ECOLE NATIONALE SUPÉRIEURE DES ARTS ET MÉTIERS MEKNES

MISE EN ŒUVRE ET STABILISATION D'UN BRAS DE DRONE QUADRIROTOR

PROJET MÉTIER

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MEKNES, JUNE 2024

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Acknowledgements

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Resume

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Palavras-Chave: Keyword A, Keyword B, Keyword C.

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Introduction

1.1 Contexte et motivation

Dans le domaine de l'ingénierie de contrôle, les systèmes de stabilisation sont essentiels pour maintenir l'équilibre de diverses structures et dispositifs mécaniques. Ces systèmes sont largement appliqués dans de nombreux domaines, notamment la robotique, l'aérospatiale, l'automobile et l'automatisation industrielle. La capacité à stabiliser un système de manière efficace peut considérablement améliorer ses performances et sa fiabilité.

Ce projet se concentre sur la stabilisation d'une barre rotative à un degré de liberté, qui sert de modèle simplifié pour des problèmes de stabilisation plus complexes. Le système de la barre rotative, souvent appelé pendule inversé, est un problème classique en théorie de contrôle et fournit une plate-forme précieuse pour tester et développer des algorithmes de contrôle.

1.2 Objectifs

1. Concevoir la structure mécanique.
2. Intégrer un IMU pour obtenir des données d'orientation en temps réel.
3. Développer et mettre en œuvre un algorithme de contrôle PID pour traiter les données de l'IMU et contrôler les rotors.

1.3 Portée

La portée de ce projet comprend la conception et la mise en œuvre des composants matériels et logiciels nécessaires pour le système de stabilisation. Les éléments clés du projet sont :

1. **Conception Mécanique :** Cela implique la conception et la construction de la barre rotative ainsi que le support fixe.

2. **Conception Électrique :** Cela couvre l'intégration de la carte d'aquisition de données et de controle y compris le câblage et la conception des circuits.
3. **Développement Logiciel :** Cela comprend la programmation de l'algorithme de contrôle PID et l'intégration de l'IMU pour obtenir des données d'orientation en temps réel.

Le projet ne couvrira pas le test et evaluation due aux limitations de temps et de ressources. Cependant, des tests préliminaires seront effectués pour vérifier le bon fonctionnement du système.

2

Bibliographie

2.1 IMU

Un IMU (Inertial Measurement Unit) est un dispositif électronique qui mesure et rapporte les données d'accélération linéaire, de vitesse angulaire et d'orientation d'un objet. Les IMU sont largement utilisés dans les applications de navigation inertielle, de robotique et de réalité virtuelle.

Les IMU sont généralement composés de trois capteurs principaux : un accéléromètre, un gyroscope et un magnétomètre. L'accéléromètre mesure l'accélération linéaire de l'objet, le gyroscope mesure la vitesse angulaire de l'objet et le magnétomètre mesure le champ magnétique terrestre pour déterminer l'orientation de l'objet.

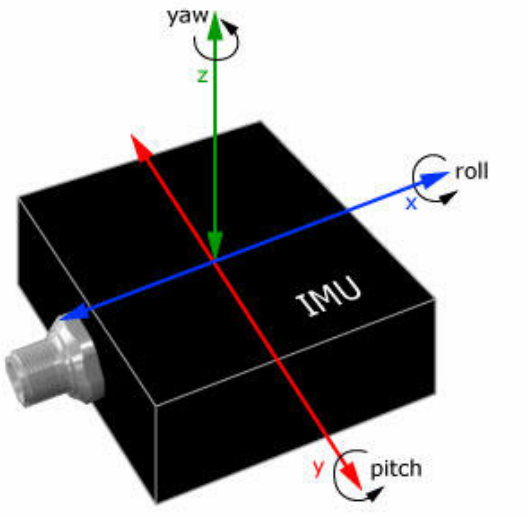


Figure 2.1: *Schéma d'un IMU.*

Les IMU sont souvent utilisés en combinaison avec d'autres capteurs, tels que les GPS et les caméras, pour fournir des données de localisation et d'orientation plus précises. Les IMU sont également utilisés dans les applications de réalité virtuelle pour suivre les mouvements de la tête de l'utilisateur et fournir une expérience immersive.

2.1.1 MPU6050

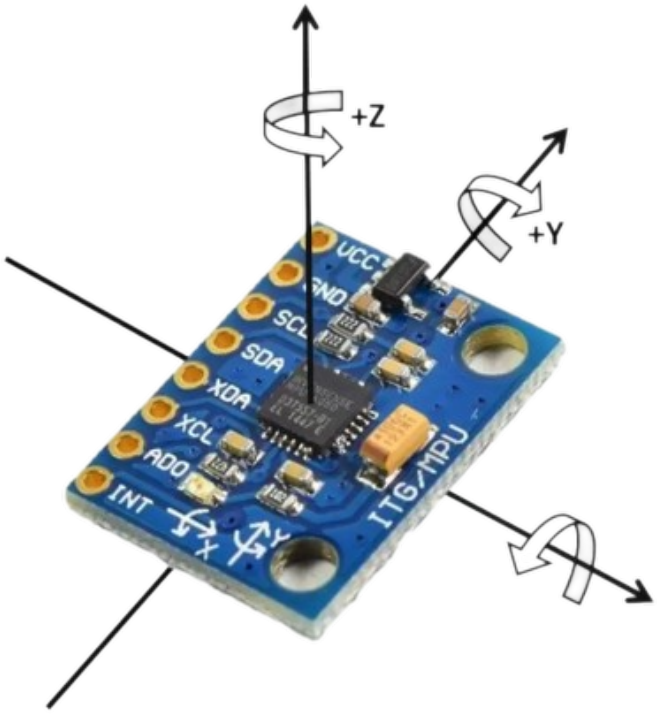


Figure 2.2: *Module MPU6050.*

Le MPU6050 est un IMU à 6 axes qui combine un accéléromètre et un gyroscope dans un seul boîtier. Le MPU6050 est largement utilisé dans les applications de robotique et de contrôle de mouvement en raison de sa petite taille, de sa faible consommation d'énergie et de sa précision élevée. Le MPU6050 est capable de mesurer l'accélération linéaire dans les trois axes et la vitesse angulaire dans les trois axes. Il utilise comme protocole de communication l'I2C.

2.1.2 I2C

L'I2C (Inter-Integrated Circuit) est un bus de communication série d'architecture Maitre-esclaves qui permet à plusieurs périphériques de communiquer entre eux à l'aide d'un seul bus de données. L'I2C est largement utilisé dans les applications de capteurs et de contrôleurs pour connecter plusieurs périphériques à un microcontrôleur.

L'I2C utilise deux fils pour la communication : un fil de données (SDA) et un fil d'horloge (SCL). Chaque périphérique connecté au bus I2C possède une adresse unique qui lui permet de communiquer avec les autres périphériques sur le bus.

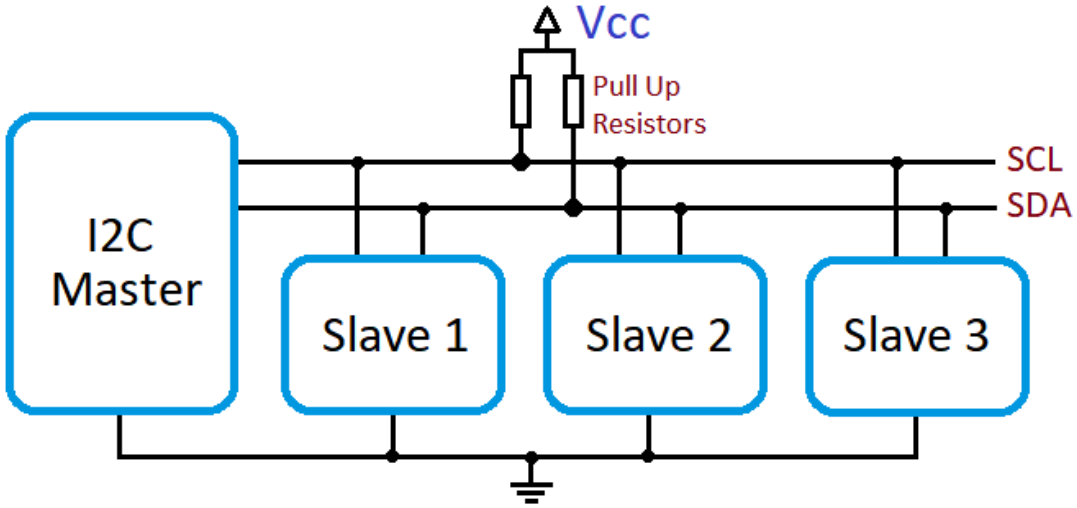


Figure 2.3: *Schéma d'un bus I2C.*

L'I2C prend en charge plusieurs vitesses de communication, allant de 100 kHz à 3,4 MHz.

2.1.3 Paquet I2C

Un paquet I2C est composé de :

1. **Condition de demarage :** Un signal de valeur haute sur SDA et SCL indique le début de la communication.
2. **Adresse client :** L'adresse du périphérique esclave auquel le maître souhaite communiquer.
3. **Ecriture/Lecture :** Un bit de lecture/écriture indique si le maître souhaite lire ou écrire des données. (R = 1, W = 0)
4. **Acknowledge :** Un bit de valeur basse sur SDA indique que le périphérique esclave a reçu les données avec succès.
5. **Données :** Les données à écrire ou lire.
6. **Acknowledge :** Un bit de valeur basse sur SDA indique que le périphérique esclave a reçu les données avec succès.
7. **Condition d'arrêt :** Un signal de valeur basse sur SDA et haute sur SCL indique la fin de la communication.

Adresse client est composé de 7 bits d'adresse et d'un bit de lecture/écriture. Alors que les paquets de données peuvent etre sequentiels composés de 8 bits de données et un bit d'acknowledge entre eux.

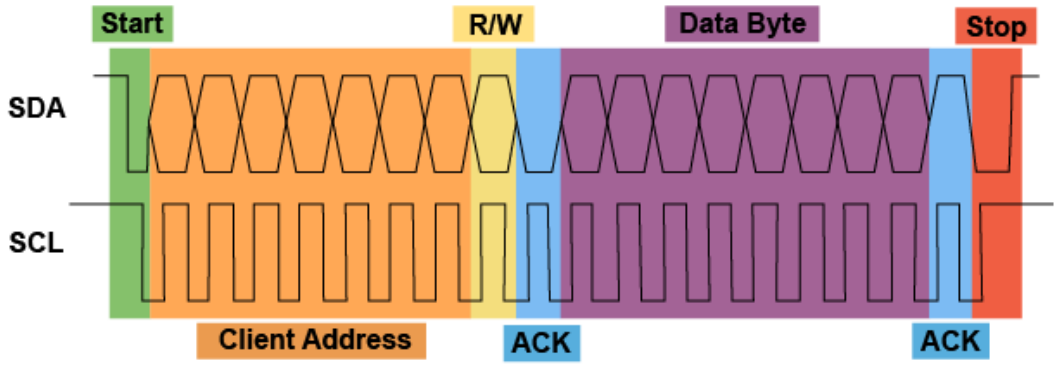


Figure 2.4: *Paquet I2C.*

2.2 Calcul de l'orientation

Il existe plusieurs méthodes pour calculer l'orientation d'un objet à partir des données d'un IMU. Les méthodes les plus courantes sont les filtres de Kalman, les filtres de Mahony et les filtres de Madgwick. Ces filtres utilisent les données de l'accéléromètre, du gyroscope (et du magnétomètre facultatif mais reduit la marge de l'erreur) pour estimer l'orientation de l'objet en temps réel.

Les Angles d'Euler

Les angles d'Euler sont une méthode courante pour représenter l'orientation d'un objet dans l'espace tridimensionnel. Les angles d'Euler sont composés de trois angles : l'angle de roulis, l'angle de tangage et l'angle de lacet. Ces angles décrivent la rotation de l'objet autour de ses axes X, Y et Z respectivement d'un système de coordonnées fixe.

1. **Roulis (Roll) :** Rotation autour de l'axe X. θ.
2. **Tangage (Pitch) :** Rotation autour de l'axe Y. ϕ.
3. **Lacet (Yaw) :** Rotation autour de l'axe Z. ψ.

$$R_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(\theta) & -\sin(\theta) \\ 0 & \sin(\theta) & \cos(\theta) \end{bmatrix}$$

$$R_y = \begin{bmatrix} \cos(\phi) & 0 & \sin(\phi) \\ 0 & 1 & 0 \\ -\sin(\phi) & 0 & \cos(\phi) \end{bmatrix}$$

$$R_z = \begin{bmatrix} \cos(\psi) & -\sin(\psi) & 0 \\ \sin(\psi) & \cos(\psi) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$R_{xyz} = R_x(\theta) \times R_y(\phi) \times R_z(\psi)$$

$$R_{xyz} = \begin{bmatrix} \cos(\phi)\cos(\psi) & \cos(\phi)\sin(\psi) & -\sin(\phi) \\ \sin(\theta)\sin(\phi)\cos(\psi) - \cos(\theta)\sin(\psi) & \sin(\theta)\sin(\phi)\sin(\psi) + \cos(\theta)\cos(\psi) & \sin(\theta)\cos(\phi) \\ \cos(\theta)\sin(\phi)\cos(\psi) + \sin(\theta)\sin(\psi) & \cos(\theta)\sin(\phi)\sin(\psi) - \sin(\theta)\cos(\psi) & \cos(\theta)\cos(\phi) \end{bmatrix}$$

On définit la matrice de R de rotation du capteur par rapport au repère fixe.

$$R = R_{xyz} \tag{2.1}$$

2.2.1 Accéléromètre

Modèle Mathématique

L'accélération gravitationnelle est définie comme :

$$g = 9.81\, m/s^2 \tag{2.2}$$

L'accélération linéaire mesurée par l'accéléromètre est composée de l'accélération gravitationnelle et de l'accélération linéaire de l'objet.

$$\vec{a} = \frac{\vec{dv}}{dt} - R * \vec{g} + b_a(t) + n_a(t) \tag{2.3}$$

1. $\vec{a}$ est l'accélération linéaire mesurée par l'accéléromètre.
2. R est la matrice de rotation du capteur.
3. $b_a(t)$ est le biais de l'accéléromètre.
4. $n_a(t)$ est le bruit de l'accéléromètre.

Dans un premier temps on se pose au repos donc l'accélération linéaire est nulle aussi nous allons négliger le bruit et le biais de l'accéléromètre pour simplifier le modèle.

$$\vec{a} = -R * \vec{g}$$

On deduit trois equations pour les trois axes de l'accéléromètre.

$$a_x = -g\sin(\theta)$$
$$a_y = g\cos(\theta)\sin(\phi)$$
$$a_z = g\cos(\theta)\cos(\phi)$$

$$\theta(n) = \arcsin\left(\frac{a_x(n)}{g}\right) \tag{2.4}$$

2.2.2 Gyroscope

L'intégrale de la rotation est une méthode simple pour estimer l'orientation d'un objet à partir des données d'un gyroscope. L'intégrale de la rotation consiste à intégrer les données du gyroscope pour estimer l'orientation de l'objet en temps réel.

$$\theta(n) = \theta(n-1) + \omega_x(n) \times \Delta t \tag{2.5}$$

Où $\theta(n)$ est l'angle de roulis à l'instant n, $\theta(n-1)$ est l'angle de roulis à l'instant n-1, ω_x est la vitesse angulaire autour de l'axe X et Δt est l'intervalle de temps entre les mesures.

3

Citations & Other Elements

In this chapter, we provide detailed guidance on the correct procedures for citing and referencing various elements within your document. Specifically, we will cover the proper methods for citing chapters, referencing figures and tables. We also provide information on how you can cite external works provided by a BibTeX bibliography.

3.1 Citations

We present two distinct approaches for citing entries in the bibliography. The first method involves in-text citations, executed using `\citet{ENTRY}`, while the second method employs `\citep{ENTRY}` for citations within a paragraph. Below is an example demonstrating both usages. It's essential to note that you can cite multiple works within the same citation environment. To achieve this, you should use the following format: `\citep{ENTRY1, ENTRY2, ...}`.

> Proper citations play a crucial role in academic writing, serving as the foundation for credibility, transparency, and the advancement of knowledge. They are a fundamental aspect of responsible scholarly writing. Please ensure accurate and appropriate citations.

Example: A novel signature scheme is introduced, along with an implementation of the Diffie-Hellman key distribution scheme that accomplishes a public key cryptosystem (**Elgamal1985**). According to **Elgamal1985**, a new signature scheme that accomplishes a public key cryptosystem is introduced.

3.2 References

Much like citations, it is advisable to employ references in your document for citing crucial elements such as chapters, sections, figures, or tables. To reference these elements, begin by creating a label. This label can be generated using `\label{TEXT}`, and it should be positioned within the element you intend to refer to. Once the element is created, you can utilise `\ref{LABEL}` to generate an in-text reference. **We strongly recommend**

using `\autoref{LABEL}`. This command automatically creates a custom link with colour corresponding to the type of element being referred to. For instance, a chapter reference will appear like this: **??**, rather than simply Chapter **??**.

> Just as with citations, ensuring proper references to elements within the document is of paramount importance. Remember to reference chapters and sections when necessary, **and consistently refer to other elements such as figures, tables, or listings.**

3.3 Glossary & Acronyms

The document includes both a glossary and an acronym list, accessible at the beginning of the document. You can create a new entry in either the `Miscellaneous/02-Glossary` or `Miscellaneous/03-Acronyms` sections, depending on the type of entry you intend to add. Once the entry is created, you can reference it using `\gls{ENTRY}` for glossary entries. For acronym entries, there are two ways to reference them. The first method, `\acrfull{ENTRY}`, should be used the first time the acronym appears in the text as it automatically provides the definition in-text. Subsequently, to refer to the acronym without repeating its meaning, use `\acrshort{ENTRY}`.

4

Figures

In LaTeX, integrating figures is a straightforward process. To insert them, you should utilise the environment `\begin{figure}`. You can customise the `width` parameter according to your requirements, but it is crucial to select a high-quality figure when inserting it into your documents. It is equally crucial to furnish a well-crafted caption. If necessary, consider including citations or references to indicate the figure's origin. The caption environment is denoted as `\caption{TEXT}`. However, to generate a smaller caption for the Table of Figures, be sure to utilise the format `\caption[SMALL_TEXT]{BIG_TEXT}`. By following the aforementioned tips, we can create a figure as demonstrated in **??**.

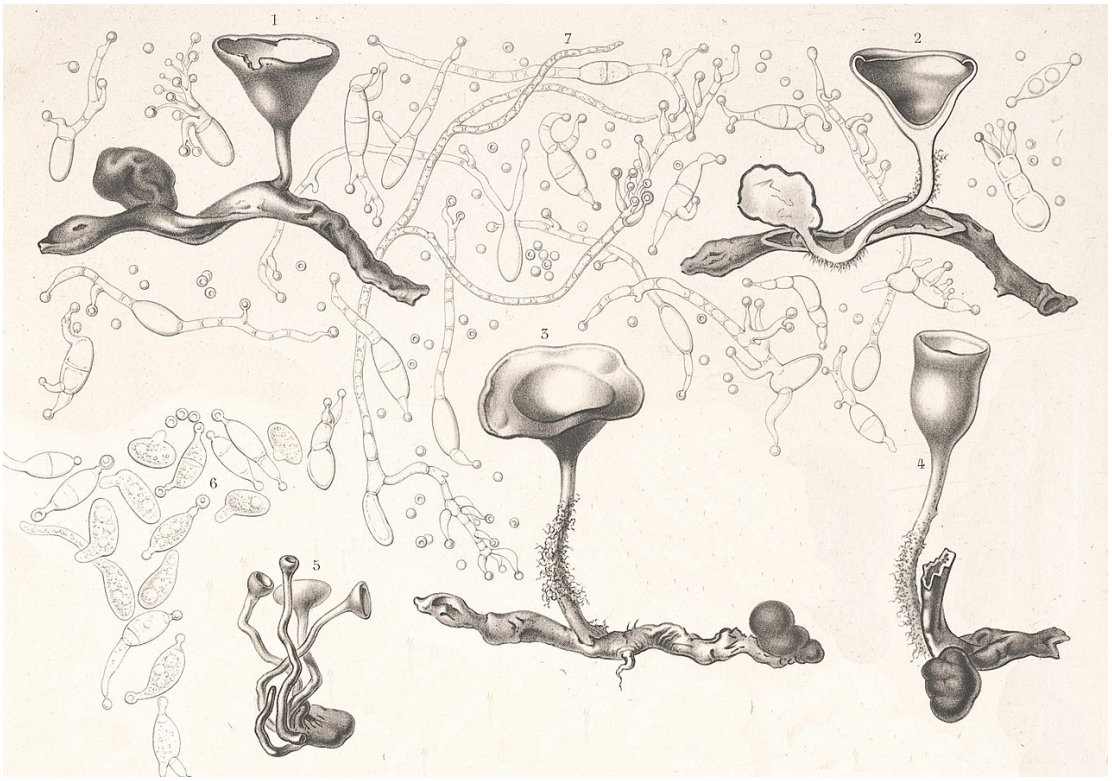
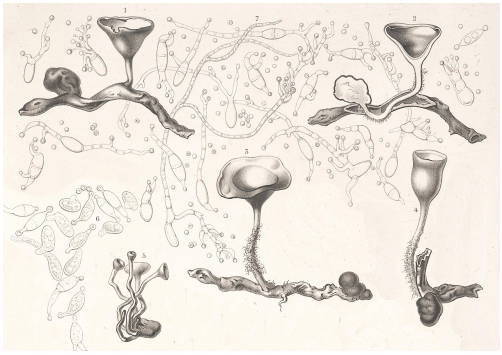


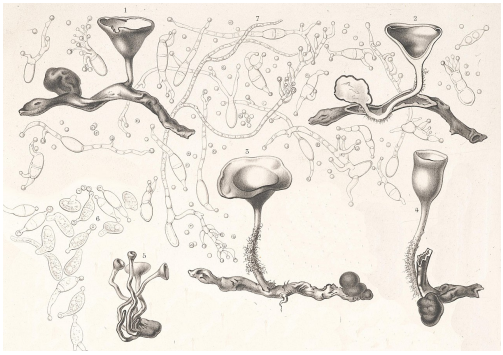
Figure 4.1: *Illustration of the fungus Dumontinia tuberosa by physician, mycologist, and illustrator Charles Tulasne (1816–1884) in the book Selecta Fungorum Carpologia (1861–65). (Name of the original work: Peziza tuberosa parasite on Anemone nemorosa)*

4.1 Side-by-Side Figures

For the purpose of comparing or for other reasons, you can insert side-by-side figures using both the `\begin{figure}` and `\begin{subfigure}` environments. You can also refer to the sub-figure as **??** and **??**.



(a) *Caption for Image 1*



(b) *Caption for Image 2*

Figure 4.2: *Overall Caption for the Figure*

To customise the spacing between sub-figures, utilise the `\hspace{VALUE}` command. Establishing adequate spacing is crucial for enhancing visual appeal and ensuring a reader-friendly experience. Below is a code snippet that represents the **??** - both label and caption text were omitted.

```
\begin{figure}[!htpb]
    \centering
    \begin{subfigure}{0.45\textwidth}
        \includegraphics[width=\textwidth]{FIGURE_PATH}
        \caption{TEXT}
        \label{TEXT}
    \end{subfigure}
    \hspace{.5cm} % Adjust the space as needed
    \begin{subfigure}{0.45\textwidth}
        \includegraphics[width=\textwidth]{FIGURE_PATH}
        \caption{TEXT}
        \label{TEXT}
    \end{subfigure}
    \caption{TEXT}
    \label{TEXT}
\end{figure}
```

5

Tables

Tables play a vital role in presenting your findings effectively. In this chapter, we delve into various techniques for conveying information through tables, employing different environments available in this template. Although defining tables in LaTeX may appear complex, using this template makes the process more straightforward.

> Prior to showcasing the different table environments, it's crucial to note that each one must be enclosed within a `\begin{table}` environment. Additionally, it is recommended to utilise the `[!htpb]` float options for improved document placement. **This advice should be taken into consideration when positioning figures as well**.

5.1 Tabular Environment

The conventional `\begin{tabular}` environment enables you to create a simple yet elegant table. **??** is generated using a centering environment for added emphasis. It also incorporates the `booktab` configuration for a more sophisticated table style.

Table 5.1: *A Table Showcasing the Usage of the Tabular Environment.*

Header 01	Header 02	Header 03
Lorem Ipsum	Lorem Ipsum	✓
Lorem Ipsum	Lorem Ipsum	✓
Lorem Ipsum	Lorem Ipsum	-
Lorem Ipsum	Lorem Ipsum	-
Lorem Ipsum	Lorem Ipsum	✓

5.2 Tabularx Environment

Employ the `\begin{tabularx}` package to construct a table featuring automatically expanding multi-columns. To achieve this automatic behaviour for multi-columns, utilise the following environment: `\begin{tabularx}{\textwidth}{@{}lX@{}}`. Take

note that we substitute `X` in place of `l` or `c`, explicitly indicating that the column will function as a multi-column, occupying the entire available space. **??** showcases the usage of the `begin{tabularx}` environment.

Table 5.2: *A Table Showcasing the Usage of the Tabularx Environment*

Header 01	Header 02
Foo Bar Baz	Quisque cursus, metus vitae pharetra auctor, sem massa mattis sem, at interdum magna augue eget diam.
Ipsum Dolor	Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Curabitur aliquet quam id dui.
Dolor Sit	Phasellus condimentum elementum justo, quis interdum est sagittis ac. Vestibulum non arcu sit amet justo lobortis semper.
Amet Consectetuer	Integer nec odio praesent libero sed cursus ante dapibus diam sed nisi vestibulum non arcu.
Consectetuer Adipiscing	Nulla quis sem at nibh elementum imperdiet. Duis sagittis ipsum. Praesent mauris.

5.3 Longtable Environment

At times, when dealing with exceptionally lengthy tables, it becomes necessary to split them across multiple pages. In LaTeX, this can be achieved using the `\begin{longtable}` environment. Feel free to consult **??** for a detailed demonstration of how the `longtable` operates.

Table 5.3: *A Table Showcasing the Usage of the Longtable Environment*

Names	E-Mails	Job/Role
Alice Johnson	alice.johnson@email.com	Project Manager
Bob Thompson	bob.thompson@email.com	Data Analyst
Charlie Davis	charlie.davis@email.com	Marketing Specialist
David Miller	david.miller@email.com	QA Tester
Emily White	emily.white@email.com	Graphic Designer
Frank Martin	frank.martin@email.com	HR Coordinator
Grace Turner	grace.turner@email.com	Financial Analyst
Henry Lee	henry.lee@email.com	System Administrator
Ivy Carter	ivy.carter@email.com	Customer Support
Jack Wilson	jack.wilson@email.com	Frontend Developer
Jane Reed	jane.reed@email.com	UX Designer
Kevin Evans	kevin.evans@email.com	Product Manager
Linda Adams	linda.adams@email.com	Accountant
Mike Hill	mike.hill@email.com	Network Engineer
Nina Garcia	nina.garcia@email.com	Business Analyst

Table 5.3 continued from previous page

Names	E-Mails	Job/Role
Oliver Smith	oliver.smith@email.com	Sales Representative
Pamela Turner	pamela.turner@email.com	Legal Counsel
Quincy Brown	quincy.brown@email.com	IT Consultant
Rachel Moore	rachel.moore@email.com	Content Writer
Samuel White	samuel.white@email.com	Research Scientist

5.4 Complex Tables

Creating intricate tables in LaTeX can be a somewhat challenging task. Therefore, we highly recommend using the Table Generator. With this tool, you can design your table with the desired style and then easily copy and paste it into your document. This approach simplifies the process and helps ensure the accurate representation of complex tables in your LaTeX document. However, it's crucial to keep in mind that a table should be easily comprehensible for the reader and should not be overly complex. The complexity of a table may impede understanding. For example, **??** presents a table with intricate details.

Table 5.4: *A Table Showcasing the Usage of the Complex Tables*

Category	**Details**	
	Subcategory	Carried Out
Long Category Name A	Long Subcategory Name A	✓
	Ipsum	✓
	Adipiscing	-
Long Category Name B	Long Subcategory Name B	-
	Ipsum	-
	Adipiscing	-
Long Category Name C	Long Subcategory Name C	✓
	Consectetur	✓
	Adipiscing	-

6

Lists

Creating lists in LaTeX is straightforward, offering various options to suit your needs. You can generate a bullet list using `\begin{itemize}`, or opt for a numbered list with `\begin{enumerate}`. Below is an example with the `\begin{itemize}` environment.

- List entries start with the `\item` command.
- Individual entries are indicated with a black dot, a so-called bullet.
- The text in the entries may be of any length.

As mentioned earlier, you can generate a numbered list using the `\begin{enumerate}` environment. Here is an example:

1. Items are numbered automatically.
2. The numbers start at 1 with each use of the `enumerate` environment.
3. Another entry in the list.

You can also nest list entries by creating a list inside another list of the same type. Here is an example:

1. First level item
2. First level item
   (a) Second level item
   (b) Second level item
      i. Third level item
      ii. Third level item
         A. Fourth level item
         B. Fourth level item

Please note that the labels change automatically regardless of the environment being the same for every list. **This demonstrates that there's no need to worry about changing the environment for something different.** However, if desired, you have the flexibility to do so.

You can also modify the label of your list to something entirely different that suits your needs. To accomplish this, insert a new `\item` and enclose your desired label in square brackets. For example, `\item[!]` will result in an exclamation point as your new label. Below are some examples of modified labels.

- This is my first point
- Another point I want to make

! A point to exclaim something!

■ Make the point fair and square.

A blank label?

Finally, you can create a description list. Unlike having a bullet point or a numbered label, a description list enables you to use custom descriptions that suit your list. In the example below, there are three `\item` entries: one without a label, and two with descriptions.

Item 1: This is the first item with a description.
Item 2: Another item with a different description.
An item without a specific label.

7

Code Listings

At times, you may want to include source code from your programs and applications within your document. To achieve this, you can use two nested environments: `\begin{listing}` to create a listing with both caption and label, and `\begin{minted}` for code highlighting. **??** provides an example of a source code in C.

```c
#include <stdio.h>
int main() {
   printf("Hello, World!"); /*printf() outputs the quoted string*/
   return 0;
}
```

Listing 7.1: *Hello World in C*

The code mentioned above was inserted into the document. However, an alternative approach is to input your code from an external file. To do so, you just need to use the command `\inputminted{CODE_LANGUAGE}{FILE}`. Of course, you should place that command inside of the `\begin{listing}` environment. **??** illustrates an example of Octave source code that has been input from an external file.

```
% Function to compute the sum without charge of two vectors
function X = BitXorMatrix(A,B)
    % Convert elements into usigned integers
    A = uint8(A);
    B = uint8(B);

    m1 = length(A);
    m2 = length(B);
    X = uint8(zeros(m1, m2));
    for n1=1:m1
        for n2=1:m2
            X(n1, n2) = bitxor(A(n1), B(n2));
        end
    end
```

Listing 7.2: *XOR Operation in Octave*

In some cases, when you simply want to highlight a specific command, it's recommended not to use `listing` or `minted`. Instead, you should utilise the `\verb` command for inline highlighting or the `\begin{verbatim}` environment for longer sections of highlighted code. An example of a lengthy `verbatim` section is provided below, demonstrating how to create a `listing` with an input code:

```
\begin{listing}[!htpb]
    \inputminted{CODE_LANGUAGE}{FILE}
    \caption{TEXT}
    \label{TEXT}
\end{listing}
```

Sometimes it is necessary to display longer code that occupies more than one page. For this purpose, please use the environment `\begin{longlisting}`. This environment will easily break your code into multiple pages for better readability without you worrying about the size of your code. An example is shown below in **??**.

```
1  IDENTIFICATION DIVISION.
2  PROGRAM-ID. BankingSystem.
3
4  DATA DIVISION.
5  WORKING-STORAGE SECTION.
6  01 CUSTOMER-RECORD.
7     05 CUSTOMER-NAME       PIC X(30).
8     05 CUSTOMER-AGE        PIC 99.
9     05 CUSTOMER-BALANCE    PIC 9(7)V99.
10    05 CUSTOMER-STATUS     PIC X(10).
11
12 01 CUSTOMER-COUNT         PIC 9999 VALUE 0.
13
14 01 TEMP-VARIABLES.
15    05 TEMP-NAME            PIC X(30).
16    05 TEMP-AGE             PIC 99.
17    05 TEMP-BALANCE         PIC 9(7)V99.
18    05 TEMP-STATUS          PIC X(10).
19
20 PROCEDURE DIVISION.
21
22     -- Accept customer details from the console
23     ACCEPT CUSTOMER-RECORD FROM CONSOLE.
24     ADD 1 TO CUSTOMER-COUNT.
25
26     -- Process customer records until 'EXIT' is entered
27     PERFORM PROCESS-CUSTOMER-RECORD UNTIL CUSTOMER-NAME = 'EXIT'.
28
29     -- Display total number of customers processed
30     DISPLAY 'Total number of customers: ' CUSTOMER-COUNT.
31
```

```
32      -- End the program
33      STOP RUN.
34
35  PROCESS-CUSTOMER-RECORD.
36      -- Copy customer details to temporary variables
37      MOVE CUSTOMER-NAME TO TEMP-NAME.
38      MOVE CUSTOMER-AGE TO TEMP-AGE.
39      MOVE CUSTOMER-BALANCE TO TEMP-BALANCE.
40      MOVE CUSTOMER-STATUS TO TEMP-STATUS.
41
42      -- Display customer details
43      DISPLAY 'Name: ' TEMP-NAME.
44      DISPLAY 'Age: ' TEMP-AGE.
45      DISPLAY 'Balance: ' TEMP-BALANCE.
46      DISPLAY 'Status: ' TEMP-STATUS.
47
48      -- Accept next customer record
49      ACCEPT CUSTOMER-RECORD FROM CONSOLE.
50      ADD 1 TO CUSTOMER-COUNT.
51  END PROGRAM BankingSystem.
```

Listing 7.3: *COBOL Code for a Basic Banking System*

8 Conclusion

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

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Appendices

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A

Appendix A

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

B

Appendix B

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

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ANNEXES

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M

Annex A

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

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ECOLE NATIONALE SUPÉRIEURE DES
ARTS ET MÉTIERS MEKNES

MISE EN ŒUVRE ET STABILISATION D'UN BRAS DE DRONE QUADRIROTOR

AHMED AMINE NOUABI

JANE SMITH

MEKNES, JUNE 2024