\frac{1}{\epsilon_{zz}}\frac{\partial(\epsilon_{uu}\cdot)}{\partial u}] \tag{11}$$

$$D_w = \frac{\partial^2}{\partial w^2} \tag{12}$$

$$\nu_{uu} = k_0^2\epsilon_{uu} - \bar{k}^2 \tag{13}$$

$$V_{uw} = \frac{\partial^2}{\partial u \partial w} - k_0^2\epsilon_{uw} - \frac{\partial}{\partial u}\frac{1}{\epsilon_{zz}}[\frac{\partial(\epsilon_{uw}\cdot)}{\partial u} + \frac{\partial(\epsilon_{ww}\cdot)}{\partial w}] \tag{14}$$

$$T_{uw} = \frac{\partial}{\partial u}[\frac{1}{\epsilon_{zz}}\frac{\partial(\epsilon_{wu}\cdot)}{\partial w}] \tag{15}$$

Example in Beamer
A Picture from Movie "Russian Ark"

Figure: Picture from Movie "Russian Ark"

Other Considerations

- To edit Chinese, some other packages are needed such as CJK or cwTeX.
  - 兵者，詭道也。故能而示之不能，用而示之不用，近而示之遠，遠而示之近。
- Document generating flow is very important.

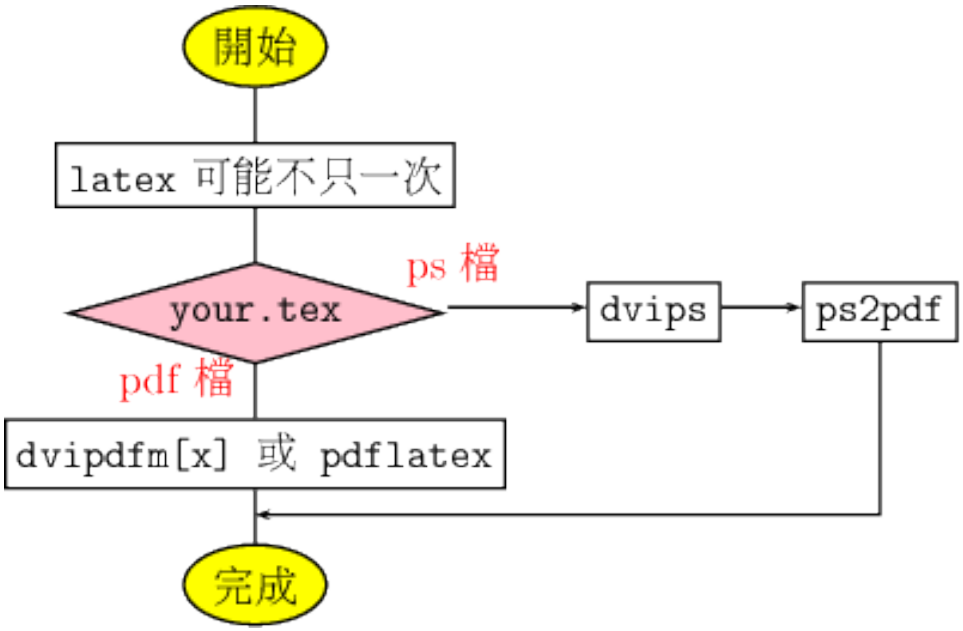

Figure: LaTeX document working flow

Other Considerations

- In Unix-based system: TeX live.
- In Windows system: MiKTeX.
- GUI editor is very helpful for editing TeX documents.
  - Linux: Kile
  - Windows: WinEdt (non-free), Latex Editor.
  - Other useful editor: ViM, UltraEditor, Crimson Editor, etc.

Outline

Conclusion

- LaTeX is a great tool to generate publications and various documents.
- You may need to make your thesis or dissertation someday. LaTeX is essential for the job.