Getting Started with LaTeX

ELEC 240: Fundamentals of Electrical Engineering I Lab

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1 Why LaTeX?

LaTeX is a typesetting system used to prepare and format technical documents. Learning how to use Latex is a critical skill in any engineering field; moving forward, many documents you see and produce will have dense equations or algorithms, and LaTeX provides a consistent format (for the audience) and interface (for you as the technical writer) for conveying this information in a textual form.

The densely technical material of ELEC 240 provides an excellent opportunity to learn how to typeset documents in LaTeX (if you have not had any prior exposure), or to practice formatting equations, figures, and accompanying technical descriptions (if you have had prior exposure).

2 Installing and Using LaTeX

The below instructions serve as a quickstart guide for creating documents in LaTeX for Linux, Windows, Mac, or in an online editor. While the steps for Linux are Debian-specific, the general approach of compiling LaTeX documents generalizes to all platforms.

2.1 Linux (Debian or Debian-derived distributions)

Firstly, to create and compile documents locally, you will need to have the `latex` package installed locally.

```
$ sudo apt-get install latex
# The `latex` package is quite large in size (1+ GB); this may take some time
```

It is recommended you use a dedicated LaTeX editor with live previews, so that you can edit your document in a (somewhat) WYSIWYG-fashion without manually re-compiling from the command line on every change. You may use an editor of your choice, but we like `gummi`.

```
$ sudo apt-get install gummi
```

LaTeX source is written in `.tex` files. To compile your document to a rendered PDF file, simply use the `pdflatex` executable (installed as part of the `latex` package).

```
$ touch lab-report.tex
# After working on lab-report.tex...
$ pdflatex lab-report.tex
# Debug output from `pdflatex`; should exit 0 if successful
# If successful, the current directory should have a file named lab-report.pdf
```

Note that if you are compiling your `.tex` document for the first time, you may need to invoke `pdflatex` twice in a row. This is slightly clumsy, but the reason for doing so is well-documented[1]. In other words, you may need to execute the following for a warning and error-free compilation:

```
$ pdflatex lab_report.tex
$ pdflatex lab_report.tex
```

Please note that a LaTeX environment and the `pdflatex` executable is avilable on all CLEAR systems if you do not have access to a local Linux machine. Please consult the Rice IT documentation[2] on how to connect to the CLEAR cluster.

2.2 Windows

Please consult the documentation online for MiKTeX[3].

2.3 Mac OS X

Please consult the documentation online for MacTeX[4].

2.4 Platform-Independent

There are a variety of browser-based LaTeX editors that are OS-independent. The following are two such options:

- ShareLaTeX[5]
- Overleaf[6]

However, we **highly recommend** that non-Linux users use CLEAR to gain access to a Linux environment to compile reports. CLEAR is available to all students and easily accessible via SSH. As an electrical engineering and/or computer science major, it is also in your best interest to learn your way around Linux now rather than later.

As always, if you have trouble creating and/or rendering LaTeX documents, do not hesitate to reach out to any of the course staff for help. Google is also your best friend.

3 Formatting Your LaTeX Document

3.1 Equations

You will inevitably need to include equations in lab reports to quantitatively explain the theoretical bases of real observations. To include an equation, use the following syntax:

```
\begin{equation}
    \label{laplacian_of_gaussian}
    \nabla^2 g(x, y) = \frac{\partial^2 g(x, y)}{\partial x^2} + \frac{\partial^2 g(x, y)}{\
        partial y^2}
\end{equation}
```

[1] http://tex.stackexchange.com/questions/107967/need-to-typeset-twice-for-correct-compile
[2] https://docs.rice.edu/confluence/pages/viewpage.action?pageId=25170799
[3] http://miktex.org/
[4] https://tug.org/mactex/
[5] https://www.sharelatex.com
[6] https://www.overleaf.com/

The above `equation` tag renders the following:

$$\nabla^2 g(x,y) = \frac{\partial^2 g(x,y)}{\partial x^2} + \frac{\partial^2 g(x,y)}{\partial y^2} \tag{1}$$

LaTeX automatically generates equation numbers as you write equations in your document. You may reference them in other parts of your document using `\ref{laplacian-of-gaussian}`, e.g. if you wanted to say "as described by Eq. 1..."

As you might notice, it is prudent to assign different label names to each of your equations so that you can reference them uniquely throughout your document (i.e., without conflicts).

3.2 Graphics

To include graphics in your document, first use the package `graphicx`[7], then use the following syntax:

```
\begin{figure}[H]
    \centering
    \includegraphics[width=0.45\textwidth]{image.png}
    \caption{Output of \lstinline$inter_scanline_search$}
    \label{disparity_map_inter_scanline_search}
\end{figure}
```

The above `figure` tag renders the following:

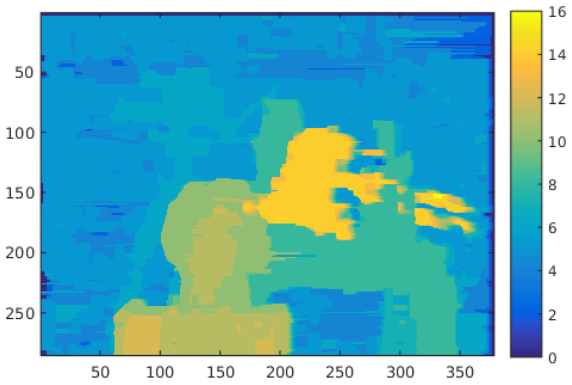

Figure 1: Output of `inter_scanline_search`

Please note that the same label-based referencing for equations applies to all LaTeX tags, including figures like the one above. In this case, simply use `\ref{disparity-map-inter-scanline-search}`.

3.3 Tables

Tables can be created using the `table` and `tabular` environments. Tables in LaTeX can be extensively customized; please see the official documentation[8] for more comprehensive instructions on how to build tables. A sample code snippet for a table appears below:

```
\begin{table}[H]
   \small
   \centering
```

[7] The syntax for using a package is `\usepackage{graphicx}`, which should be included at the top of your document.
[8] https://en.wikibooks.org/wiki/LaTeX/Tables

```
   \caption{Execution Time of Direct 2D Convolution, $O(MNk^2)$}
   \label{convolution-complexity-comparison}
   \begin{tabular}{llll}
    Image dimensions & Pixel count ($\times10^6$) & Execution time (s) \\
    $100 \times 100$ & $0.01$ & $0.000489$ \\
    $500 \times 500$ & $0.25$ & $0.008784$ \\
    $1000 \times 1000$ & $1.00$ & $0.034249$ \\
    $1500 \times 1500$ & $2.25$ & $0.076803$ \\
    $2000 \times 2000$ & $4.00$ & $0.136222$ \\
    $2500 \times 2500$ & $6.25$ & $0.212414$ \\
   \end{tabular}
\end{table}
```

The above code formats a four-column borderless table because of the `{llll}` option on the `tabular` environment. Note that columns of the table are delimited by the `&` character and rows are delimited by two backslahes, `\\`. The above code renders the following:

Table 1: Execution Time of Direct 2D Convolution, $O(MNk^2)$

Image dimensions	Pixel count ($\times 10^6$)	Execution time (s)
100×100	0.01	0.000489
500×500	0.25	0.008784
1000×1000	1.00	0.034249
1500×1500	2.25	0.076803
2000×2000	4.00	0.136222
2500×2500	6.25	0.212414

3.4 Source Code

To include source code in your document, first use the package `listings`, then use the following syntax:

```
\begin{lstlisting}[
   caption=Similarity profile implementation,
   label=similarity-profile-implementation,
]
function [column_pixel_delta, image_similarity_profile] = similarity_profile(img_left,
    img_right, row, col, patch_size, plot_profile)
    [height, width] = size(img_left);
    half_patch_size = patch_size / 2;

    % Only some pixels can be checked due to boundary conditions imposed by a nonzero patch
        size
    image_similarity_profile = zeros(1, width - patch_size);

    % Cut out a portion of the left image centered at (row, col): this is the reference
        patch
    patch_left = img_left(row - half_patch_size:row + half_patch_size, col - half_patch_size
        :col + half_patch_size);

    ...
end
\end{lstlisting}
```

The above `lstlisting` tag renders the following:

```
function [column_pixel_delta, image_similarity_profile] = similarity_profile(img_left,
    img_right, row, col, patch_size, plot_profile)
    [height, width] = size(img_left);
    half_patch_size = patch_size / 2;

    % Only some pixels can be checked due to boundary conditions imposed by a nonzero patch
        size
    image_similarity_profile = zeros(1, width - patch_size);

    % Cut out a portion of the left image centered at (row, col): this is the reference
        patch
    patch_left = img_left(row - half_patch_size:row + half_patch_size, col - half_patch_size
        :col + half_patch_size);

    ...
end
```

Listing 1: Similarity profile implementation

4 Additional Resources

- The LaTeX wiki is the most authoritative and comprehensive source of information on how to use LaTeX: https://en.wikibooks.org/wiki/LaTeX
- The TeX Stack Exchange site is a Q+A community where many common questions are addressed: http://tex.stackexchange.com/