

# Bachelor Thesis Review

Faculty of Mathematics and Physics, Charles University

<b>Thesis author</b>	Walter Herold Veedla	
<b>Thesis title</b>	Automatic analysis of squash straight drives accuracy from a single camera view	
<b>Year submitted</b>	2023	
<b>Study program</b>	Computer Science	
<b>Specialization</b>	Artificial Intelligence	
<b>Review author</b>	Mgr. Matúš Goliaš	Reviewer
<b>Department</b>	Department of Software and Computer Science Education	

**Overall** good    OK    poor    insufficient

Assignment difficulty		X		
Assignment fulfilled		X		
Total size <i>... text and code, overall workload</i>		X		

The thesis assignment aims to develop an application for analysing straight drives in squash from a single static camera. It includes ball tracking and the detection of the ball's contact with the floor. Squash players can use such an application to estimate the accuracy of their straight drives for improvement. Further, the problem of object tracking in video, especially in real-time, still needs to be solved, which makes the topic well-suited for a thesis.

The student completed the assignment by creating an easy-to-use application that requires a video with several limitations described in the text. The thesis proposes an adequate solution to the straight drive accuracy sub-problem in squash automated analysis. The application works with smartphone recordings which makes it usable by virtually anyone. I also have to commend the student for creating a video annotation system and for annotating data used in the thesis himself, even though it introduces bias into the evaluation.

Overall, the thesis is of high quality; however, I have several remarks regarding the text and its structure, described in the next part of the review.

**Thesis Text** good    OK    poor    insufficient

Form <i>... language, typography, references</i>		X	X	
Structure <i>... context, goals, analysis, design, evaluation, level of detail</i>		X	X	
Problem analysis		X	X	
Developer documentation		X		
User Documentation		X		

*Form remarks:* The student's English is at a high level, and it is easy to read for the most part. That being said, there are a few significant problems, and I have many nitpicks. The student uses the third person to talk about himself (Illeism) in about half of the thesis and the standard academic *we* in the rest. Further, since he refers to related literature the same way as his work, as *the author*, it is often confusing. Next, I would like to correct some terminology. The student refers to almost everything in object detection as *contour* because he used the Canny contour detector on masks to separate objects. More precisely, the student is detecting *objects*, he computes *masks* of moving objects from the video frames, he computes object *contours* as an intermediate step and almost exclusively works with object *bounding boxes/rectangles*. Other than that, in-text references to figures are often missing, and all reference words should start with a capital letter (in Chapter, in Figure, etc.). On top of that, attachments are not referenced at all. There are also some notable grammatical and syntactical mistakes and other terminology inaccuracies.

*Structure remarks:* Introduction and chapter 1 *Introduction of squash* should have been just Introduction. Next, chapter 3 *Dataset* should have been a subsection somewhere else, for instance, in chapter *Evaluation*. Chapter 4 *Implementation* should have been split into Methodology with theoretical and mathematical analysis and Implementation with implementation details. Further, user and developer documentations are in attachments, whereas a software-based bachelor thesis should have the documentation in the main text. Finally, there is no Future work section or paragraph.

The student cites 29 articles (many of which are web pages, and one is a link to an image last accessed in 2010). Nevertheless, I would welcome references to state-of-the-art ball-tracking papers for other sports since their algorithms are probably more developed.

Concerning Future work, I would like to ask about the possibility of reconstructing the full 3D path of the ball. Is it possible to extrapolate the required information from floor bounces and known dimensions of the court, or is a second smartphone necessary?

*Problem analysis remarks:* The student's problem and implementation analyses are pretty good, but I would like to see more information about the algorithms used in the implementation. For example, what are morphological operations, how are contours computed or how is a homography matrix computed? A person knowledgeable in computer vision knows these things, but the thesis should provide a brief description for others. The student references OpenCV implementations, but that is not enough. On top of that, the graphs on page 22 are not good, and a much better explanation should accompany them.

## Thesis Code

good    OK    poor    insufficient

Design	<i>... architecture, algorithms, data structures, used technologies</i>		X		
Implementation	<i>... naming conventions, formatting, comments, testing</i>		X		
Stability		X	X		

The student's application is written in Python and uses standard libraries as well as Numpy, OpenCV and Matplotlib. The code is well-separated and well-encapsulated. I appreciate the application's quality of life additions and visualisations, such as zoomed-in view during point-of-interest selection and detection results drawn in the video during computation.

**Overall grade**    Excellent (worse)  
**Award level thesis**    No

**Date** 26. 1. 2023

**Signature**