Electrical, Electromagnetic, and Optical Characterization of the InP/InGaAs Alloy System

A Capstone Project on Operational Technologies
Presented to the Faculty of the
Department of Electronics and Computer Engineering
Gokongwei College of Engineering
De La Salle University

In Partial Fulfillment of the
Operational Technologies

by

CALAGUIAN Nathan Raekel L.
ELLAR Gerald Antonio P.
MAHAIT Hans

September, 2025

ABSTRACT

Keep your abstract short by giving the gist/nutshell of your capstone project on operational technologies. Use the following checklist questions to help you in crafting your abstract.

- ☐ Did you briefly state what you intend to do?
- ☐ Did you concisely discuss the problem statement?
- ☐ Did you tersely mention the objectives in general terms?
- ☐ Did you succinctly describe the methodology for the target audience?
- ☐ Did you strongly describe your significant results and your conclusions?

Index Terms—alloy system, characterization, InP, InGaAs (see IEEE Taxonomy and Thesaurus).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

NOTATION

Throughout this capstone project on operational technologies, mathematical notations conform to ISO 80000-2 standard, e.g., variable names are printed in italics, the only exception being acronyms like, e.g., SNR, which are printed in regular font. Constants are also set in regular font like j. Standard functions and operators are also set in regular font, e.g., in $\sin(\cdot)$, $\max\{\cdot\}$. Commonly used notations are t, f, $\mathrm{j} = \sqrt{-1}$, n and $\exp(\cdot)$, which refer to the time variable, frequency variable, imaginary unit, nth variable, and exponential function, respectively.

GLOSSARY

LISTINGS

Chapter 1

INTRODUCTION

1.1 Background of the Study

Classical CV approaches used skin color segmentation, contour analysis, optical flow, and handcrafted descriptors (HOG, motion history images) to detect and classify gestures. Despite being simple and interpretable, those methods struggle with background variation and scale. The deep-learning era replaced handcrafted features with CNNs that learn hierarchical visual features directly from image data, yielding much higher accuracy for static hand pose and short-sequence recognition tasks. Many recent capstone and journal implementations pair OpenCV (for capture/preprocessing) with CNNs built and trained in TensorFlow/PyTorch to recognize a fixed vocabulary of gestures in real time. These hybrid pipelines are practical for capstone projects because OpenCV handles efficient frame processing while CNNs provide generalization across users and backgrounds. (https://pmc.ncbi.nlm.nih.gov/articles/PMC8321080/)

Instead of classifying raw images, several high-performance systems first extract skeletal landmarks (e.g., MediaPipe's 21-point hand model) and feed those coordinates to a classifier (small CNN, MLP, or temporal model like LSTM). Landmark-based pipelines reduce sensitivity to background and scale and make models smaller and faster, which is ideal for mobile or AR deployment. Markerless commercial devices such as the Leap Motion Controller and Ultraleap cameras provide very accurate 3D joint data using IR illumination and multi-camera setups; those give superior fidelity but add hardware cost and integration work. For a capstone aiming at broad deployability, a practical approach is to prototype with MediaPipe + OpenCV + CNN (or lightweight temporal model) and consider Ultraleap integration later for high-precision installations. (https://arxiv.org/abs/2006.10214)

1.2 Prior Studies

MediaPipe Hands (Zhang et al., Google / arXiv; MediaPipe docs). MediaPipe Hands presents a two-stage on-device pipeline (palm detector + hand-landmark regressor) that extracts 21 hand landmarks from a single RGB frame and runs in real time on mobile GPUs; the architecture and open implementation are widely used as a practical basis for gesture recognition because they offer compact, robust landmark outputs that are easier to classify than raw images. This work is especially relevant to mobile or cross-platform deployment without extra hardware. (https://arxiv.org/abs/2006.10214) Ultraleap / Leap Motion surveys and reviews. Reviews and vendor docs show that Ultraleap's IR stereo cameras and LED illumination give very precise 3D joint tracking and low latency, making them popular for VR/installation work; academic comparisons find Leap/Ultraleap and MediaPipe are both capable, with trade-offs in precision versus hardware requirements. Ultraleap or similar IR camera hardware is a practical choice for professional installation quality (amusement park kiosk, VR attraction). (docs.ultraleap.com) Sign-language gesture recognition studies (landmark + CNN/LSTM). ASL and other sign recognition papers demonstrate that combining landmark features (from MediaPipe or depth sensors) with temporal models (LSTM/CNN temporal stacks) yields state-of-the-art results for complex hand sequences. These studies emphasize the importance of considering variable visibility conditions as spellcasting often requires temporal tracing (drawing shapes), and not just static poses. This also provides insight into dataset design and labeling strategies. (https://arxiv.org/html/2406.03729v1) A comparative study of advanced technologies and methods in hand gesture analysis and recognition systems (Rahman et.al, 2025) Hand gesture recognition is advancing as a key technology for human–machine interaction. This

study reviews both non-vision (e.g., sensor-based) and vision-based approaches, examining tools such as hidden Markov models, finite state machines, color modeling, naive Bayes, deep networks, histogram features, and fuzzy clustering. Methods are categorized into detection, tracking, and recognition phases, with comparisons across static and dynamic gestures. The review highlights current technologies, their advantages and limitations, and identifies directions for future research. Hand Gesture Recognition Based on Computer Vision: A Review of Techniques (Oudah, Al-Naji, Chahl, 2020) Hand gestures, as a form of nonverbal communication, are applied in fields such as HCI, assistive communication, robotics, home automation, and healthcare. Research spans sensor-based and vision-based methods, with gestures categorized as static, dynamic, or hybrid. This paper reviews literature on gesture recognition, comparing techniques in terms of segmentation, classification, datasets, gesture types, camera use, detection range, and performance. It provides a comprehensive overview of methods, their merits and limitations, and potential applications.

1.3 Problem Statement

Immersive interactive systems in gaming, AR, amusement parks, and accessibility still rely heavily on handheld controllers, touchscreens, or specialized hardware that break immersion, add cost, or exclude users with differing motor abilities. Markerless, camera-based hand-gesture recognition promises touchless, expressive input suitable for “magical” metaphors (casting spells, tracing runes) that are intuitive and socially engaging. However, real-world deployment is challenged by variable lighting, occlusion, noisy backgrounds, and latency. These problems make accuracy and robustness the central obstacles for any spell-

casting CV system. Modern solutions that combine real-time hand-landmark extraction and convolutional neural networks (CNNs) have narrowed the gap, but careful design is required to meet the high level competency goals for responsiveness, cross-platform deployment, and accessibility. (https://pmc.ncbi.nlm.nih.gov/articles/PMC8321080/)A persuasive problem statement from a contextualized and intended-audience-awareness perspective consists of:

1. PS1: description of the ideal scenario for your intended audience
    - Describe the goals, desired state, or the values that your audience considers important and that are relevant to the problem.
2. PS2: reality of the situation
    - Describe a condition that prevents the goal, state, or value discussed in PS1 from being achieved or realized at the present time.
    - It is imperative to make the audience feel the pain point.
3. PS3: consequences for the audience
    - Using specific details, show how the situation contains a little promise of improvement unless something is done.

After the above-mentioned items, succinctly describe your solution. Please avoid describing your entire solution here since you will articulate and elucidate it by showing what you want to achieve through your objectives, and how you will make it through your methodology. A well-constructed problem statement will convince your audience that the problem is real and worth having you solve it.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

1.4 Objectives and Deliverables

Your objectives are the states that you desire to achieve in solving the problem. The general objective is the main state to be achieved whereas the specific ones are sub-states to be achieved.

1.4.1 General Objective (GO)

GO: To Morbi quis dolor. ;

1.4.2 Specific Objectives (SOs)

- SO1: To implement a real-time pipeline that captures camera frames, extracts robust hand features (landmarks or processed images), and classifies gestures into a configurable spell vocabulary with low latency (30 fps target) and high accuracy;;

- SO2: To make the model robust to lighting, background clutter, and user variation through data augmentation and landmark-based representations ;
- SO3: To design the system to be deployable across desktop, mobile, and simple AR setups using cross-platform libraries (OpenCV, MediaPipe, TensorFlow/TensorFlow Lite) ;
- SO4: To make the interaction ergonomically accessible by supporting alternative gestures and calibration for users with different ranges of motion ;
- SO5: On UX side, to make spells feel immediately meaningful (clear mapping between motion and effect), provide instant feedback when a spell is recognized, and allow easy extension of the spell set. ;

1.4.3 Expected Deliverables

Table 1.1 shows the outputs, products, results, achievements, gains, realizations, and/or yields of the Capstone Project on Operational Technologies.

TABLE 1.1 EXPECTED DELIVERABLES PER OBJECTIVE

Objectives	Expected Deliverables
GO: To Morbi quis dolor.	⋮

1.5 Significance of the Study

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec

ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

1.5.1 Technical Benefit

1. First itemtext
2. Second itemtext
3. Last itemtext
4. First itemtext
5. Second itemtext

1.5.2 Social Impact

1. First itemtext
2. Second itemtext

3. Last itemtext
4. First itemtext
5. Second itemtext

1.5.3 Environmental Welfare

1. First itemtext
2. Second itemtext
3. Last itemtext
4. First itemtext
5. Second itemtext

1.6 Assumptions, Scope, and Delimitations

Bulletize your assumptions in one group, and then bulletize the scope in another, and do the same for your delimitations. The assumptions to put here are those major facts or statements that are *key* for your proposed solution to work. Scope refers to the space(s) for the operation of your proposed solution, whereas delimitations are the limits of the operation of your proposed solution.

1.6.1 Assumptions

1. ...;
2. ...;
3. ...;

1.6.2 Scope

1. ...;
2. ...;
3. ...;

1.6.3 Delimitations

1. ...;
2. ...;
3. ...;

1.7 Description and Methodology of the Capstone Project on Operational Technologies

A purpose of the description here is to re-steer/remind the panelist/reader again by tersely describing what your thesis is about (i.e. the problem and the main goal you want to achieve) in another way without sounding repetitive.

Your methodology is your means of achieving your stated objectives. What you put here is the summary of your methodology chapter.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

1.8 Estimated Work Schedule and Budget

The estimated work schedule can be represented as a Gantt Chart or a combination of Project Network Diagram, Work Breakdown Structure, and Critical Path. The budget can be made into a Bill of Materials, financial plan, or if your Capstone Project on Operational Technologies is funded and part of larger project, the cost, and date for reaching each milestone and/or deliverable for your part of the project.

For ECE Department undergraduate theses, the individual Gantt Chart or Work Breakdown Schedule and Bill of Materials will be included in this section and be removed in the final document.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec

ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

1.9 Overview of the Capstone Project on Operational Technologies

Provide here a brief summary and what the reader should expect from each succeeding chapter. Show how each chapter is connected with each other.

Chapter 2

LITERATURE REVIEW

It is to be noted that each subsection in this chapter should discuss in narrative form each table that is presented in order to point out to the reader what the author(s) intend to convey.

2.1 Existing Work

Cite and summarize here relevant and significant literature (dissertations, theses, journals, patents, notable conference papers) through a table and descriptions to prove that no one has done your work yet and/or that your work is not a duplication of existing ones. Your focus here is what has *been done*.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla

tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec

ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

2.2 Lacking in the Approaches

You can summarize the weaknesses of existing approaches by a tabular comparison of the literature. Your focus here is what has *not been done*, i.e. what features were missed, what solutions were not considered, what the demerits are, etc. Through these items, you then can introduce the necessity for doing your proposed solution.

It is to be noted that the degree of novelty for undergraduate thesis is lower than those for graduate school. If a Ph.D. dissertation/thesis has a high degree of novelty and that for an undergraduate is low, then a master's thesis is somewhere between the two.

Briefly include here the following in order to remind the reader why you are highlighting the weaknesses of the solutions of existing literature.

- mentioning the problem
- showing how your solution is better (can be better (for proposals))

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec

ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit

amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

2.3 Summary

Provide the gist of this chapter such that it reflects the contents and the message.

Chapter 3

THEORETICAL CONSIDERATIONS

Before starting the first section, provide an overview of the purpose of this chapter and its contents, and how they are relevant to your methodology. Discuss in this chapter the relevant theories and concepts that should support your proposed solutions.

This chapter is for providing the context to your panelist/reader. It is actually an expanded form of the Background of the Study that you have put in Chapter 1.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue

a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

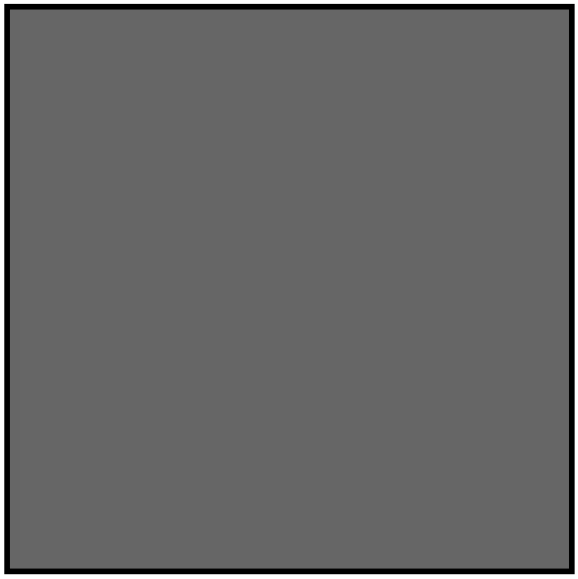


Fig. 3.1 A quadrilateral image example.

3.1 Summary

Provide the gist of this chapter such that it reflects the contents and the message.

Chapter 4

DESIGN CONSIDERATIONS

Before starting the first section, provide an overview of the purpose of this chapter and its contents, and how they are relevant to your methodology.

Your primary goal in the Design Considerations chapter is to describe to your panelist/readers the key topics that fall further under Theoretical Considerations, but should be placed here instead since they are geared towards your Methodology. These key topics are those that you have directly adopted in making your solution/methodology. You can think of the connection of the Design Considerations chapter to the Theoretical Considerations chapter in this way: if your Theoretical Considerations chapter serves as the main foundation of a building, then the Design Considerations chapter functions as the columns.

The Design Considerations chapter is an avenue for explaining why you considered the topics here for your proposed methodology. This chapter is different from your methodology, because topics you discuss here are already accepted as part of the body of knowledge, and may have not been developed by you.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec

ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit

amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

4.1 Standards

Standards are essential for successful projects and impactful research. They provide a common framework and ensure consistency, quality, and safety across various disciplines. By adhering to established standards, your work becomes more reliable, interoperable, and valuable in real-world applications. Standards also demonstrate your understanding of industry best practices and enhance the credibility of your research.

To effectively integrate standards into your project, begin by identifying relevant standards related to your specific field. Thoroughly research and understand the requirements and guidelines outlined within these standards. Align your project objectives and methodologies to meet or exceed these standards. Document your use of standards in this section, including how and why specific standards were chosen. Finally, evaluate your results against the established standards, justifying any deviations from the norm with sound

reasoning and evidence.

4.2 Summary

Provide the gist of this chapter such that it reflects the contents and message.

Chapter 5

METHODOLOGY

Put an overview of the contents of chapter. Mention here your methodology flow through a figure and provide an overview of it and how your methodology achieves your objectives. How your methodology achieves each of your specific objectives is what your panelists/examiners will be looking for. Specify how your methodology achieves your general objective and specific objectives. A point-by-point comparison how your methodology achieves each of your specific objectives is expected in the final Capstone Project on Operational Technologies.

Also make sure that you refer clearly to the chapters on the Literature Review, Theoretical Considerations, and Design Considerations showing how your methodology ties with those that you have discussed in those chapters.

Make an overview of the contents of the chapter. Put here your methodology flow through a figure and provide an overview of it.

In summative form, Table 5.1 indicates the approaches, designs, modes, processes, programs, techniques, and/or ways that the Capstone Project on Operational Technologies-reaches the objectives.

TABLE 5.1 SUMMARY OF METHODS FOR REACHING THE OBJECTIVES

Objectives	**Methods**	**Locations**
GO: To Morbi quis dolor.	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31

Continued on next page

Continued from previous page

Objectives	Methods	Locations
SO1: To implement a real-time pipeline that captures camera frames, extracts robust hand features (landmarks or processed images), and classifies gestures into a configurable spell vocabulary with low latency (30 fps target) and high accuracy;	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31
SO2: To make the model robust to lighting, background clutter, and user variation through data augmentation and landmark-based representations	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31
SO3: To design the system to be deployable across desktop, mobile, and simple AR setups using cross-platform libraries (OpenCV, MediaPipe, TensorFlow/TensorFlow Lite)	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31

Continued on next page

Continued from previous page

Objectives	Methods	Locations
SO4: To make the interaction ergonomically accessible by supporting alternative gestures and calibration for users with different ranges of motion	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31
SO5: On UX side, to make spells feel immediately meaningful (clear mapping between motion and effect), provide instant feedback when a spell is recognized, and allow easy extension of the spell set.	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31

5.1 Implementation

Summarize the process used to create/set-up the work with an explanation of such process, instruments, and materials that you used if any. If the description is lengthy, use condensed bullet points.

Rule of thumb: Implementation is how you made your work; (keywords: implemented, created, made, soldered, programmed, etc.).

If you wrote a program or made a simulation, you must state how the program or simulation functions in this section. An algorithm or a pseudocode as shown in Table **??** is a good example.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue

a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

5.2 Evaluation

Describe the procedures for evaluating the correct behavior and outcome of your work, including what information you need to gather and how you will obtain or measure it.

Rule of thumb: Evaluation is how you tested your work; (keywords: measured, tested, compared, simulated, etc.).

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue

a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

5.3 Summary

Provide the gist of this chapter such that it reflects the contents and the message.

Chapter 6

RESULTS AND DISCUSSIONS

Show in this chapter proofs why your proposed solution works. However, presenting results (”It worked”) without an appropriate explanation does not show thorough understanding. Aside from the data and results that you have obtained, and their explanation, the discussion includes why components of your proposed solution work did or did not work in accordance to what you described in the evaluation process, and how the proposed solution performed and faired. Interpret the results and the reasons why they were obtained. If your results are incorrect, apparent discrepancies from theory should be pointed out and explained. In essence, what do the results mean? Citing existing publication can help you compare your results and your explanations.

The next items below is not related to the description of this results and discussions chapter, but serves as an opener for the LaTeXportion of this template.

Here is an example of a citation for ISO 80000-2 standard [ISO, 2009]. Another one is [Einstein, 1905] and [Croft, 1978].

In using this template, the user is expected to have a working knowledge of LaTeX. A good introduction is in [Oetiker et al., 2014]. Its latest version can be accessed at `http://www.ctan.org/tex-archive/info/lshort`. See the Appendix of `document_guide.pdf` for examples.

In aggregate form, Table 6.1 shows the outcomes and completions in applying the methodology of the Capstone Project on Operational Technologiesper objective.

TABLE 6.1 SUMMARY OF RESULTS FOR ACHIEVING THE OBJECTIVES

Objectives	Results	Locations

Continued on next page

Continued from previous page

Objectives	Results	Locations
GO: To Morbi quis dolor.	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31
SO1: To implement a real-time pipeline that captures camera frames, extracts robust hand features (landmarks or processed images), and classifies gestures into a configurable spell vocabulary with low latency (30 fps target) and high accuracy;	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31
SO2: To make the model robust to lighting, background clutter, and user variation through data augmentation and landmark-based representations	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31

Continued on next page

Continued from previous page

Objectives	Results	Locations
SO3: To design the system to be deployable across desktop, mobile, and simple AR setups using cross-platform libraries (OpenCV, MediaPipe, TensorFlow/TensorFlow Lite)	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31
SO4: To make the interaction ergonomically accessible by supporting alternative gestures and calibration for users with different ranges of motion	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31
SO5: On UX side, to make spells feel immediately meaningful (clear mapping between motion and effect), provide instant feedback when a spell is recognized, and allow easy extension of the spell set.	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor.

Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem.

Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

6.1 Summary

Provide the gist of this chapter such that it reflects the contents and the message.

Chapter 7

CONCLUSIONS, RECOMMENDATIONS, AND FUTURE DIRECTIVES

7.1 Concluding Remarks

In this Capstone Project on Operational Technologies, . . .

Put here the main points that should be known and learned about the work topic. Summarize or give the gist of the essential principles and inferences drawn from your results.

7.2 Contributions

The interrelated contributions and supplements that have been developed by the author(s) in this Capstone Project on Operational Technologies are listed as follows. Only those that are unique to the authors' work are included.

- the ;
- the ;
- the ;

7.3 Recommendations

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue

a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus

placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

7.4 Future Prospects

There are several prospects that may be extended for further studies. . . . So the suggested topics are listed in the following.

1. the . . . .
2. the . . . .
3. the . . . .

Note that for ECE undergraduate theses, as per the directions of the thesis adviser, Recommendations and Future Directives will be removed for the hardbound copy but will be retained for database storage.

REFERENCES

[Aamport, 1986a] Aamport, L. A. (1986a). The gnats and gnus document preparation system. *G-Animal's Journal*, 41(7):73+. This is a full ARTICLE entry.

[Aamport, 1986b] Aamport, L. A. (1986b). The gnats and gnus document preparation system. *G-Animal's Journal*.

[Aamport, 2004] Aamport, L. A. (2004). The gnats and gnus document preparation system. In [GAJ, 1986], pages 73+. This is a cross-referencing ARTICLE entry.

[ABCM, 1959] ABCM (1959). *British chemicals and their manufacturers*.

[Aksın et al., 2006] Aksın, Ö., Türkmen, H., Artok, L., Çetinkaya, B., Ni, C., Büyükgüngör, O., and Özkal, E. (2006). Effect of immobilization on catalytic characteristics of saturated pd-n-heterocyclic carbenes in mizoroki-heck reactions. *Journal of Organometallic Chemistry*, 691(13):3027–3036.

[Almendro et al., 1998] Almendro, J. L., Martín, J., Sánchez, A., and Nozal, F. (1998). Elektromagnetisches signalhorn.

[Angenendt, 2002] Angenendt, A. (2002). In honore salvatoris – vom sinn und unsinn der patrozinienkunde. *Revue d'Histoire Ecclésiastique*, 97:431–456, 791–823.

[Aristotle, 1877] Aristotle (1877). *The Rhetoric of Aristotle with a commentary by the late Edward Meredith Cope*.

[Aristotle, 1907] Aristotle (1907). *De Anima*.

[Aristotle, 1929] Aristotle (1929). *Physics*. G. P. Putnam.

[Aristotle, 1968] Aristotle (1968). *Poetics*. Clarendon Aristotle. Clarendon Press.

[Aslin, 1949] Aslin, E. J. (1949). Photostat recording in library work. *Aslib Proceedings*, 1:49–52.

[Augustine, 1995] Augustine, R. L. (1995). *Heterogeneous catalysis for the synthetic chemist*. Marcel Dekker.

[Averroes, 1982] Averroes (1982). *The Epistle on the Possibility of Conjunction with the Active Intellect by Ibn Rushd with the Commentary of Moses Narboni*. Number 7 in Moreshet: Studies in Jewish History, Literature and Thought. Jewish Theological Seminary of America.

[Baez and Lauda, 2004a] Baez, J. C. and Lauda, A. D. (2004a). Higher-dimensional algebra v: 2-groups. *Theory and Applications of Categories*, 12:423–491.

[Baez and Lauda, 2004b] Baez, J. C. and Lauda, A. D. (2004b). Higher-dimensional algebra v: 2-groups.

[Bertram and Wentworth, 1996] Bertram, A. and Wentworth, R. (1996). Gromov invariants for holomorphic maps on riemann surfaces. 9(2):529–571.

['Brunswick', 1985] 'Brunswick' (1985). The piper and the rats: A musical experiment. Technical Report 1984, Rodent Activities Termination Section (RATS), Pest Control Division, Brunswick Public Welfare Department, Hamelin.

[Bry and Afflerbach, 1968] Bry, I. and Afflerbach, L. (1968). In search of an organizing principle for behavioural science literature. *Community Mental Health*, 4(1):75–84.

[BSI, 1973a] BSI (1973a). *BS 2570: Natural Fibre Twines*, Table 5. British Standards Institution, London, 3rd edition.

[BSI, 1973b] BSI (1973b). Natural fibre twines. BS 2570, British Standards Institution, London. 3rd. edn.

[BSI, 1976] BSI (1976). Bibliographic references. BS 1629, British Standards Institution.

[BSI, 1978] BSI (1978). Citing publications by bibliographic references. BS 5606, British Standards Institution.

[BSI, 1983] BSI (1983). Citation of unpublished documents. BS 6371, British Standards Institution.

[Butcher, 1981] Butcher, J. (1981). *Copy-editing*. Cambridge University Press, 2nd edition.

[Chapman, 1975] Chapman, J. (1975). *The Icehouse Bottom Site—40MR23*. Number 23 in University of Tennessee Department of Anthropology Publication. Univ. of Tennessee Press, Knoxville.

[Chave, 1964] Chave, K. E. (1964). Skeletal durability and preservation. In Imbrie, J. and Newel, N., editors, *Approaches to paleoecology*, pages 377–87, New York. Wiley.

['Chicago', 1982] 'Chicago' (1982). *The Chicago Manual of Style*. University of Chicago Press, 13th edition.

[Chiu and Chow, 1978] Chiu, W. W. and Chow, W. M. (1978). A hybrid hierarchical model of a multiple virtual storage (mvs) operating system.

[Chomsky, 1973] Chomsky, N. (1973). Conditions on transformations. In Anderson, S. R. and Kiparsky, P., editors, *A festschrift for Morris Halle*, New York. Holt, Rinehart & Winston.

[Cicero, 1995] Cicero, M. T. (1995). *De natura deorum. Über das Wesen der Götter*. Reclam.

[Coleridge, 1983] Coleridge, S. T. (1983). *Biographia literaria, or Biographical sketches of my literary life and opinions*, volume 7 of *Bollingen Series*. Routledge and Kegan Paul.

[Cotton et al., 1999] Cotton, F. A., Wilkinson, G., Murillio, C. A., and Bochmann, M. (1999). *Advanced inorganic chemistry*. Wiley, 6 edition.

[Croft, 1978] Croft, W. B. (1978). *Organizing and searching large files of document descriptions*. PhD thesis, Cambridge University.

[Doody, 1974] Doody, T. (1974). Hemingway's style and jake's narration. *The Journal of Narrative Technique*, 4(3):212–225.

[Downes, 1974] Downes, W. J. (1974). Systemic grammar and structural sentence relatedness.

London School of Economics. Mimeo.

[Eckstein and Zuckermann, 1960] Eckstein, P. and Zuckermann, S. (1960). Morphology of the reproductive tract. In Parkes, A. S., editor, *Marshall's Physiology of Reproduction*, volume 1, pages 43–154. Longman, London.

[Einstein, 1905] Einstein, A. (1905). Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]. *Annalen der Physik*, 322(10):891–921.

[Ellis and Walton, 1971] Ellis, B. and Walton, A. K. (1971). A bibliography on optical modulators. Technical Report RAE-TR-71009, Royal Aircraft Establishment.

[Exchequer, 1639] Exchequer (1634–1639). Act books. Edinburgh, Scottish Record Office, E.4/5.

[Feigl, 1958] Feigl, F. (1958). *Spot Tests in Organic Analysis*, chapter 6. Publisher publisher, 5th edition.

[Fletcher and Hopkins, 1907] Fletcher, W. M. and Hopkins, F. G. (1907). Lactic acid in amphibian muscle. *J. Physiol.*, 35:247–309.

[GAJ, 1986] GAJ (1986). *G-Animal's Journal*, 41(7). The entire issue is devoted to gnats and gnus (this entry is a cross-referenced ARTICLE (journal)).

[Gerhardt, 2000] Gerhardt, M. J. (2000). *The Federal Appointments Process*. Duke University Press.

[Gillies, 1933] Gillies, A. (1933). Herder and the preparation of goethe's idea of world literature. *Publications of the English Goethe Society*, 9:46–67.

[Glashow, 1961] Glashow, S. (1961). Partial symmetries of weak interactions. *Nucl. Phys.*, 22:579–588.

[Godfrey, 1959] Godfrey, G. B. (1959). Joints in tubular structures. *Struct. Eng.*, 37(4):126–135.

[Gonzalez, 2001] Gonzalez, R. (2001). *The Ghost of John Wayne and Other Stories*. The University of Arizona Press.

[Goossens et al., 1994] Goossens, M., Mittelbach, F., and Samarin, A. (1994). *The LaTeX Companion*. Addison-Wesley, 1 edition.

[Gordon, 1975] Gordon, R. (1975). The tunes of Chicken Little. In Ballet, A. H., editor, *Playwrights for Tomorrow: A Collection of Plays*, volume 13. University of Minnesota Press, Minneapolis. One of four plays included in vol. 13.

[Hammond, 1997] Hammond, C. (1997). *The basics of crystallography and diffraction*. International Union of Crystallography and Oxford University Press.

[Hanlon, 1972] Hanlon, J. (1972). Designing buildings by computer. *New Scientist*, pages 429–432.

[Hanson, 1967] Hanson, C. W. (1967). Subject inquiries and literature searching. In Ashworth, W., editor, *Handbook of special librarianship and information work*, pages 414–452. 3rd edition.

[Heller and Lederis, 1958] Heller, H. and Lederis, K. (1958). Paper chromatography of small

amounts of vasopressin and oxytocin. *Nature*, 182:1231–2.

[Herrmann et al., 2006] Herrmann, W. A., Öfele, K., Schneider, S. K., Herdtweck, E., and Hoffmann, S. D. (2006). A carbocyclic carbene as an efficient catalyst ligand for c–c coupling reactions. 45(23):3859–3862.

[Hershkovitz, 1962] Hershkovitz, P. (1962). *Evolution of Neotropical cricetine rodents (Muridae) with special reference to the phyllotine group*, volume 46 of *Fieldiana: Zoology*. Field Museum of Natural History, Chicago.

[Hoel, 1971a] Hoel, P. G. (1971a). *Elementary Statistics*. Wiley series in probability and mathematical statistics. Wiley, New York, Chichester, 3rd edition. ISBN 0 471 40300.

[Hoel, 1971b] Hoel, P. G. (1971b). *Elementary Statistics*, pages 19–33. Wiley series in probability and mathematical statistics. Wiley, New York, Chichester, 3rd edition. ISBN 0 471 40300.

[Homer, 2004] Homer (2004). *Die Ilias*. Artemis & Winkler, 3 edition.

[Hostetler et al., 1998] Hostetler, M. J., Wingate, J. E., Zhong, C.-J., Harris, J. E., Vachet, R. W., Clark, M. R., Londono, J. D., Green, S. J., Stokes, J. J., Wignall, G. D., Glish, G. L., Porter, M. D., Evans, N. D., and Murray, R. W. (1998). Alkanethiolate gold cluster molecules with core diameters from 1.5 to 5.2 nm. *Langmuir*, 14(1):17–30.

[Howells, 1951] Howells, W. W. (1951). Factors of human physique. *American Journal of Physical Anthropology*, 9:159–192.

[Howells, 1966a] Howells, W. W. (1966a). Population distances: Biological, linguistic, geographical and environmental. *Current Anthropology*, 7:531–540.

[Howells, 1966b] Howells, W. W. (1966b). Variability in family lines vs. population variability. *Annals of the New York Academy of Sciences*, 134:624–631.

[Hyman, 1981] Hyman, A. (1981). Aristotle's theory of the intellect and its interpretation by averroes. In O'Meara, D. J., editor, *Studies in Aristotle*, number 9 in Studies in Philosophy and the History of Philosophy, pages 161–191. The Catholic University of America Press.

[ISO, 2009] ISO (2009). 80000-2. *Quantities and units–Part 2: Mathematical signs and symbols to be used in the natural sciences and technology*.

[Itzhaki, 1996] Itzhaki, N. (1996). Some remarks on 't hooft's s-matrix for black holes.

[Jackson, 1979] Jackson, R. (1979). Running down the up-escalator: Regional inequality in Papua New Guinea. *Australian Geographer*, 14:175–84.

[Johnson, 1974] Johnson, G. B. (1974). Enzyme polymorphism. *Science*, 184:28–37.

[Kant, 1968a] Kant, I. (1968a). *Kritik der praktischen Vernunft*, volume 5, pages 1–163. Walter de Gruyter.

[Kant, 1968b] Kant, I. (1968b). *Kritik der Urtheilskraft*, volume 5, pages 165–485. Walter de Gruyter.

[Knuth, 1973a] Knuth, D. E. (1973a). *The Art of Computer Programming*. Four volumes. Addison-

Wesley. Seven volumes planned (this is a cross-referenced set of BOOKs).

[Knuth, 1973b] Knuth, D. E. (1973b). *Fundamental Algorithms*, volume 1 of *The Art of Computer Programming*, section 1.2, pages 10–119. Addison-Wesley, Reading, Massachusetts, second edition. This is a full INBOOK entry.

[Knuth, 1973c] Knuth, D. E. (1973c). *Fundamental Algorithms*, chapter 1.2. Addison-Wesley.

[Knuth, 1981a] Knuth, D. E. (1981a). *Seminumerical Algorithms*, volume 2 of *The Art of Computer Programming*. Addison-Wesley, Reading, Massachusetts, second edition. This is a full BOOK entry.

[Knuth, 1981b] Knuth, D. E. (1981b). *Seminumerical Algorithms*. Addison-Wesley.

[Knvth, 1988] Knvth, J. C. (1988). The programming of computer art. Vernier Art Center, Stanford, California. This is a full BOOKLET entry.

[Kowalik and Isard, 1995] Kowalik, F. and Isard, M. (1995). Estimateur d'un défaut de fonctionnement d'un modulateur en quadrature et étage de modulation l'utilisant.

[Kullback, 1959] Kullback, S. (1959). *Information Theory and Statistics*. John Wiley & Sons.

[Kullback, 1997a] Kullback, S. (1997a). *Information Theory and Statistics*. Dover Publications.

[Kullback, 1997b] Kullback, S. (1997b). *Information Theory and Statistics*. Dover Publications.

[Laufenberg et al., 2006] Laufenberg, X., Eynius, D., Suelzle, H., Usbeck, S., Spaeth, M., Neuser-Hoffmann, M., Myrzik, C., Schmid, M., Nietfeld, F., Thiel, A., Braun, H., and Ebner, N. (2006). Elektrische einrichtung und betriebsverfahren.

[Lincoll, 1977a] Lincoll, D. D. (1977a). Semigroups of recurrences. In Lipcoll, D. J., Lawrie, D. H., and Sameh, A. H., editors, *High Speed Computer and Algorithm Organization*, number 23 in Fast Computers, part 3, pages 179–183. Academic Press, New York, third edition. This is a full INCOLLECTION entry.

[Lincoll, 1977b] Lincoll, D. D. (1977b). Semigroups of recurrences. In *High Speed Computer and Algorithm Organization*. Academic Press.

[Lincoll, 2004] Lincoll, D. D. (2004). Semigroups of recurrences. In [Lipcoll et al., 1977], pages 179–183. This is a cross-referencing INCOLLECTION entry.

[Lipcoll et al., 1977] Lipcoll, D. J., Lawrie, D. H., and Sameh, A. H., editors (1977). *High Speed Computer and Algorithm Organization*. Number 23 in Fast Computers. Academic Press, New York, third edition. This is a cross-referenced BOOK (collection) entry.

[Loh, 1992] Loh, N. C. (1992). High-resolution micromachined interferometric accelerometer.

[Maguire, 1976] Maguire, J. (1976). *A taxonomic and ecological study of the living and fossil Hystricidae with particular reference to southern Africa*. Ph.d. diss., Department of Geology, University of the Witwatersrand, Johannesburg.

[Malinowski, 1972] Malinowski, B. (1972). *Argonauts of the Western Pacific*. Routledge and Kegan Paul, 8 edition.

[Mann, 1968] Mann, A. E. (1968). *The palaeodemography of Australopithecus*. Ph.d. diss., University of California, Berkeley.

[Markey, 2005] Markey, N. (2005). Tame the beast.

[Maron, 2000] Maron, M. (2000). *Animal Triste*. University of Nebraska Press.

[Massa, 2004] Massa, W. (2004). *Crystal structure determination*. Spinger, 2 edition.

[Masterly, 1988a] Masterly, É. (1988a). Mastering thesis writing. Master's project, Stanford University, English Department. This is a full MASTERSTHESIS entry.

[Masterly, 1988b] Masterly, É. (1988b). Mastering thesis writing. Master's thesis, Stanford University.

[McColvin, 2004] McColvin, L. R. (2004). *Libraries in Britain*. Longmans Green, for the British Council, London.

[McNeill, 1963] McNeill, W. H. (1963). The era of Middle Eastern dominance to 500 B.C. In *The Rise of the West*, part 1. University of Chicago Press, Chicago.

[Milton, 1924] Milton, J. (1924). Paradise lost. In Moody, W. V., editor, *The Complete Poetical Works of John Milton*. Houghton Mifflin, Boston, Student's Cambridge edition.

[Missilany, 2004] Missilany (2004). This is a minimal MISC entry.

[Missilany, 1984] Missilany, J.-B. (1984). Handing out random pamphlets in airports. Handed out at O'Hare. This is a full MISC entry.

[Moore, 1965] Moore, G. E. (1965). Cramming more components onto integrated circuits. *Electronics*, 38(8):114–117.

[Moore, 1998] Moore, G. E. (1998). Cramming more components onto integrated circuits. *Proceedings of the IEEE*, 86(1):82–85.

[Moraux, 1979] Moraux, P. (1979). Le *De Anima* dans la tradition grècque. In Lloyd, G. E. R. and Owen, G. E. L., editors, *Aristotle on Mind and the Senses*, pages 281–324.

[Nietzsche, 1988a] Nietzsche, F. (1988a). *Die Geburt der Tragödie. Unzeitgemäße Betrachtungen I–IV. Nachgelassene Schriften 1870–1973*, volume 1. and Walter de Gruyter, 2 edition.

[Nietzsche, 1988b] Nietzsche, F. (1988b). *Sämtliche Werke*. and Walter de Gruyter, 2 edition.

[Nietzsche, 1988c] Nietzsche, F. (1988c). *Unzeitgemässe Betrachtungen. Zweites Stück*, volume 1, pages 243–334. and Walter de Gruyter.

[Oaho et al., 1983a] Oaho, A. V., Ullman, J. D., and Yannakakis, M. (1983a). On notions of information transfer in VLSI circuits. In Oz, W. V. and Yannakakis, M., editors, *Proc. Fifteenth Annual ACM*, number 17 in All ACM Conferences, pages 133–139, Boston. Academic Press. This is a full INPROCEDINGS entry.

[Oaho et al., 1983b] Oaho, A. V., Ullman, J. D., and Yannakakis, M. (1983b). On notions of information transfer in VLSI circuits. In *Proc. Fifteenth Annual ACM*.

966 [Oaho et al., 2004] Oaho, A. V., Ullman, J. D., and Yannakakis, M. (2004). On notions of informa-
967 tion transfer in VLSI circuits. pages 133–139. This is a cross-referencing INPROCEEDINGS
968 entry.

969 [Oetiker et al., 2014] Oetiker, T., Partl, H., Hyna, I., and Schlegl, E. (2014). *The Not So Short*
970 *Introduction to LaTeX 2ε Or LaTeX 2ε in 157 minutes*. n.a.

971 [Ogilvy, 1965] Ogilvy, D. (1965). The creative chef. In Steiner, G. A., editor, *The Creative*
972 *Organization*, pages 199–213. University of Chicago Press, Chicago.

973 [Oz and Yannakakis, 1983] Oz, W. V. and Yannakakis, M., editors (1983). *Proc. Fifteenth Annual*,
974 number 17 in All ACM Conferences, Boston. Academic Press. This is a full PROCEEDINGS
975 entry.

976 [Padhye et al., 1999] Padhye, J., Firoiu, V., and Towsley, D. (1999). A stochastic model of tcp reno
977 congestion avoidance and control.

978 [Phony-Baloney, 1988a] Phony-Baloney, F. P. (1988a). *Fighting Fire with Fire: Festooning French*
979 *Phrases*. PhD dissertation, Fanstord University, Department of French. This is a full PHDTHESIS
980 entry.

981 [Phony-Baloney, 1988b] Phony-Baloney, F. P. (1988b). *Fighting Fire with Fire: Festooning French*
982 *Phrases*. PhD thesis, Fanstord University.

983 [Piccato, 2001] Piccato, P. (2001). *City of Suspects*. Duke University Press.

984 [Pines, 1979] Pines, S. (1979). The limitations of human knowledge according to al-farabi, ibn
985 bajja, and maimonides. In Twersky, I., editor, *Studies in Medieval Jewish History and Literature*,
986 pages 82–109.

987 [Prufer, 1964] Prufer, O. (1964). The Hopewell cult. *Scientific American*, pages 90–102.

988 [Pym, 1624] Pym, J. (1624). Diary. Northampton, Northamptonshire Record Office, Finch-Hatton
989 50.

990 [Ramsbottom, 1931] Ramsbottom, J. (1931). Fungi pathogenic to man. In *A System of Bacteriology*
991 *in relation to Medicine*, volume 8, pages 11–70. HMSO, for Medical Research Council, London.

992 [Ranganthan, 1951] Ranganthan, S. R. (1951). Colon classification and its approach to documenta-
993 tion. In Shera, J. H. and Egan, M. E., editors, *Bibliographic Organization*, pages 94–105.

994 [Reese, 1958] Reese, T. R. (1958). Georgia in anglo-spanish diplomacy, 1736-1739. *William and*
995 *Mary Quarterly*, 15:168–190.

996 [Salam, 1968] Salam, A. (1968). Weak and electromagnetic interactions. In Svartholm, N., editor,
997 *Elementary particle theory*, pages 367–377. Almquist & Wiksell.

998 [Sarfraz and Razzak, 2002] Sarfraz, M. and Razzak, M. F. A. (2002). Technical section: An
999 algorithm for automatic capturing of the font outlines. *Computers and Graphics*, 26(5):795–804.

1000 [Shore, 1991] Shore, B. (1991). Twice-born, once conceived. *American Anthropologist*, 93(1):9–
1001 27.

[Sigfridsson and Ryde, 1998] Sigfridsson, E. and Ryde, U. (1998). Comparison of methods for deriving atomic charges from the electrostatic potential and moments. *Journal of Computational Chemistry*, 19(4):377–395.

[Smart, 1976] Smart, N. (1976). *The religious experience of mankind*. Schribner, New York, 2nd edition.

[Sorace et al., 1997] Sorace, R. E., Reinhardt, V. S., and Vaughn, S. A. (1997). High-speed digital-to-rf converter.

[Térrific, 1988] Térrific, T. (1988). An $O(n \log n / \log \log n)$ sorting algorithm. Wishful Research Result 7, Fanstord University, Computer Science Department, Fanstord, California. This is a full TECHREPORT entry.

[Terrific, 1988] Terrific, T. (1988). An $O(n \log n / \log \log n)$ sorting algorithm. Technical report, Fanstord University.

[Thomson, 1971] Thomson, V. (1971). Cage and the collage of noises. In *American Music since 1910*, chapter 8. Holt, Rinehart and Winston, New York.

[Traquair, 1638] Traquair, E. (1638). Letter to Marquess of Hamilton, 28 Aug. Lennoxlove (E. Lothian), Muniments of Duke of Hamilton and Brandon, C.1, no. 963.

[Ünderwood et al., 1988] Ünderwood, U., Ñet, N., and P̄ot, P. (1988). Lower bounds for wishful research results. Talk at Fanstord University (this is a full UNPUBLISHED entry).

[Ünderwood et al., 2004] Ünderwood, U., Ñet, N., and P̄ot, P. (2004). Lower bounds for wishful research results. Talk at Fanstord University (this is a minimal UNPUBLISHED entry).

[van Gennep, 1909a] van Gennep, A. (1909a). *Les rites de passage*. Nourry.

[van Gennep, 1909b] van Gennep, A. (1909b). *Les rites de passage*. Nourry.

[van Gennep, 1960] van Gennep, A. (1960). *The Rites of Passage*. University of Chicago Press.

[Vázques de Parga et al., 1993] Vázques de Parga, L., Lacarra, J. M., and Uría Ríu, J. (1993). *Las Peregrinaciones a Santiago de Compostela*. Iberdrola. Ed. facs. de la realizada en 1948–49.

[von Brandt and Hoffmann, 1987] von Brandt, A. and Hoffmann, E. (1987). Die nordischen länder von der mitte des 11. jahrhunderts bis 1448. In Seibt, F., editor, *Europa im Hoch- und Spätmittelalter*, number 2 in Handbuch der europäischen Geschichte, pages 884–917. Klett-Cotta.

[Wassenberg and Sanders, 2010] Wassenberg, J. and Sanders, P. (2010). Faster radix sort via virtual memory and write-combining.

[Weinberg, 1967] Weinberg, S. (1967). A model of leptons. *Phys. Rev. Lett.*, 19:1264–1266.

[Westfahl, 2004] Westfahl, G. (2004). The true frontier. pages 55–65.

[Wilde, 1899] Wilde, O. (1899). *The Importance of Being Earnest: A Trivial Comedy for Serious People*. English and American drama of the Nineteenth Century. Leonard Smithers and Company.

[Winget Ltd., 1967] Winget Ltd. (1967). Detachable bulldozer attachment for dumper vehicles.

GB Patent Specification 1060631.

[Wood, 1961] Wood, R. H. (1961). *Plastic and Elastic Design of Slabs and Plates*. Thames & Hudson, London.

[Worman, 2002] Worman, N. (2002). *The Cast of Character*. University of Texas Press.

[Wright, 1963] Wright, R. C. (1963). *Report Literature*, pages 46–59.

[Wright, 1978a] Wright, S. (1978a). *Evolution and the genetics of populations*, volume 4. Univ. of Chicago Press, Chicago.

[Wright, 1978b] Wright, S. (1978b). Variability within and among natural populations. In *Evolution and the genetics of populations*, vol. 4. Univ. of Chicago Press, Chicago.

[Yoon et al., 2006] Yoon, M. S., Ryu, D., Kim, J., and Ahn, K. H. (2006). Palladium pincer complexes with reduced bond angle strain: efficient catalysts for the heck reaction. *Organometallics*, 25(10):2409–2411.

LaTeX-comment this and the following texts after you have implemented them. See the following references for helpful guides for the bibliography and script editing in general. Note that the links might be unavailable, but the names can be searched in the Web.

1. IEEE Citation Reference: www.ieee.org/documents/ieeecitationref.pdf
2. IEEE Editorial Style manual: www.ieee.org/documents/style_manual.pdf
3. IEEE Abbreviations for Transactions, Journals, Letters, and Magazines: www.ieee.org/documents/trans_journal_names.pdf

Also in your BibTeX file, enclose letters or words that should all be in uppercase in curly brackets. Example: IBM, Philippines, eXtensible Markup Language.

Chapter 8

STUDENT RESEARCH ETHICS CLEARANCE

1061

RESEARCH ETHICS CLEARANCE FORM[1]
For Thesis Proposals

Names of Student Researcher(s):

Dela Cruz, Juan Z.

College: Gokongwei College of Engineering

Department: Electronics and Communications Engineering

Course: PhD-ECE

Expected Duration of the Project: from: **April 2015** to: **April 2017**

Ethical considerations

None

(The Ethics Checklists may be used as guides in determining areas for ethical concern/consideration)

To the best of my knowledge, the ethical issues listed above have been addressed in the research.

Dr. Francisco D. Baltasar

_____

Name and Signature of Adviser/Mentor:
Date: April 8, 2017

Noted by:

Dr. Rafael W. Sison

_____

Name and Signature of the Department Chairperson:
Date: April 8, 2017

[1] The same form can be used for the reports of completed projects. The appropriate heading need only be used.

Chapter 9

ANSWERS TO QUESTIONS TO THIS CAPSTONE PROJECT ON OPERATIONAL TECHNOLOGIES

9.1 How important is the problem to practice?

A possible answer to this question is the summary of your Significance of the Study, and that portion of the Problem Statement where you describe the ideal scenario for your intended audience.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.2 How will you know if the solution/s that you will achieve would be better than existing ones?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue

a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.2.1 How will you measure the improvement/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.2.1.1 What is/are your basis/bases for the improvement/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris.

Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.2.1.2 Why did you choose that/those basis/bases?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.2.1.3 How significant are your measure/s of the improvement/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.3 What is the difference of the solution/s from existing ones?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.3.1 How is it different from previous and existing ones?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.4 What are the assumptions made (that are behind for your proposed solution to work)?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.4.1 Will your proposed solution/s be sensitive to these assumptions?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit

amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.4.2 Can your proposed solution/s be applied to more general cases when some assumptions are eliminated? If so, how?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.5 What is the necessity of your approach / proposed solution/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue

a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.5.1 What will be the limits of applicability of your proposed solution/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.5.2 What will be the message of the proposed solution to technical people? How about to non-technical managers and busines people?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor.

Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.6 How will you know if your proposed solution/s is/are correct?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.6.1 Will your results warrant the level of mathematics used (i.e., will the end justify the means)?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec

ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.7 Is/are there an/_ alternative way/s to get to the same solution/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.7.1 Can you come up with illustrating examples, or even better, counterexamples to your proposed solution/s?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.7.2 Is there an approximation that can arrive at essentially the same proposed solution/s more easily?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.8 If you were the examiner of your Capstone Project on Operational Technologies, how would you present the Capstone Project on Operational Technologies in another way? Give your remarks, especially for your methodology and the results and discussions.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

9.8.1 What are the weaknesses of your Capstone Project on Operational Technologies, specifically your methodology and the results and discussions?

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus

placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Chapter 10

REVISIONS TO THE PROPOSAL

Make a table with the following columns for showing the summary of revisions to the proposal based on the comments of the panel of examiners.

1. Examiner
2. Comment
3. Summary of how the comment was addressed
4. Locations in the document where the changes have been reflected

Continued on next page

Continued from previous page

Examiner	Comment	Summary of how the comment was addressed	Locations

TABLE 10.1 SUMMARY OF REVISIONS TO THE PROPOSAL

Examiner	Comment	Summary of how the comment was addressed	Locations
Dr. Francisco D. Baltasar	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper. **First** itemtext **Second** itemtext **Last** itemtext **First** itemtext **Second** itemtext	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22

Continued from previous page

Examiner	Comment	Summary of how the comment was addressed	Locations
Dr. Amado Z. Hernandez	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper. **First** itemtext **Second** itemtext **Last** itemtext **First** itemtext **Second** itemtext	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22

Continued on next page

Continued from previous page

Examiner	Comment	Summary of how the comment was addressed	Locations
Dr. Jose Y. Alonzo	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper. • First itemtext • Second itemtext • Last itemtext • First itemtext • Second itemtext	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22

Continued on next page

Continued from previous page

Examiner	Comment	Summary of how the comment was addressed	Locations
Dr. Mariana X. Mercado	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper. 1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22

Continued on next page

Continued from previous page

Examiner	Comment	Summary of how the comment was addressed	Locations
Dr. Rafael W. Sison	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22

Continued on next page

Continued from previous page

Examiner	Comment	Summary of how the comment was addressed	Locations

Chapter 11

REVISIONS TO THE FINAL

Make a table with the following columns for showing the summary of revisions to the proposal based on the comments of the panel of examiners.

1. Examiner
2. Comment
3. Summary of how the comment has been addressed
4. Locations in the document where the changes have been reflected

TABLE 11.1 SUMMARY OF REVISIONS TO THE CAPSTONE PROJECT ON OPERATIONAL TECHNOLOGIES

Examiner	Comment	Summary of how the comment has been addressed	Locations
Dr. Francisco D. Baltasar	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext **First** itemtext **Second** itemtext **Last** itemtext **First** itemtext **Second** itemtext	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22

Continued on next page

Continued from previous page

Examiner	Comment	Summary of how the comment has been addressed	Locations
Dr. Amado Z. Hernandez	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext **First** itemtext **Second** itemtext **Last** itemtext **First** itemtext **Second** itemtext	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22

Continued on next page

Continued from previous page

Examiner	Comment	Summary of how the comment has been addressed	Locations
Dr. Jose Y. Alonzo	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext • First itemtext • Second itemtext • Last itemtext • First itemtext • Second itemtext	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22
Dr. Mariana X. Mercado	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22

Continued on next page

Continued from previous page

Examiner	Comment	Summary of how the comment has been addressed	Locations
Dr. Rafael W. Sison	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	1. First itemtext 2. Second itemtext 3. Last itemtext 4. First itemtext 5. Second itemtext	Sec. 5.1 on p. 31, Sec. 5.2 on p. 34, Fig. 3.1 on p. 22

Chapter 12

USAGE EXAMPLES

The user is expected to have a working knowledge of LaTeX. A good introduction is in [Oetiker et al., 2014]. Its latest version can be accessed at http://www.ctan.org/tex-archive/info/lshort.

12.1 Equations

The following examples show how to typeset equations in LaTeX. This section also shows examples of the use of `\gls{ }` commands in conjunction with the items that are in the `notation.tex` file. **Please make sure that the entries in `notation.tex` are those that are referenced in the LaTeX document files used by this Capstone Project on Operational Technologies. Please comment out unused notations and be careful with the commas and brackets in `notation.tex` .**

In (**??**), the output signal $y\left(t\right)$ is the result of the convolution of the input signal $x\left(t\right)$ and the impulse response $h\left(t\right)$.

$$y\left(t\right)=h\left(t\right)*x\left(t\right)=\int_{-\infty}^{+\infty}h\left(t-\tau\right)x\left(\tau\right)\mathrm{d}\tau \tag{12.1}$$

Other example equations are as follows.

$$\begin{bmatrix}\frac{V_1}{I_1}\end{bmatrix}=\begin{bmatrix}A & B\\ C & D\end{bmatrix}\begin{bmatrix}\frac{V_2}{I_2}\end{bmatrix} \tag{12.2}$$

$$\frac{1}{2}<\left\lfloor \mathrm{mod}\left(\left\lfloor\frac{y}{17}\right\rfloor 2^{-17\lfloor x\rfloor-\mathrm{mod}(\lfloor y\rfloor,17)},2\right)\right\rfloor, \tag{12.3}$$

$$|\zeta(x)^3\zeta(x+iy)^4\zeta(x+2iy)| = \exp\sum_{n,p}\frac{3+4\cos(ny\log p)+\cos(2ny\log p)}{np^{nx}} \geq 1 \quad (12.4)$$

1330 The verbatim LaTeX code of Sec. **??** is in List. **??**.

Listing 12.1: Sample LaTeX code for equations and notations usage

```
1  The following examples show how to typeset equations in \LaTeX.  This
       section also shows examples of the use of \verb| \gls{ } | commands
       in conjunction with the items that are in the \verb| notation.tex |
       file. \textbf{Please make sure that the entries in} \verb| notation.
       tex |\textbf{  are those that are referenced in the \LaTeX \
       document files used by this \documentType.  Please comment out
       unused notations and be careful with the commas and brackets  in} \
       verb| notation.tex |.
2
3  In~\eqref{eq:conv}, the output signal \gls{not:output_sigt} is the
       result of the convolution of the input signal \gls{not:input_sigt}
       and the impulse response \gls{not:ir}.
4
5  \begin{eqnarray}
6       y\left( t \right) = h\left( t \right) * x\left( t \right)=\int_{-\
            infty}^{+\infty}h\left( t-\tau \right)x\left( \tau \right) \
            mathrm{d}\tau
7     \label{eq:conv}
8  \end{eqnarray}
9
10 Other example equations are as follows.
11
12 \begin{eqnarray}
13    \left[ \dfrac{ V_{1} }{ I_{1} } \right] =
14    \begin{bmatrix}
15       A & B \\
16       C & D
17    \end{bmatrix}
18    \left[ \dfrac{ V_{2} }{ I_{2} } \right]
19    \label{eq:ABCD}
20 \end{eqnarray}
21
22 \begin{eqnarray}
23 \dfrac{1}{2} < \left\lfloor \mathrm{mod}\left(\left\lfloor \dfrac{y}{17}
       \right\rfloor 2^{-17 \lfloor x \rfloor - \mathrm{mod}(\lfloor y\
       rfloor, 17)},2\right)\right\rfloor,
24 \end{eqnarray}
25
26 \begin{eqnarray}
27 | \zeta(x)^3 \zeta(x + iy)^4 \zeta(x + 2iy) | =
28 \exp\sum_{n,p} \frac{3 + 4 \cos( ny \log p) + \cos (2ny \log p)}{np^{nx
       }} \ge 1
29 \end{eqnarray}
```

12.2 Notations

In order to use the standardized notation, the user is highly suggested to see the ISO 80000-2 standard [ISO, 2009].

See https://en.wikipedia.org/wiki/Help:Displaying_a_formula and https://en.wikipedia.org/wiki/List_of_mathematical_symbols for LaTeX maths and other notations, respectively.

The following were taken from `isomath-test.tex` .

12.2.1 Math alphabets

If there are other symbols in place of Greek letters in a math alphabet, it uses T1 or OT1 font encoding instead of OML.

mathnormal	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9$
mathit	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, ff, fi, ß, \text{˚}, !, v, w, 0, 1, 9$
mathrm	$\mathrm{A}, \mathrm{B}, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \mathrm{ff}, \mathrm{fi}, ß, \text{˚}, !, \mathrm{v}, \mathrm{w}, 0, 1, 9$
mathbf	$\mathbf{A}, \mathbf{B}, \mathbf{\Gamma}, \mathbf{\Delta}, \mathbf{\Theta}, \mathbf{\Lambda}, \mathbf{\Xi}, \mathbf{\Pi}, \mathbf{\Sigma}, \mathbf{\Phi}, \mathbf{\Psi}, \mathbf{\Omega}, \mathbf{ff}, \mathbf{fi}, ß, \text{˚}, \mathbf{!}, \mathbf{v}, \mathbf{w}, \mathbf{0}, \mathbf{1}, \mathbf{9}$
mathsf	$\mathsf{A}, \mathsf{B}, \mathsf{\Gamma}, \mathsf{\Delta}, \mathsf{\Theta}, \mathsf{\Lambda}, \mathsf{\Xi}, \mathsf{\Pi}, \mathsf{\Sigma}, \mathsf{\Phi}, \mathsf{\Psi}, \mathsf{\Omega}, \mathsf{ff}, \mathsf{fi}, ß, \text{˚}, !, \mathsf{v}, \mathsf{w}, 0, 1, 9$
mathtt	$\mathtt{A}, \mathtt{B}, \mathtt{\Gamma}, \mathtt{\Delta}, \mathtt{\Theta}, \mathtt{\Lambda}, \mathtt{\Xi}, \mathtt{\Pi}, \mathtt{\Sigma}, \mathtt{\Phi}, \mathtt{\Psi}, \mathtt{\Omega}, \uparrow, \downarrow, ß, \text{˚}, !, \mathtt{v}, \mathtt{w}, 0, 1, 9$

New alphabets bold-italic, sans-serif-italic, and sans-serif-bold-italic.

mathbfit	$\boldsymbol{A}, \boldsymbol{B}, \boldsymbol{\Gamma}, \boldsymbol{\Delta}, \boldsymbol{\Theta}, \boldsymbol{\Lambda}, \boldsymbol{\Xi}, \boldsymbol{\Pi}, \boldsymbol{\Sigma}, \boldsymbol{\Phi}, \boldsymbol{\Psi}, \boldsymbol{\Omega}, \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\pi}, \boldsymbol{\nu}, \boldsymbol{\omega}, \boldsymbol{v}, \boldsymbol{w}, \mathbf{0}, \mathbf{1}, \mathbf{9}$
mathsfit	$\mathit{A}, \mathit{B}, \mathit{\Gamma}, \mathit{\Delta}, \mathit{\Theta}, \mathit{\Lambda}, \mathit{\Xi}, \mathit{\Pi}, \mathit{\Sigma}, \mathit{\Phi}, \mathit{\Psi}, \mathit{\Omega}, \mathit{\alpha}, \mathit{\beta}, \mathit{\pi}, \mathit{\nu}, \mathit{\omega}, \mathit{v}, \mathit{w}, 0, 1, 9$
mathsfbfit	$\boldsymbol{\mathit{A}}, \boldsymbol{\mathit{B}}, \boldsymbol{\mathit{\Gamma}}, \boldsymbol{\mathit{\Delta}}, \boldsymbol{\mathit{\Theta}}, \boldsymbol{\mathit{\Lambda}}, \boldsymbol{\mathit{\Xi}}, \boldsymbol{\mathit{\Pi}}, \boldsymbol{\mathit{\Sigma}}, \boldsymbol{\mathit{\Phi}}, \boldsymbol{\mathit{\Psi}}, \boldsymbol{\mathit{\Omega}}, \boldsymbol{\mathit{\alpha}}, \boldsymbol{\mathit{\beta}}, \boldsymbol{\mathit{\pi}}, \boldsymbol{\mathit{\nu}}, \boldsymbol{\mathit{\omega}}, \boldsymbol{\mathit{v}}, \boldsymbol{\mathit{w}}, \mathbf{0}, \mathbf{1}, \mathbf{9}$

Do the math alphabets match?

$ax\alpha\omega\boldsymbol{ax\alpha\omega}\mathsf{ax\alpha\omega}\quad\mathsf{TC\Theta\Gamma}\boldsymbol{\mathsf{TC\Theta\Gamma}}TC\Theta\Gamma$

12.2.2 Vector symbols

Alphabetic symbols for vectors are boldface italic, $\boldsymbol{\lambda} = \boldsymbol{e}_1 \cdot \boldsymbol{a}$, while numeric ones (e.g. the zero vector) are bold upright, $\boldsymbol{a} + \mathbf{0} = \boldsymbol{a}$.

12.2.3 Matrix symbols

Symbols for matrices are boldface italic, too:[1] $\boldsymbol{\Lambda} = \boldsymbol{E} \cdot \boldsymbol{A}$.

12.2.4 Tensor symbols

Symbols for tensors are sans-serif bold italic,

$$\boldsymbol{\mathsf{\alpha}} = \boldsymbol{\mathsf{e}} \cdot \boldsymbol{\mathsf{a}} \quad \Longleftrightarrow \quad \alpha_{ijl} = e_{ijk} \cdot a_{kl}.$$

The permittivity tensor describes the coupling of electric field and displacement:

$$\boldsymbol{D} = \epsilon_0 \boldsymbol{\mathsf{\epsilon}}_\mathrm{r} \boldsymbol{E}$$

[1] However, matrix symbols are usually capital letters whereas vectors are small ones. Exceptions are physical quantities like the force vector $\boldsymbol{F}$ or the electrical field $\boldsymbol{E}$.

12.2.5 Bold math version

The "bold" math version is selected with the commands `\boldmath` or `\mathversion{bold}`

mathnormal	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9$
mathit	$A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, ff, fi, ß, \circ, !, v, w, 0, 1, 9$
mathrm	$\mathrm{A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, ff, fi, ß, \circ, !, v, w, 0, 1, 9}$
mathbf	$\mathbf{A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, ff, fi, ß, \circ, !, v, w, 0, 1, 9}$
mathsf	$\mathsf{A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, ff, fi, ß, \circ, !, v, w, 0, 1, 9}$
mathtt	$\mathtt{A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \uparrow, \downarrow, ß, \circ, !, v, w, 0, 1, 9}$

New alphabets bold-italic, sans-serif-italic, and sans-serif-bold-italic.

mathbfit	$\boldsymbol{A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9}$
mathsfit	$\mathsf{A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9}$
mathsfbfit	$\mathsf{A, B, \Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Phi, \Psi, \Omega, \alpha, \beta, \pi, \nu, \omega, v, w, 0, 1, 9}$

Do the math alphabets match?

$ax\alpha\omega ax\alpha\omega ax\alpha\omega \quad TC\Theta\Gamma TC\Theta\Gamma TC\Theta\Gamma$

12.2.5.1 Vector symbols

Alphabetic symbols for vectors are boldface italic, $\boldsymbol{\lambda = e_1 \cdot a}$, while numeric ones (e.g. the zero vector) are bold upright, $\boldsymbol{a + 0 = a}$.

12.2.5.2 Matrix symbols

Symbols for matrices are boldface italic, too:[2] $\boldsymbol{\Lambda} = \boldsymbol{E} \cdot \boldsymbol{A}$.

12.2.5.3 Tensor symbols

Symbols for tensors are sans-serif bold italic,

$$\boldsymbol{\alpha} = \mathsf{e} \cdot \mathsf{a} \quad \Longleftrightarrow \quad \boldsymbol{\alpha}_{ijl} = \boldsymbol{e}_{ijk} \cdot \boldsymbol{a}_{kl}.$$

The permittivity tensor describes the coupling of electric field and displacement:

$$\boldsymbol{D} = \epsilon_0 \epsilon_\mathrm{r} \boldsymbol{E}$$

[2] However, matrix symbols are usually capital letters whereas vectors are small ones. Exceptions are physical quantities like the force vector $\boldsymbol{F}$ or the electrical field $\boldsymbol{E}$.

The verbatim LaTeX code of Sec. **??** is in List. **??**.

Listing 12.2: Sample LaTeX code for notations usage

```
1  % A teststring with Latin and Greek letters::
2  \newcommand{\teststring}{%
3  % capital Latin letters
4  % A,B,C,
5  A,B,
6  % capital Greek letters
7  %\Gamma,\Delta,\Theta,\Lambda,\Xi,\Pi,\Sigma,\Upsilon,\Phi,\Psi,
8  \Gamma,\Delta,\Theta,\Lambda,\Xi,\Pi,\Sigma,\Phi,\Psi,\Omega,
9  % small Greek letters
10 \alpha,\beta,\pi,\nu,\omega,
11 % small Latin letters:
12 % compare \nu, \omega, v, and w
13 v,w,
14 % digits
15 0,1,9
16 }
17
18
19 \subsection{Math alphabets}
20
21 If there are other symbols in place of Greek letters in a math
22 alphabet, it uses T1 or OT1 font encoding instead of OML.
23
24 \begin{eqnarray*}
25 \mbox{mathnormal} &  & \teststring \\
26 \mbox{mathit} &  & \mathit{\teststring}\\
27 \mbox{mathrm} &  & \mathrm{\teststring}\\
28 \mbox{mathbf} &  & \mathbf{\teststring}\\
29 \mbox{mathsf} &  & \mathsf{\teststring}\\
30 \mbox{mathtt} &  & \mathtt{\teststring}
31 \end{eqnarray*}
```

```
1397  32  New alphabets bold-italic, sans-serif-italic, and sans-serif-bold-
1398          italic.
1399  33  \begin{eqnarray*}
1400  34  \mbox{mathbfit}     &  & \mathbfit{\teststring}\\
1401  35  \mbox{mathsfit}     &  & \mathsfit{\teststring}\\
1402  36  \mbox{mathsfbfit} &  & \mathsfbfit{\teststring}
1403  37  \end{eqnarray*}
1404  38  %
1405  39  Do the math alphabets match?
1406  40
1407  41  $
1408  42  \mathnormal  {a x \alpha \omega}
1409  43  \mathbfit    {a x \alpha \omega}
1410  44  \mathsfbfit{a x \alpha \omega}
1411  45  \quad
1412  46  \mathsfbfit{T C \Theta \Gamma}
1413  47  \mathbfit    {T C \Theta \Gamma}
1414  48  \mathnormal  {T C \Theta \Gamma}
1415  49  $
1416  50
1417  51  \subsection{Vector symbols}
1418  52
1419  53  Alphabetic symbols for vectors are boldface italic,
1420  54  $\vec{\lambda}=\vec{e}_{1}\cdot\vec{a}$,
1421  55  while numeric ones (e.g. the zero vector) are bold upright,
1422  56  $\vec{a} + \vec{0} = \vec{a}$.
1423  57
1424  58  \subsection{Matrix symbols}
1425  59
1426  60  Symbols for matrices are boldface italic, too:%
1427  61  \footnote{However, matrix symbols are usually capital letters whereas
1428          vectors
1429  62  are small ones. Exceptions are physical quantities like the force
1430  63  vector $\vec{F}$ or the electrical field $\vec{E}$.%
```

```
}
$\matrixsym{\Lambda}=\matrixsym{E}\cdot\matrixsym{A}.$


\subsection{Tensor symbols}

Symbols for tensors are sans-serif bold italic,

\[
   \tensorsym{\alpha}  =  \tensorsym{e}\cdot\tensorsym{a}
   \quad \Longleftrightarrow \quad
   \alpha_{ijl}  =  e_{ijk}\cdot a_{kl}.
\]


The permittivity tensor describes the coupling of electric field and
displacement: \[
\vec{D}=\epsilon_{0}\tensorsym{\epsilon}_{\mathrm{r}}\vec{E}\]



\newpage
\subsection{Bold math version}

The ``bold'' math version is selected with the commands
\verb+\boldmath+ or \verb+\mathversion{bold}+

{\boldmath
   \begin{eqnarray*}
   \mbox{mathnormal} &  & \teststring \\
   \mbox{mathit} &  & \mathit{\teststring}\\
   \mbox{mathrm} &  & \mathrm{\teststring}\\
   \mbox{mathbf} &  & \mathbf{\teststring}\\
   \mbox{mathsf} &  & \mathsf{\teststring}\\
```

```
\mbox{mathtt} &  & \mathtt{\teststring}
\end{eqnarray*}
 New alphabets bold-italic, sans-serif-italic, and sans-serif-bold-
    italic.
\begin{eqnarray*}
\mbox{mathbfit}     &  & \mathbfit{\teststring}\\
\mbox{mathsfit}     &  & \mathsfit{\teststring}\\
\mbox{mathsfbfit} &  & \mathsfbfit{\teststring}
\end{eqnarray*}
%
Do the math alphabets match?

$
\mathnormal  {a x \alpha \omega}
\mathbfit    {a x \alpha \omega}
\mathsfbfit{a x \alpha \omega}
\quad
\mathsfbfit{T C \Theta \Gamma}
\mathbfit    {T C \Theta \Gamma}
\mathnormal  {T C \Theta \Gamma}
$

\subsection{Vector symbols}

Alphabetic symbols for vectors are boldface italic,
$\vec{\lambda}=\vec{e}_{1}\cdot\vec{a}$,
while numeric ones (e.g. the zero vector) are bold upright,
$\vec{a} + \vec{0} = \vec{a}$.




\subsection{Matrix symbols}
```

```
Symbols for matrices are boldface italic, too:%
\footnote{However, matrix symbols are usually capital letters whereas vectors
are small ones. Exceptions are physical quantities like the force vector $\vec{F}$ or the electrical field $\vec{E}$.%
}
$\matrixsym{\Lambda}=\matrixsym{E}\cdot\matrixsym{A}.$


\subsection{Tensor symbols}

Symbols for tensors are sans-serif bold italic,

\[
    \tensorsym{\alpha}  =  \tensorsym{e}\cdot\tensorsym{a}
    \quad \Longleftrightarrow \quad
    \alpha_{ijl}  =  e_{ijk}\cdot a_{kl}.
\]

The permittivity tensor describes the coupling of electric field and displacement: \[
\vec{D}=\epsilon_{0}\tensorsym{\epsilon}_{\mathrm{r}}\vec{E}\]
}
```

12.3 Abbreviation

This section shows examples of the use of LaTeXcommands in conjunction with the items that are in the `abbreviation.tex` and in the `glossary.tex` files. Please see List. **??**. **To lessen the LaTeX parsing time, it is suggested that you use `\acr{ }` only for the first occurrence of the word to be abbreviated.**

Again please see List. **??**. Here is an example of first use: alternating current (ac). Next use: ac. Full: alternating current (ac). Here's an acronym referenced using `\acr` : hyper-text markup language (html). And here it is again: html. If you are used to the `glossaries` package, note the difference in using `\gls` : hyper-text markup language (html). And again (no difference): hyper-text markup language (html). For plural use `\glspl` . Here are some more entries:

- extensible markup language (xml) and cascading style sheet (css).
- Next use: xml and css.
- Full form: extensible markup language (xml) and cascading style sheet (css).
- Reset again.
- Start with a capital. Hyper-text markup language (html).
- Next: Html. Full: Hyper-text markup language (html).
- Prefer capitals? Extensible markup language (XML). Next: XML. Full: extensible markup language (XML).

- Prefer small-caps? Cascading style sheet (CSS). Next: CSS. Full: cascading style sheet (CSS).
- Resetting all acronyms.
- Here are the acronyms again:
- Hyper-text markup language (HTML), extensible markup language (XML) and cascading style sheet (CSS).
- Next use: HTML, XML and CSS.
- Full form: Hyper-text markup language (HTML), extensible markup language (XML) and cascading style sheet (CSS).
- Provide your own link text: style sheet.

The verbatim LaTeX code of Sec. **??** is in List. **??**.

Listing 12.3: Sample LaTeX code for abbreviations usage

```
Again please see List.~\ref{lst:abbrv}. Here is an example of first use:
    \acr{ac}. Next use: \acr{ac}. Full: \gls{ac}.  Here's an acronym
   referenced using \verb| \acr |: \acr{html}.  And here it is again: \
   acr{html}. If you are used to the \texttt{glossaries} package, note
   the difference in using \verb| \gls |: \gls{html}. And again (no
   difference): \gls{html}. Here are some more entries:

\begin{itemize}

   \item \acr{xml} and \acr{css}.

   \item Next use: \acr{xml} and \acr{css}.

   \item Full form: \gls{xml} and \gls{css}.

   \item Reset again. \glsresetall{abbreviation}

   \item Start with a capital. \Acr{html}.

   \item Next: \Acr{html}. Full: \Gls{html}.

   \item Prefer capitals? \renewcommand{\acronymfont}[1]{\
      MakeTextUppercase{#1}} \Acr{xml}. Next: \acr{xml}. Full: \gls{xml
      }.

   \item Prefer small-caps? \renewcommand{\acronymfont}[1]{\textsc{#1}}
      \Acr{css}. Next: \acr{css}. Full: \gls{css}.

   \item Resetting all acronyms.\glsresetall{abbreviation}

   \item Here are the acronyms again:

   \item \Acr{html}, \acr{xml} and \acr{css}.

   \item Next use: \Acr{html}, \acr{xml} and \acr{css}.

   \item Full form: \Gls{html}, \gls{xml} and \gls{css}.

   \item Provide your own link text: \glslink{[textbf]css}{style}

\end{itemize}
```

12.4 Glossary

This section shows examples of the use of `\gls{ }` commands in conjunction with the items that are in the `glossary.tex` and `notation.tex` files. Note that entries in `notation.tex` are prefixed with "`not:`" label (see List. **??**).

Please make sure that the entries in `notation.tex` are those that are referenced in the LaTeX document files used by this Capstone Project on Operational Technologies. Please comment out unused notations and be careful with the commas and brackets in `notation.tex` .

- are usually denoted by a bold capital letter, such as $\boldsymbol{A}$. The 's (i, j)th element is usually denoted a_{ij}. $\mathbf{I}$ is the identity .
- A set, denoted as $\mathcal{S}$, is a collection of objects.
- The universal set, denoted as $\mathcal{U}$, is the set of everything.
- The empty set, denoted as $\emptyset$, contains no elements.
- is seen as the study of complete normed vector spaces, i.e., Banach spaces.
- The cardinality of a set, denoted as $|\mathcal{S}|$, is the number of elements in the set.

The verbatim LaTeX code for the part of Sec. **??** is in List. **??**.

Listing 12.4: Sample LaTeX code for glossary and notations usage

```
\begin{itemize}

   \item \Glspl{matrix} are usually denoted by a bold capital letter,
       such as $\mathbfit{A}$. The \gls{matrix}'s $(i,j)$th element is
       usually denoted $a_{ij}$. \Gls{matrix} $\mathbf{I}$ is the
       identity \gls{matrix}.

   \item A set, denoted as \gls{not:set}, is a collection of objects.

   \item The universal set,  denoted as \gls{not:universalSet}, is the
       set of everything.

   \item The empty set, denoted as \gls{not:emptySet}, contains no
       elements.

   \item \Gls{Functional Analysis} is seen as the study of complete
       normed vector spaces, i.e., Banach spaces.

   \item The cardinality of a set, denoted as \gls{not:cardinality}, is
       the number of elements in the set.

\end{enumerate}
```

12.5 Figure

This section shows several ways of placing figures. PDFLaTeX compatible files are PDF, PNG, and JPG. Please see the `figure` subdirectory.

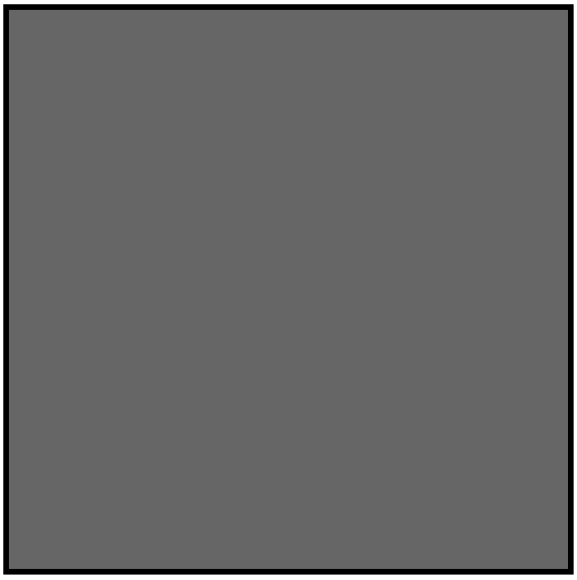
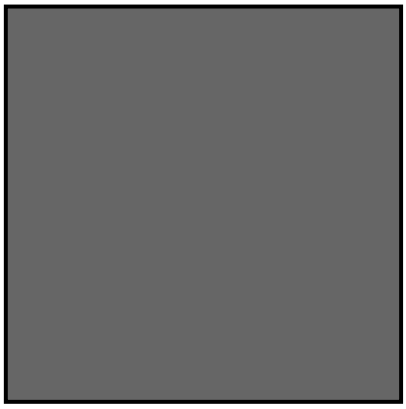


Fig. 12.1 A quadrilateral image example.

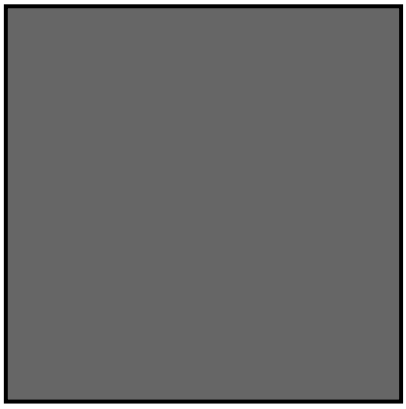
Fig. **??** is a gray box enclosed by a dark border. List. **??** shows the corresponding LaTeX code.

Listing 12.5: Sample LaTeX code for a single figure

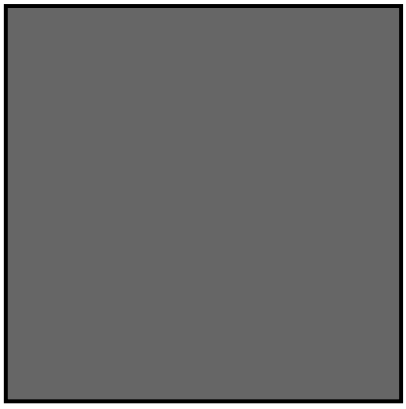
```
\begin{figure}[!htbp]
   \centering
      \includegraphics[width=0.5\textwidth]{example}
   \caption{A quadrilateral image example.}
   \label{fig:example}
\end{figure}
\cleardoublepage

Fig.~\ref{fig:example} is a gray box enclosed by a dark border. List.~\
   ref{lst:onefig} shows the corresponding \LaTeX \ code.
\end{figure}
```



(a) A sub-figure in the top row.



(b) A sub-figure in the middle row.

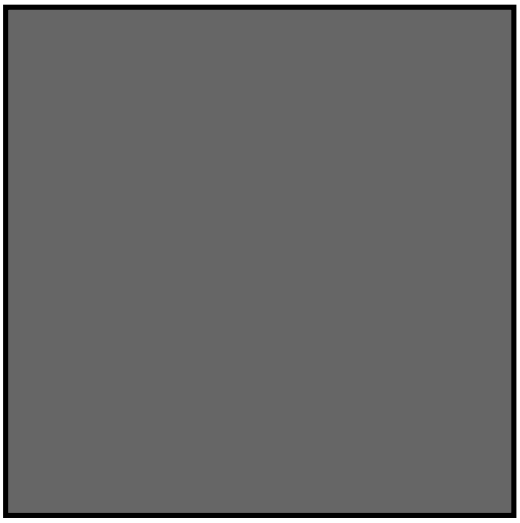


(c) A sub-figure in the bottom row.

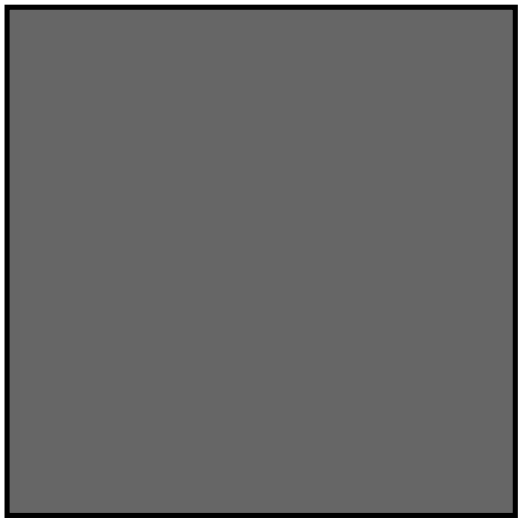
Fig. 12.2 Figures on top of each other. See List. **??** for the corresponding LaTeX code.

Listing 12.6: Sample LaTeX code for three figures on top of each other

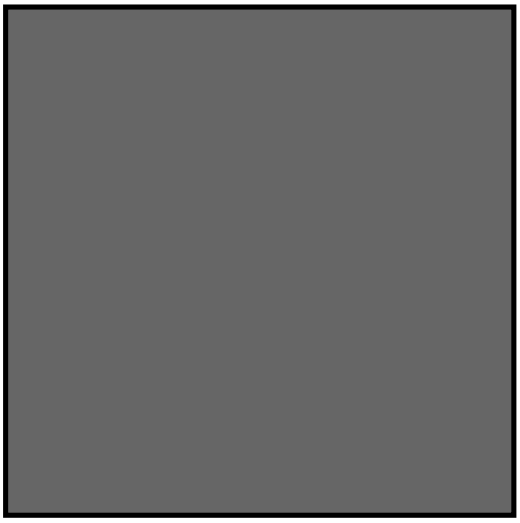
```
\begin{figure}[!htbp]
\centering
\subbottom[A sub-figure in the top row.]{
\includegraphics[width=0.35\textwidth]{example_gray_box}
\label{fig:top}
}
\vfill
\subbottom[A sub-figure in the middle row.]{
\includegraphics[width=0.35\textwidth]{example_gray_box}
\label{fig:mid}
}
\vfill
\subbottom[A sub-figure in the bottom row.]{
\includegraphics[width=0.35\textwidth]{example_gray_box}
\label{fig:botm}
}
\caption{Figures on top of each other}
\label{fig:tmb}
\end{figure}
```



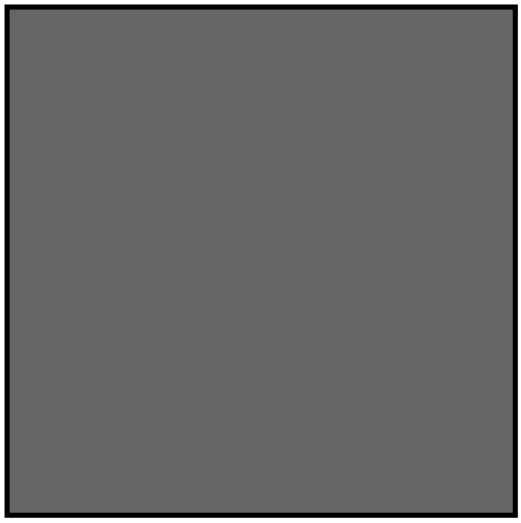
(a) A sub-figure in the upper-left corner.



(b) A sub-figure in the upper-right corner.



(c) A sub-figure in the lower-left corner.



(d) A sub-figure in the lower-right corner

Fig. 12.3 Four figures in each corner. See List. **??** for the corresponding LaTeX code.

Listing 12.7: Sample LaTeX code for the four figures

```
\begin{figure}[!htbp]
\centering
\subbottom[A sub-figure in the upper-left corner.]{
\includegraphics[width=0.45\textwidth]{example_gray_box}
\label{fig:upprleft}
}
\hfill
\subbottom[A sub-figure in the upper-right corner.]{
\includegraphics[width=0.45\textwidth]{example_gray_box}
\label{fig:uppright}
}
\vfill
\subbottom[A sub-figure in the lower-left corner.]{
\includegraphics[width=0.45\textwidth]{example_gray_box}
\label{fig:lowerleft}
}
\hfill
\subbottom[A sub-figure in the lower-right corner]{
\includegraphics[width=0.45\textwidth]{example_gray_box}
\label{fig:lowright}
}
\caption{Four figures in each corner. See List.~\ref{lst:fourfigs} for
    the corresponding \LaTeX \ code.}
\label{fig:fourfig}
\end{figure}
```

12.6 Table

This section shows an example of placing a table (a long one). Table **??** are the triples.

TABLE 12.1 FEASIBLE TRIPLES FOR HIGHLY VARIABLE GRID

Time (s)	Triple chosen	Other feasible triples
0	(1, 11, 13725)	(1, 12, 10980), (1, 13, 8235), (2, 2, 0), (3, 1, 0)
2745	(1, 12, 10980)	(1, 13, 8235), (2, 2, 0), (2, 3, 0), (3, 1, 0)
5490	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
8235	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
10980	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
13725	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
16470	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
19215	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
21960	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
24705	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
27450	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
30195	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
32940	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
35685	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
38430	(1, 13, 10980)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
41175	(1, 12, 13725)	(1, 13, 10980), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
43920	(1, 13, 10980)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
46665	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
49410	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
52155	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
54900	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
57645	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
60390	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
63135	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
65880	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
68625	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)

Continued on next page

Continued from previous page

Time (s)	Triple chosen	Other feasible triples
71370	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
74115	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
76860	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
79605	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
82350	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
85095	(1, 12, 13725)	(1, 13, 10980), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
87840	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
90585	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
93330	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
96075	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
98820	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
101565	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
104310	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
107055	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
109800	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
112545	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
115290	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
118035	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
120780	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
123525	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
126270	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
129015	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
131760	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
134505	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
137250	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
139995	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
142740	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
145485	(1, 12, 16470)	(1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1, 0)
148230	(2, 2, 2745)	(2, 3, 0), (3, 1, 0)
150975	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
153720	(1, 12, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
156465	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)

Continued on next page

Continued from previous page

Time (s)	Triple chosen	Other feasible triples
159210	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
161955	(1, 13, 16470)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)
164700	(1, 13, 13725)	(2, 2, 2745), (2, 3, 0), (3, 1, 0)

List. **??** shows the corresponding LaTeX code.

Listing 12.8: Sample LaTeX code for making typical table environment

```
\begin{center}
{\scriptsize
\begin{tabularx}{\textwidth}{p{0.1\textwidth}|p{0.2\textwidth}|p{0.5\textwidth}}
\caption{Feasible triples for highly variable grid} \label{tab:triple_grid} \\
\hline
\hline
\textbf{Time (s)} &
\textbf{Triple chosen} &
\textbf{Other feasible triples} \\
\hline
\endfirsthead
\multicolumn{3}{c}%
{\textit{Continued from previous page}} \\
\hline
\hline
\textbf{Time (s)} &
\textbf{Triple chosen} &
\textbf{Other feasible triples} \\
\hline
\endhead
\hline
\multicolumn{3}{r}{\textit{Continued on next page}} \\
\endfoot
\hline
\endlastfoot
\hline

0 & (1, 11, 13725) & (1, 12, 10980), (1, 13, 8235), (2, 2, 0), (3, 1, 0) \\
```

```
29 2745 & (1, 12, 10980) & (1, 13, 8235), (2, 2, 0), (2, 3, 0), (3, 1, 0)
       \\
30 5490 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
31 8235 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
       0) \\
32 10980 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
        0) \\
33 13725 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
        0) \\
34 16470 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
35 19215 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
        0) \\
36 21960 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
        0) \\
37 24705 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
        0) \\
38 27450 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
        0) \\
39 30195 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
40 32940 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
41 35685 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
42 38430 & (1, 13, 10980) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
43 41175 & (1, 12, 13725) & (1, 13, 10980), (2, 2, 2745), (2, 3, 0), (3, 1,
        0) \\
44 43920 & (1, 13, 10980) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
45 46665 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
46 49410 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
47 52155 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3, 1,
        0) \\
48 54900 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
49 57645 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
50 60390 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
51 63135 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
52 65880 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
```

```
1645    53 | 68625 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1646    54 | 71370 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1647    55 | 74115 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1648    56 | 76860 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1649    57 | 79605 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1650    58 | 82350 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1651    59 | 85095 & (1, 12, 13725) & (1, 13, 10980), (2, 2, 2745), (2, 3, 0), (3, 1,
1652       |      0) \\
1653    60 | 87840 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1654    61 | 90585 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1655    62 | 93330 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1656    63 | 96075 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1657    64 | 98820 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1658    65 | 101565 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1659    66 | 104310 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1660    67 | 107055 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1661    68 | 109800 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1662    69 | 112545 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3,
1663       |     1, 0) \\
1664    70 | 115290 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1665    71 | 118035 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1666    72 | 120780 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1667    73 | 123525 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1668    74 | 126270 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3,
1669       |     1, 0) \\
1670    75 | 129015 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1671    76 | 131760 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1672    77 | 134505 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1673    78 | 137250 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
1674    79 | 139995 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1675    80 | 142740 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
1676    81 | 145485 & (1, 12, 16470) & (1, 13, 13725), (2, 2, 2745), (2, 3, 0), (3,
1677       |     1, 0) \\
1678    82 | 148230 & (2, 2, 2745) & (2, 3, 0), (3, 1, 0) \\
```

```
150975 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
153720 & (1, 12, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
156465 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
159210 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
161955 & (1, 13, 16470) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
164700 & (1, 13, 13725) & (2, 2, 2745), (2, 3, 0), (3, 1, 0) \\
\end{tabularx}
}
\end{center}
```

12.7 Algorithm or Pseudocode Listing

Table **??** shows an example pseudocode. Note that if the pseudocode exceeds one page, it can mean that its implementation is not modular. List. **??** shows the corresponding LaTeX code.

TABLE 12.2 CALCULATION OF $y = x^n$

Input(s):		
n	:	nth power; $n \in \mathbb{Z}^+$
x	:	base value; $x \in \mathbb{R}^+$
Output(s):		
y	:	result; $y \in \mathbb{R}^+$

Require: $n \geq 0 \vee x \neq 0$
Ensure: $y = x^n$
1: $y \Leftarrow 1$
2: **if** $n < 0$ **then**
3: $X \Leftarrow 1/x$
4: $N \Leftarrow -n$
5: **else**
6: $X \Leftarrow x$
7: $N \Leftarrow n$
8: **end if**
9: **while** $N \neq 0$ **do**
10: **if** N is even **then**
11: $X \Leftarrow X \times X$
12: $N \Leftarrow N/2$
13: **else** $\{N$ is odd$\}$
14: $y \Leftarrow y \times X$
15: $N \Leftarrow N - 1$
16: **end if**
17: **end while**

Listing 12.9: Sample LaTeX code for algorithm or pseudocode listing usage

```
\begin{table}[!htbp]
   \caption{Calculation of $y = x^n$}
   \label{tab:calcxn}
   {\footnotesize
   \begin{tabular}{lll}
   \hline
   \hline
   {\bfseries Input(s):} & & \\
   $n$ & : & $n$th power; $n \in \mathbb{Z}^{+}$ \\
   $x$ & : & base value; $x \in \mathbb{R}^{+}$ \\
   \hline
   {\bfseries Output(s):} & & \\
   $y$ & : & result; $y \in \mathbb{R}^{+}$  \\
   \hline
   \hline
   \\
   \end{tabular}
   }
   \begin{algorithmic}[1]
   {\footnotesize
      \REQUIRE $n \geq 0 \vee x \neq 0$
      \ENSURE $y = x^n$
      \STATE $y \Leftarrow 1$
      \IF{$n < 0$}
            \STATE $X \Leftarrow 1 / x$
            \STATE $N \Leftarrow -n$
      \ELSE
            \STATE $X \Leftarrow x$
            \STATE $N \Leftarrow n$
      \ENDIF
      \WHILE{$N \neq 0$}
            \IF{$N$ is even}
                  \STATE $X \Leftarrow X \times X$
                  \STATE $N \Leftarrow N / 2$
            \ELSE[$N$ is odd]
                  \STATE $y \Leftarrow y \times X$
                  \STATE $N \Leftarrow N - 1$
            \ENDIF
      \ENDWHILE
   }
   \end{algorithmic}
\end{table}
```

12.8 Program/Code Listing

List. **??** is a program listing of a C code for computing Fibonacci numbers by calling the actual code. Please see the `code` subdirectory.

List. **??** shows the corresponding LaTeX code.

Listing 12.10: Computing Fibonacci numbers in C (./code/fibo.c)

```
/* fibo.c -- It prints out the first N Fibonacci
 *           numbers.
 */

#include <stdio.h>

int main(void) {
    int n;        /* Number of fibonacci numbers we will print */
    int i;        /* Index of fibonacci number to be printed next */
    int current;  /* Value of the (i)th fibonacci number */
    int next;     /* Value of the (i+1)th fibonacci number */
    int twoaway;  /* Value of the (i+2)th fibonacci number */

    printf("How many Fibonacci numbers do you want to compute? ");
    scanf("%d", &n);
    if (n<=0)
       printf("The number should be positive.\n");
    else {
      printf("\n\n\tI \t Fibonacci(I) \n\t====================\n");
      next = current = 1;
      for (i=1; i<=n; i++) {
   printf("\t%d \t\t\t%d\n", i, current);
   twoaway = current+next;
   current = next;
   next    = twoaway;
      }
    }
}

/* The output from a run of this program was:

How many Fibonacci numbers do you want to compute? 9

   I   Fibonacci(I)
   ====================
   1      1
   2      1
   3      2
   4      3
   5      5
   6      8
   7      13
   8      21
   9      34

*/
```

Listing 12.11: Sample LaTeX code for program listing

```
List.~\ref{lst:fib_c} is a program listing of a C code for computing
    Fibonacci numbers by calling the actual code. Please see the \verb|
    code | subdirectory.
```

12.9 Referencing

Referencing chapters: This appendix is in Appendix **??**, which is about examples in using various LaTeX commands.

Referencing sections: This section is Sec. **??**, which shows how to refer to the locations of various labels that have been placed in the LaTeX files. List. **??** shows the corresponding LaTeX code.

Listing 12.12: Sample LaTeX code for referencing sections

```
Referencing sections: This section is Sec.~\ref{sec:ref}, which shows
    how to refer to the locations of various labels that have been
    placed in the \LaTeX \ files. List.~\ref{lst:refsec} shows the
    corresponding \LaTeX \ code.
```

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

12.9.1 A subsection

Referencing subsections: This section is Sec. **??**, which shows how to refer to a subsection. List. **??** shows the corresponding LaTeX code.

Listing 12.13: Sample LaTeX code for referencing subsections

```
Referencing subsections: This section is Sec.~\ref{sec:subsec}, which
    shows how to refer to a subsection. List.~\ref{lst:refsub} shows the
     corresponding \LaTeX \ code.
```

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

12.9.1.1 A sub-subsection

Referencing sub-subsections: This section is Sec. **??**, which shows how to refer to a sub-subsection. List. **??** shows the corresponding LaTeX code.

Listing 12.14: Sample LaTeX code for referencing sub-subsections

```
Referencing sub-subsections: This section is Sec.~\ref{sec:subsubsec},
    which shows how to refer to a sub-subsection. List.~\ref{lst:
    refsubsub} shows the corresponding \LaTeX \ code.
```

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

12.10 Citing

Citing bibliography content is done using BibTeX. It requires the creation of a BibTeX file (.bib extension name), and then added in the argument of `\bibliography{ }` . For each .bib file, separate them by a comma in the argument of `\bibliography{ }` without the extension name. Building your BibTeX file (references.bib) can be done easily with a tool called JabRef (www.jabref.org).

The following subsections are examples of citations.

12.10.1 Books

- [‘Chicago’, 1982]
- [Aristotle, 1877]
- [Aristotle, 1907]
- [Aristotle, 1968]
- [Aristotle, 1929]
- [ABCM, 1959]
- [Augustine, 1995]
- [Averroes, 1982]
- [Butcher, 1981]
- [Chapman, 1975]

- [Cicero, 1995]
- [Coleridge, 1983]
- [Cotton et al., 1999]
- [**?**]
- [**?**]
- [**?**]
- [Gerhardt, 2000]
- [Gonzalez, 2001]
- [Goossens et al., 1994]
- [Hammond, 1997]
- [Hershkovitz, 1962]
- [Hoel, 1971a]
- [Homer, 2004]
- [Knuth, 1981a]
- [Knuth, 1981b]
- [Knuth, 1973a]
- [Kullback, 1997a]

- [Kullback, 1997b]
- [Kullback, 1959]
- [Malinowski, 1972]
- [Maron, 2000]
- [Massa, 2004]
- [McColvin, 2004]
- [Nietzsche, 1988b]
- [Nietzsche, 1988a]
- [Oetiker et al., 2014]
- [Piccato, 2001]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [Lipcoll et al., 1977]

12.10.2 Booklets

- [Knvth, 1988]

12.10.3 Proceedings

- [Oz and Yannakakis, 1983]

12.10.4 In books

- [**?**]
- [BSI, 1973a]
- [Eckstein and Zuckermann, 1960]
- [Feigl, 1958]
- [Gordon, 1975]
- [Hanson, 1967]
- [Hoel, 1971b]
- [Hyman, 1981]
- [Kant, 1968a]
- [Kant, 1968b]
- [Knuth, 1973b]
- [Knuth, 1973c]

- [Lincoll, 1977a]
- [Lincoll, 2004]
- [Lincoll, 1977b]
- [McNeill, 1963]
- [Milton, 1924]
- [Nietzsche, 1988c]
- [Ogilvy, 1965]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [**?**]

12.10.5 In proceedings

- [Chave, 1964]
- [Chomsky, 1973]

- [Moraux, 1979]
- [Oaho et al., 1983a]
- [Oaho et al., 2004]
- [Oaho et al., 1983b]
- [**?**]

12.10.6 Journals

- [Aamport, 2004]
- [Aamport, 1986a]
- [Aamport, 1986b]
- [Aksın et al., 2006]
- [Angenendt, 2002]
- [Aslin, 1949]
- [Baez and Lauda, 2004a]
- [Bertram and Wentworth, 1996]
- [Bry and Afflerbach, 1968]
- [Doody, 1974]
- [Einstein, 1905]

- [Fletcher and Hopkins, 1907]
- [Gillies, 1933]
- [Glashow, 1961]
- [Godfrey, 1959]
- [Hanlon, 1972]
- [Heller and Lederis, 1958]
- [Herrmann et al., 2006]
- [Hostetler et al., 1998]
- [Howells, 1966a]
- [Howells, 1966b]
- [Howells, 1951]
- [ISO, 2009]
- [Jackson, 1979]
- [Johnson, 1974]
- [Moore, 1998]
- [Moore, 1965]
- [**?**]

- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [GAJ, 1986]

12.10.7 Theses/dissertations

- [Croft, 1978]
- [Maguire, 1976]
- [Mann, 1968]
- [Masterly, 1988a]
- [Masterly, 1988b]
- [Phony-Baloney, 1988a]
- [Phony-Baloney, 1988b]

12.10.8 Technical Reports and Others

- ['Brunswick', 1985]
- [BSI, 1983]
- [BSI, 1978]
- [BSI, 1976]
- [BSI, 1973b]
- [Ellis and Walton, 1971]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [**?**]
- [Downes, 1974]
- [Exchequer, 1639]
- [**?**]
- [**?**]

12.10.9 Miscellaneous

- [Almendro et al., 1998]
- [Baez and Lauda, 2004b]
- [Chiu and Chow, 1978]
- [Itzhaki, 1996]
- [Kowalik and Isard, 1995]
- [Laufenberg et al., 2006]
- [Loh, 1992]
- [Markey, 2005]
- [Missilany, 1984]
- [Padhye et al., 1999]
- [**?**]
- [**?**]
- [Missilany, 2004]

12.11 Index

For key words or topics that are expected (or the user would like) to appear in the Index, use `index{key}`, where `key` is an example keyword to appear in the Index. For example, Fredholm integral and Fourier operator of the following paragraph are in the Index.

If we make a very large matrix with complex exponentials in the rows (i.e., cosine real parts and sine imaginary parts), and increase the resolution without bound, we approach the kernel of the Fredholm integral equation of the 2nd kind, namely the Fourier operator that defines the continuous Fourier transform.

List. **??** is a program listing of the above-mentioned paragraph.

Listing 12.15: Sample LaTeX code for Index usage

```
If we make a very large matrix with complex exponentials in the rows (i.
    e., cosine real parts and sine imaginary parts), and increase the
    resolution without bound, we approach the kernel of the \index{
    Fredholm integral} Fredholm integral equation of the 2nd kind,
    namely the \index{Fourier} Fourier operator that defines the
    continuous Fourier transform.
```

12.12 Adding Relevant PDF Pages

Examples of such PDF pages are Standards, Datasheets, Specification Sheets, Application Notes, etc. Selected PDF pages can be added (see List. **??**), but note that the options must be tweaked. See the manual of `pdfpages` for other options.

Listing 12.16: Sample LaTeX code for including PDF pages

```
\includepdf[pages={8-10},%
offset=3.5mm -10mm,%
scale=0.73,%
frame,%
pagecommand={},]
{./reference/Xilinx2015-UltraScale-Architecture-Overview.pdf}
```

1914

Virtex UltraScale FPGA Feature Summary

Table 6: **Virtex UltraScale FPGA Feature Summary**

	VU065	VU080	VU095	VU125	VU160	VU190	VU440
Logic Cells	626,640	780,000	940,800	1,253,280	1,621,200	1,879,920	4,432,680
CLB Flip-Flops	716,160	891,424	1,075,200	1,432,320	1,852,800	2,148,480	5,065,920
CLB LUTs	358,080	445,712	537,600	716,160	926,400	1,074,240	2,532,960
Maximum Distributed RAM (Mb)	4.8	3.9	4.8	9.7	12.7	14.5	28.7
Block RAM/FIFO w/ECC (36Kb each)	1,260	1,421	1,728	2,520	3,276	3,780	2,520
Total Block RAM (Mb)	44.3	50.0	60.8	88.6	115.2	132.9	88.6
CMT (1 MMCM, 2 PLLs)	10	16	16	20	30	30	30
I/O DLLs	40	64	64	80	120	120	120
Fractional PLLs	5	8	8	10	15	15	0
Maximum HP I/Os(1)	468	780	780	780	650	650	1,404
Maximum HR I/Os(2)	52	52	52	104	52	52	52
DSP Slices	600	672	768	1,200	1,560	1,800	2,880
System Monitor	1	1	1	2	3	3	3
PCIe Gen3 x8	2	4	4	4	5	6	6
150G Interlaken	3	6	6	6	8	9	0
100G Ethernet	3	4	4	6	9	9	3
GTH 16.3Gb/s Transceivers	20	32	32	40	52	60	48
GTY 30.5Gb/s Transceivers	20	32	32	40	52	60	0

Notes:
1. HP = High-performance I/O with support for I/O voltage from 1.0V to 1.8V.
2. HR = High-range I/O with support for I/O voltage from 1.2V to 3.3V.

1915

Virtex UltraScale Device-Package Combinations and Maximum I/Os

Table 7: **Virtex UltraScale Device-Package Combinations and Maximum I/Os**

Package[1][2][3]	Package Dimensions (mm)	VU065	VU080	VU095	VU125	VU160	VU190	VU440
		HR, HP GTH, GTY	HR, HP GTH, GTY	HR, HP GTH, GTY	HR, HP GTH, GTY	HR, HP GTH, GTY	HR, HP GTH, GTY	HR, HP GTH, GTY
FFVC1517	40x40	52, 468 20, 20	52, 468 20, 20	52, 468 20, 20				
FFVD1517	40x40		52, 286 32, 32	52, 286 32, 32				
FLVD1517	40x40				52, 286 40, 32			
FFVB1760	42.5x42.5		52, 650 32, 16	52, 650 32, 16				
FLVB1760	42.5x42.5				52, 650 36, 16			
FFVA2104	47.5x47.5		52, 780 28, 24	52, 780 28, 24				
FLVA2104	47.5x47.5				52, 780 28, 24			
FFVB2104	47.5x47.5		52, 650 32, 32	52, 650 32, 32				
FLVB2104	47.5x47.5				52, 650 40, 36			
FLGB2104	47.5x47.5					52, 650 40, 36	52, 650 40, 36	
FFVC2104	47.5x47.5			52, 364 32, 32				
FLVC2104	47.5x47.5				52, 364 40, 40			
FLGC2104	47.5x47.5					52, 364 52, 52	52, 364 52, 52	
FLGB2377	50x50							52, 1248 36, 0
FLGA2577	52.5x52.5						0, 448 60, 60	
FLGA2892	55x55							52, 1404 48, 0

Notes:

1. Go to Ordering Information for package designation details.
2. All packages have 1.0mm ball pitch.
3. Packages with the same last letter and number sequence, e.g., A2104, are footprint compatible with all other UltraScale architecture-based devices with the same sequence. The footprint compatible devices within this family are outlined. See the UltraScale Architecture Product Selection Guide for details on inter-family migration.

Virtex UltraScale+ FPGA Feature Summary

Table 8: **Virtex UltraScale+ FPGA Feature Summary**

	VU3P	VU5P	VU7P	VU9P	VU11P	VU13P
Logic Cells	689,640	1,051,010	1,379,280	2,068,920	2,147,040	2,862,720
CLB Flip-Flops	788,160	1,201,154	1,576,320	2,364,480	2,453,760	3,271,680
CLB LUTs	394,080	600,577	788,160	1,182,240	1,226,880	1,635,840
Max. Distributed RAM (Mb)	12.0	18.3	24.1	36.1	34.8	46.4
Block RAM/FIFO w/ECC (36Kb each)	720	1,024	1,440	2,160	2,016	2,688
Block RAM (Mb)	25.3	36.0	50.6	75.9	70.9	94.5
UltraRAM Blocks	320	470	640	960	1,152	1,536
UltraRAM (Mb)	90.0	132.2	180.0	270.0	324.0	432.0
CMTs (1 MMCM and 2 PLLs)	10	20	20	30	12	16
Max. HP I/O(1)	520	832	832	832	624	832
DSP Slices	2,280	3,474	4,560	6,840	8,928	11,904
System Monitor	1	2	2	3	3	4
GTY Transceivers 32.75Gb/s	40	80	80	120	96	128
PCIe Gen3 x16 and Gen4 x8	2	4	4	6	3	4
150G Interlaken	3	4	6	9	9	12
100G Ethernet w/RS-FEC	3	4	6	9	6	8

Notes:
1. HP = High-performance I/O with support for I/O voltage from 1.0V to 1.8V.

Virtex UltraScale+ Device-Package Combinations and Maximum I/Os

Table 9: **Virtex UltraScale+ Device-Package Combinations and Maximum I/Os**

Package (1)(2)(3)	Package Dimensions (mm)	VU3P	VU5P	VU7P	VU9P	VU11P	VU13P
		HP, GTY	HP, GTY	HP, GTY	HP, GTY	HP, GTY	HP, GTY
FFVC1517	40x40	520, 40					
FLVF1924	45x45					624, 64	
FLVA2104	47.5x47.5		832, 52	832, 52	832, 52		
FHVA2104	52.5x52.5(4)						832, 52
FLVB2104	47.5x47.5		702, 76	702, 76	702, 76	624, 76	
FHVB2104	52.5x52.5(4)						702, 76
FLVC2104	47.5x47.5		416, 80	416, 80	416, 104	416, 96	
FHVC2104	52.5x52.5(4)						416, 104
FLVA2577	52.5x52.5				448, 120	448, 96	448, 128

Notes:
1. Go to Ordering Information for package designation details.
2. All packages have 1.0mm ball pitch.
3. Packages with the same last letter and number sequence, e.g., A2104, are footprint compatible with all other UltraScale devices with the same sequence. The footprint compatible devices within this family are outlined.
4. These 52.5x52.5mm overhang packages have the same PCB ball footprint as the corresponding 47.5x47.5mm packages (i.e., the same last letter and number sequence) and are footprint compatible.

Chapter 13

VITA

Nathan Raekel L. Calaguian is a BS CPE student from De La Salle University Manila.

Gerald Antonio P. Ellar is a BS CPE student from De La Salle University Manila.

Hans Jamee Mahait is a BS CPE student from De La Salle University Manila.

Chapter 14

ARTICLE PAPER(S)