

Cairo University

Faculty of Engineering

Department of Computer Engineering

**LA**خ**SLY**



A Graduation Project Report Submitted

to

Faculty of Engineering, Cairo University

in Partial Fulfillment of the requirements of the degree

of

Bachelor of Science in Computer Engineering.

**Presented by**

Ahmed Salama Hamed Ahmed Maher

Moamen hassan attia Mohamed Talaat Mohame

**Supervised by**

Dr. MagdaFayek

2020

All rights reserved. This report may not be reproduced in whole or in part, by photocopying or other means, without the permission of the authors/department

**General Guidelines**

* The color of the cover page should be green
* Throughout your text, use the font type, font size, and spacing, as in this template. In general, Arial font should be used. Chapter headings should be of size 24. Sections should be of size 18, and regular text should be of size 12. Your text should be justified on both left and right sides.
* The reference list should be written using a font size of 10. Ensure that the references are written correctly and all fields are included. References should be ordered according to their appearance in the text “[1], [2], [3] … etc”
* The table of content is a tentative one. You could add more sections as required. However, the mentioned sections should be included in your report
* For the appendices, add any appendix you see necessary. Remove any appendix that is not applicable to your project. However, the feasibility study and user guide should be included
* Ensure that the report is clear and self-contained, such that any future interested reader could completely understand your project “to the extent of building another one similar to yours”
* Use figures as much as possible to clarify and enrich your discussion. You have to draw all figures yourself. Ensure that the figures are clear and their size is suitable.
* Any figure caption should be inserted below the figure. Figures within any chapter should be numbered starting from 1. For example, the first figure of chapter 2 should be “Figure 2.1”. Similarly, the fourth figure of chapter 3 should be “Figure 3.4”
* Any table caption should be inserted above the table. Tables within any chapter should be numbered starting from 1. For example, the first table of chapter 4 should be “Table 4.1”. Similarly, the seventh table of chapter 5 should be “Table 5.7”
* Copy and paste from any other source is not allowed by any shape. Even for the background knowledge, you have to use your own wording.
* The complete report should be submitted 48 hours before the final project demonstration day. Ensure that you would meet this deadline to avoid any late penalty

**Abstract**

Soccer is one of the most popular team sports all over the world. Most sports games are naturally organized into successive and alternating plays of offence and defence, cummulating at events such as goal or attack. If a sport videos can be segmented according to these semantically meaning¬ful events, it then can be used in numerous applications to enhance their values and enrich the user's viewing experiences. According to this, soccer video summarization and analysis has recently attracted much research and a wide spectrum of possible applications have been considered.

Soccer video summarization and analysis is concerned with the extraction of valuable semantics by efficient and effective processing of combination of visual, audio and text information. However, one of the major limitations of current soccer analysis is the semantic gap between the low level features such as (color, texture, shape and motion) and high level representation such as (shot types, shot length, and shot replays).

This thesis presents an automatic soccer video summarization system using machine learning techniques. The proposed system is composed of five phases. Namely; in the pre-processing phase, the system segments the whole video stream into small video shots. Then, in the shot processing phase, it applies two types of classification (shot type classification and play / break classification) to the video shots resulted from the pre-processing phase. Afterwards, in the replay detection phase, the proposed system applies two machine learning algorithms, namely; support vector machine (SVM) and artificial neural network (ANN), for emphasizing important seg¬ments with championship logo appearance. Also, in the excitement event

**الملخص**

**ACKNOWLEDGMENT**

We would like to express our sincere gratitude to Dr. Motaz El-Saban for letting us

work on the exciting topic of sports video processing, giving us so much freedom to

explore and investigate new areas of video processing, providing invaluable personal and

professional guidance, being accessible all the time, and always being ready to answer our

so many questions. He has been and continues to be a source of inspiration for us. He

always encourages us to produce better results and to be more proactive.

We have found Dr.Motaz to be extremely honest while giving information to us. We have

always been impressed of his high-level of motivation and goal oriented. He has a depth of

Information Science knowledge, especially in computer vision, pattern recognition and

image processing which directed us to the best way

**Table of Contents**

Abstract ...........................................................................................................…........................ iii

الملخص ........................................................................................................................................... iv

Acknowledgment ......................................................................................................................... v

Table of Contents .....................................................................................................................… vi

List of Figures ............................................................................................................................. ix

List of Tables .............................................. .............................................................................. x

List of Abbreviations .............................................. ..................................................................... xi

List of Symbols ............................................................................................................................ xii

Contacts ..................................................................................................................................... xiii

**Chapter 1: Introduction**

1.1. Motivation and Justification…..……………………………………………..……………………1

1.2. Project Objectives and Problem Definition………………………………….………………….1

1.3. Project Outcomes ............................................................................................................... 1

1.4. Document Organization ...................................................................................................... 1

**Chapter 2: Visibility Study**

2.1. Target Customers .............................................................................................................. 2

2.2. Market Survey ……………………......................................................................................... 2

2.2.1. Example of Subsection 1 .............................................................................................. 2

2.2.2. Example of Subsection 2 ............................................................................................. 2

2.2.2.1. Example of subsubsection .................................................................................. 2

2.3 Business Case and Financial Analysis ……………………………………………………………………. 2

**Chapter 3: Literature Survey**

3.1. Background on Topic1 ….................................................................................................... 4

3.2. Background on Topic 2 .........................................................................................................4

3.3. Comparative Study of Previous Work …......................................................................................................4

3.4. Implemented Approach .............................................................................. 4

**Chapter 4: System Design and Architecture**

4.1. Overview and Assumptions ................................................................................................ 5

4.2. System Architecture ………………………………...………………………………………....… 5

4.2.1. Block Diagram .............................................................................................................. 5

4.3. Module 1 …………………………………………………………………………………..……… 6

4.3.1. Functional Description .................................................................................................. 6

4.3.2. Modular Decomposition ................................................................................................ 6

4.3.3. Design Constraints ....................................................................................................... 6

4.3.4. Other Description of Module 1 ...................................................................................... 6

4.4. Module 2 …………………………………………………………………………………..…....… 6

4.4.1. Functional Description .................................................................................................. 6

4.4.2. Modular Decomposition ................................................................................................ 6

4.4.3. Design Constraints ....................................................................................................... 6

4.4.4. Other Description of Module 2 ...................................................................................... 6

**Chapter 5: System Testing and Verification**

5.1. Testing Setup ……………................................................................................................... 7

5.2. Testing Plan and Strategy................................................................................................... 7

5.2.1. Module Testing ............................................................................................................. 7

5.2.2. Integration Testing ........................................................................................................ 7

5.3. Test Schedule.......................................................................................................................7

5.4. Comparative Results to previous work……………………………….......................................7

**Chapter 6: Conclusions and Future Work**

6.1. Faced Challenges ................................................................................................................8

6.2. Gained Experience ............................................................................................................... 8

6.3. Conclusions ..............................................................................................................8

6.4. Future Work ........................................................................................................................ 8

References .................................................................................................................................. 9

Appendix A: Development Platforms and Tools ..…………………................ 10

Appendix B: Use Cases ............................................................................................................ 11

Appendix C: User Guide ............................................................................................................ 12

Appendix D: Code Documentation ............................................................................................ 13

Appendix E: Feasibility Study .................................................................................................... 14

**List of Figures**

Figure 1.1: Same caption as in the text ................................................................................. page

Figure 2.1: Same caption as in the text ................................................................................. page

**List of Tables**

Table 1.1: Same caption as in the text .................................................................................. page

Table 2.1: Same caption as in the text .................................................................................. page

**List of Abbreviation**

[The abbreviations should be put in an alphabetical order]

AI Artificial Intelligence

EA Evolutionary Algorithms

GA Genetic Algorithms

SA Simulated Annealing

VLSI Very Large Scale Integration

**List of Symbols**

[The symbols should be put in an alphabetical order. Greek symbols come first, followed by English symbols]

σ Noise standard deviation

B Buffer size

fop Operating frequency

**Contacts**

**Team Members**

|  |  |  |
| --- | --- | --- |
| Name | Email | Phone Number |
| Ahmed Salama Hamed | [abc1@email.com](mailto:abc1@email.com) | +2 01xxxxxxxxx |
| Ahmed Maher | [abc2@email.com](mailto:abc2@email.com) | +2 01xxxxxxxxx |
| Moamen Hassan Attia | [abc3@email.com](mailto:abc3@email.com) | +2 01xxxxxxxxx |
| Mohamed Talaat Mohamed | [mohamedtalaat0111790@gmail.com](mailto:mohamedtalaat0111790@gmail.com) | +2 01115598525 |

**Supervisor**

|  |  |  |
| --- | --- | --- |
| Name | Email | Number |
| Dr. Magda Fayek | [magdafayek@gmail.com](mailto:magdafayek@gmail.com) | +2 01xxxxxxxxx |

This page is left intentionally empty

**Chapter 1: Introduction**

This chapter presents the importance of soccer video analysis and summarization. Soc-cer video matches always attract major sports audience. Recently, the amount of digi-tized video content has been increasing rapidly and watching a soccer match needs a lot of time, many TV fans of sport competitions prefer to watch a summary of soccer video matches. A summary is presented about the problems that are facing the automatic soccer video summarization and the proposed solutions. Finally an overview about the organization of the thesis is shown at the end of the chapter.

* 1. **Motivation and Justification**

Nowadays, with the progress in video compression, storage and communication, we are able to put a large amount of digital videos in database or online for users to perform query for some interesting or meaningful data. While the amount of video data is rapidly increasing, multimedia applications are still very limited in content manage¬ment capability. Therefore, mining information in video data becomes an increasingly important problem as digital video becomes more and more pervasive.

The ubiquitous consumption of video, however, poses many problems among which the field of multimedia processing focuses on the effective description of video infor-mation (video modeling), the relationship between low level features and semantic meanings of video information (video processing / analysis), and the querying of such information for fast and easy access to the relevant set at a later time (video querying / video search and retrieval).

Automatic video indexing becomes one of the major challenges in the field of in-formation systems. The automatic soccer video summarization extracts the important events to produce general summaries for the most important moments in which soccer viewers may be interested. Researchers have proposed many techniques to take full ad-vantage of the fact that sport videos have typical and predictable temporal structures, recurrent events, consistent features, and fixed number of camera views.

The multimedia analysis tool, which could automatically parse soccer video and output required video clips or the most interesting events such as goals, corner kicks and free kicks, fans could go though many more games without spending much time. This can entertain these fans and in turn further popularize the sport itself. So, soccer video indexing, especially event detection is absolutely necessary.

Event detection in soccer video is a high level analysis, which needs an effective description of soccer video information and approaches to bridge the gap between low level features and semantic meanings as its foundations. However, research in this field is far from enough. Shot is commonly used as an intermediate representation, but its propriety for soccer video parsing needs to be further studied and other high level rep-resentations should be explored. This thesis work has been inspired by this motivation.

We have two propellants which motivated us to develop an automated system for soccer match summarization. First, most people cannot watch the whole matches which are played on same time within different time zones because of lack of time. Second, coaches need to view the highlighted events to truly developing plans and evaluate the team players. From this point we concluded the importance of our proposed program to put a solution for the mentioned problems.

* 1. **Project Objectives and Problem Definition**

Analyzing general sport games is still an open problem because of the variance and

diversity of different games. Some former researchers have proposed many highlight

summarization methods both for general sports game and for a specific kind of sports

game (2). detected the play and break event in sports videos to generate the summary. Some other researchers summarize sports videos using slow motion replays (3). On the other hand, another group of researchers turn to study specific sport games such as soccer, basketball or diving (4).

Summarization process is an essential part in several applications such as (Infor¬mation retrieval, video retrieval, etc), to retrieve the important parts. This field is undergoing rapid change, as computers are now prevalent in virtually every application, from games for children through the most sophisticated planning tools for governments and multinational firms.

When we are talking about soccer game, we can refer to a continuous sports which man that if there is an existence of such a break during the match, it can an indica¬tor of the occurrence of important event such as (goal, penalty shot and red / yellow card). Therefore the summarization process which we aim for can be recognized by a combination of these events, so the summarized segment may contain only the goal shots, goal attempts or penalty shots that can be described as important events.

The input is a soccer video match needed to be summarized using a computer based application, our concern here is to extract the most exciting events in the soccer game such as (goal, attacks, and other events) using our proposed application then output those events into summarized video.

In this thesis, we are going to highlight the most important events such as (goals, attacks, and the other events), to facilitate the process of automatic match, save the viewer's time, and introduce the technology of computer based summarization into sports field.

Soccer video analysis and summarization is concerned with the extraction of valu-able semantics by efficient and effective processing of combination of visual, audio and text information. However, one of the major limitations of current soccer video summa¬rization is the semantic gap between the low level features and mid level representation.

* 1. **Project Outcomes**

Proposed solutions have been presented to avoid most of the problems discussed in the previous section, these solutions are involved in each of the stages of the proposed system . In the preprocessing stage, grass color extraction and shot boundary detec¬tion (5) is proposed to the system segments the whole input video stream into small video shots. Also shot processing phase, it applies two types of classification (shot type classification and play/break classification) to the video shots resulted from the pre-processing phase. Afterwards, in the replay detection phase, the system applies two machine learning algorithms (6) , namely; support vector machine (SVM) and artificial neural network (ANN), for emphasizing important segments with logo appearance.

Subsequently, in the excitement event detection phase (6, 7) the proposed system detect some cinematic features; like (scoreboard, goal mouth, etc), for scoreboard de-tection, the system uses both ML algorithms for detecting the caption region providing information about the score of the game. The system uses k-means algorithm and hough line transform for detecting vertical goal posts and gabor filter for detecting goal net. Finally, in the logo based event detection and summarization phase, the system highlights the most important events during the match.

* 1. **Document Organization**

In this section, you have to give the organization of the report and a quick description of the following chapters.

**Chapter 2: Market Visibility Study**

Multimedia information systems are increasingly important with the advantage of broadband networks, high powered workstations, and compression standards. Com¬pared with still images, videos are dynamic data with the temporal dimensions. That means a video cannot be only regarded as a sequence of still images with information in temporal dimensions ignored. While lots of techniques are developed in image retrieval, unique features of video data give rise to many new challenging issues.

The purpose of this thesis is to discuss semantic soccer video summarization, so the theory and methods used in soccer video summarization need to be carefully studied. In this chapter, existing works on video segmentation and retrieval are surveyed in the first and second sections because it an help us understand commonly used approaches in video analysis. With these understandings, we can better study related work in soccer video summarization, which is discussed and compared in the third section, and finally we get overview about the machine learning techniques in the last section.

**2.1. Targeted Customers**

In this section, mention who are the intended customers of your project and explain how these customers benefit from it

**2.2. Market Survey**

In this section, list the competitive products to your work. Similar commercial tools/platforms should be mentioned and discussed. Write a subsection for everyone of them and explain its pros and cons in that subsection

**2.2.1. Competitive Project 1**

Explain and discuss each competitive project

**2.2.2. Competitive Project 2**

Explain and discuss each competitive project

**2.3**. **Business** **Case** **and** **Financial** **Analysis**

In this section you describe the success of establishing a company to sell your product (or service)

Two Aspects must be addressed

Business Case: Based on Market survey above you should anticipate how many products you will sell over the next 5 years and how will you set your price to counter the competition.

Financial Analysis: Based on the business case we must anticipate

1. The Capex (Capital Expenditure): These are one-time spending that you pay for development and buying things for the company
2. The Opex (Operational Expenses): These are recurring payments for salaries and marketing and … etc.

Then you create what we call a cash flow table (on an excel sheet). In this sheet you put down your monthly capex and opex on a set of rows and your reveneus (money you get back from selling product/services) on another set of rows.

The difference between both sums is your profit before tax.

It is likely that this difference is negative at beginning until your sales increase and counter the expenses.

From this cash flow analysis you find the date of the break even point wbich is the date at which all the money you get back equals the money you spent. From that date onward you will be making true profit ☺.

**Chapter 3: Literature Survey**

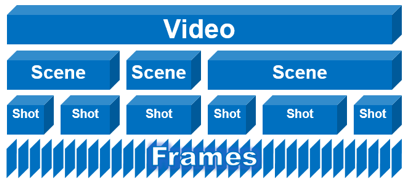
This chapter consists of two parts. In part one, give any necessary engineering and non-engineering backgrounds that you see important for the complete understanding of your project. These backgrounds include, but are not limited to, facts, theory, formulas, algorithms and techniques. In other words, any pivotal knowledge to your project should be given, discussed, and properly defined. In part two give a short literature review of the latest publications related to your project within past three years if applicable. Specially in this chapter, avoid lengthy unrelated discussion. More important, copy-and-paste should never be used. You have to write everything with your style and wording.

In this space, before the first section, write an introductory paragraph to describe the topics and organization of the chapter

**3.1. Background on soccer analysis**

Give this section a title related to the topic you cover and then write the related information as explained above.

**3.2. Background on video structure**



**3.3. Comparative Study of Previous Work**

Y.H. Gong et al. in (40) proposed a system that can automatically parse soccer video programs using domain knowledge. The parsing process was mainly built upon line mark recognition and motion detection. They categorized the position of the play into several predefined classes by recognizing the compound line pattern with signature method. The motion vectors field is used to infer the play positions for those scenes without line marks. Despite the strong semantic indexes from the categorization of play positions, they have to address these two problems:

• How to identify different camera angle and shooting scale, otherwise the line mark recognition cannot be robust.

• How to determine reasonable segment for processing.

D. Yow et al. in (41) presents techniques to automatically detect and extract the soccer highlights by analyzing the image contents, and to present these shots of action by the panoramic reconstruction of selected events. The analysis include the recognition of prominent features of the game, tracking of ball, camera movement compensation for effective recognition, and construction of the panoramic views. The authors pointed out a direction for application of soccer video summarization.

V. lbvinkere et al. in (42) present an effective data mining framework for automatic extraction of goal events in soccer videos. The extracted goal events can be used for high level indexing and selective browsing of soccer videos. The proposed multime¬dia data mining framework first analyzes the soccer videos by using joint multimedia

features (visual and audio features). Then the data pr•filtering step is performed on raw video features with aid of domain knowledge, and the pre-filtered data are used as the input data in the data mining process using classification rules. The proposed framework fully exploits the rich semantic information contained in visual and audio features for soccer video data, and incorporates the data mining process for effective detection of soccer goal events. This framework has been tested using soccer videos with different styles as produced by different broadcasters. The results are promising and can provide a good basis for analyzing the high level structure of video content.

0. Utsumi et al. in (43) proposed a novel object detecting and tracking method in order to detect and track objects necessary to describe contents of a soccer game. On the contrary to intensity oriented conventional object detection methods, the proposed method refers to color rarity and local edge property, and integrally evaluate them by a fuzzy function to achieve better detection quality. These image features were chosen considering the characteristics of soccer video images, that most nosi•object regions are roughly single colored (green) and most objects tend to have locally strong edges. We also propose a simple object tracking method, which could track objects with occlusion with other objects using a color based template matching. The result of an evaluation experiment applied to actual soccer video showed very high detection rate in detecting player regions without occlusion, and promising ability for regions with occlusion.

P. Xu et al. in (44) introduced a framework for play / break events detection in soccer video. In this paper, three kinds of views in soarr video, global, zoom-in and close-up, are predefined. The counterpart's terms of these views are long shot, medium shot, and close-up, respectively. Here the grass value and classification rules are learned and automatically adjusted to each new clip. Then heuristic rules are used in process¬ing the view label sequence, and obtain play / break status of the game. The system is novel, but it is just a good start for further event detection in soccer video.

A. Ekin et al. in (2) presented a fully automatic and computationally efficient framework for analysis and summarization of soccer videos using cinematic and object based features. In this paper, algorithms of dominant color region detection, robust

A. Ekin et al. in (2) presented a fully automatic and computationally efficient framework for analysis and summarization of soccer videos using cinematic and object based features. In this paper, algorithms of dominant color region detection, robust

shot boundary detection and shot classification, as well as goal detection, referee de¬tection, and penalty box detection are discussed. The algorithm of dominant color region detection is very impressive, but the methods used in goal detection and referee detection depend heavily on man made rules. Three types of summaries can be automatically produced:

• All slow motion segments in a game.

• All goals in a game.

• Slow motion segments classified according to object based features.

1..Y. Duan et al. in (45) presented a unified framework for semantic shot classi¬fication in sports videos. Unlike previous approaches, which focus on clustering by aggregating shots with similar low level features, the proposed scheme makes use of domain knowledge of a specific sport to perform a top down video shot classification, including identification of video shot classes for each sport, and supervised learning and classification of the given sports video with low level and middle level features extracted from the sports video. This framework looks good but still has some problems:

• Where the eat data aunt from is not clearly mentioned.

• Methods used to detect flying graphics are ton specific.

• Methods for shot classification is mainly based on shot segmentation, which is done by some commercial software.

Other works such as (46)(47) arc also related to soccer video summarization. With consideration of our research work, a comparison among (2)(44)(45) is given in Table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| hex | Fonts of Spies | Fent used | Clams of Slot | Re It | Contritebee | Comment |
| P.A. | View dandscatwa  Ouns Onentitsoa Clastficaton  Nay Break  SCIFOrYttlial | Wm fate)  Texture  Ades | Loot Slot War= Stec Close-np | Fa stew clansficaboo. 85%  For Lb.  Break Sepaectanot 75% | Cola-bed grass deem  Play. Break Sereaccrawo | The to bolds for 'lament *poses* int view clatuncanct see *tans*  Cut! waft it to do Play. Break Sep...went |
| 1 V  Dom | ChM  C trash:anon | Other  M 0030  Tryture  Omen  moron  peens  Deanssant  Oblect  Monoo  Hanoreneous  Reports  Auk, | Ost-op  field View. Faroe/et Myer  Median Soh Audzence. tower Mkt Goal View. Reply | 85% -95% | Iteletombis  beh.ns shot  and setnatax  moot!:  Macrae from low-keel  furores to mad- level \*ann.  Nlidlemi  features sernerenunce  Funs of sad and level  frown ad gal test  Reds= Aerfoccoance | Ice OH ThAS WI  Flytng Gye, detecbou as too rode  Method for  Memo. of Field. Mayen Inenetton Cane irPtC) say be heavily affected by bad Light  coed:noes  Mae that teats dais came tome not *clew:).* mennoned |
| A Elan | Sbot 02.1ot:scab.=  Slow 4317t:Ot dciecton  Event detection | Color  MINatTJ  Roles | *Loft* Stce In•field sets Jot Clourop /Out field  shot  God  Reiree  Paisley Box | For nu detection 9135 recall sod 91 7% preens=  Fut Cnakal transabont. 853% recall mod 86 6'. precinct  *■hott* tlattsfitanoo ET% | Fete color &tech=  Npel features fot shot chntificanon | Make lbil use of cola wfoortoon Bat have/al *put* tench effort on  bow to one :natal keener, |

**3.4. Implemented Approach**

**Chapter 4: System Design and Architecture**

This chapter represents the main body of your project. It should describe the project in full details. This chapter should answer the questions: “what has been done?” and “how it has been done?”. As such, the steps you went through to realize the project should be highlighted and properly discussed. Your scientific approaches and methodologies should be clarified. The discussion should adopt a logical flow starting from the whole block diagram, to coarse modules, and finally to fine modules. While writing this chapter, try to give as much details as possible, such that an interested reader could easily replicate your work and improve it.

In this space, before the first section, write an introductory paragraph on how you design and build your project

**4.1. Overview and Assumptions**

In this section, introduce how you design you system and develop its underlying architecture. Any employed assumptions should be clearly enumerated and justified.

**4.2. System Architecture**

The architecture of your system should be given in this section. This architecture should be first represented as a block diagram (subsection 5.2.1), which clarifies different project modules and the connections between them. You may add more subsections to properly explain your design. If possible, flowcharts are better included to ensure that the big picture and the interaction between different modules are very clear to the reader. Thereafter, each module should have a separate subsequent section to clearly describe and discuss it.

**4.2.1. Block Diagram**

Draw the block diagram of your architecture and generally discuss its modules. After reading this subsection, interested audience should have understood the big picture of your system design and architecture. The interaction between modules should also be conveyed in this subsection

**4.3. Module 1**

Each module within your architecture should have a distinct section to explain the design of the module itself. Again, give as much details as possible, so that the reader could easily understand how the module is designed and what are the constraints that affect its design?

**4.3.1. Functional Description**

Explain the functional description of the module

**4.3.2. Modular Decomposition**

Explain the modular decomposition of the coarse module into smaller fine ones

**4.3.3. Design Constraints**

Explain the constraints that affect the design of the module

**4.3.4. Other Description of Module 1**

Give any other necessary discussion of the module to ensure that it is clearly described.

**4.4. Module 2**

Each module within your architecture should have a distinct section to explain the design of the module itself. Again, give as much details as possible, so that the reader could easily understand how the module is designed and what are the constraints that affect its design?

**4.4.1. Functional Description**

Explain the functional description of the module

**4.4.2. Modular Decomposition**

Explain the modular decomposition of the coarse module into smaller fine ones

**4.4.3. Design Constraints**

Explain the constraints that affect the design of the module

**4.4.4. Other Description of Module 2**

Give any other necessary discussion of the module to ensure that it is clearly described.

**Chapter 5: System Testing and Verification**

In this chapter, you have to explain all the steps you carried out to ensure that project outcomes are realized correctly. Your testing setup, strategy and environment should therefore be described. Your efforts for unit testing as well as integrated system testing should be given. Finally, the results from different testing scenarios should be highlighted and discussed.

In this space, before the first section, write an introductory paragraph on how you test and verify the correct operation of your system

**5.1. Testing Setup**

Explain the setup you are using in testing your project

**5.2. Testing Plan and Strategy**

Explain the methodology you follow while testing your project in details

**5.2.1. Module Testing**

Explain the steps you carried out to test different modules within the project. Give and discuss the results obtained from the testing of these modules

**5.2.2. Integration Testing**

Explain the steps you carried out to test the integrated system of your project. Give and discuss the results obtained from this whole project testing

**5.3. Testing Schedule**

Mention your testing schedule

**5.4. Comparative Results to Previous Work**

Give a summary of comparative results to previous work in Tabulated and or Graphical form along with a short commentary.

**Chapter 6: Conclusions and Future Work**

This chapter should summarize the whole project, it features and limitation. Moreover, you should give directions for future work

In this space, before the first section, write an introductory paragraph for the chapter

**6.1. Faced Challenges**

Mention all the problems/challenges that you faced while working with the project and how you overcome them

**6.2. Gained Experience**

Mentioned the experience/skills that you gained from working with the project

**6.3. Conclusions**

Write your conclusions regarding the project. Mention its features and limitations

**6.4. Future Work**

Give possible extensions, enhancements and future work of you project, such that subsequent students could build on your work and develop larger systems/platforms.

**References**

The references should be ordered according to their appearance in the text. Ensure that all references are cited throughout your report text. The following are examples of how to write different types of references “[1] Book, [2] Journal/magazine articles, [3] conference paper, [4] website, [5] thesis”. Replace the fields with those of your used references. Question marks “??” should be replaced by the corresponding number

1. Author1, Author 2,…, “Book title,” name of publishing firm, edition, year
2. Author1, Author2,…., “Title of journal article,” name of the journal, vol. ??, no. ??, pp. ??, year of publication
3. Author1, Author2,…, “Title of conference paper,” in proceedings of conference name, city, country, date, year, pp. ??
4. Author or Corporation name, “Title,” year, link for the website, last accessed: date of last access
5. Author, “Thesis title,” M.Sc./Ph.D. thesis, Department, University, year

**Appendix A: Development Platforms**

**and Tools**

This appendix explains used tools, platforms, and hardware kits. Any ready-made module should be mentioned and discussed in this appendix. The appendix is divided into two main sections; one for the hardware and the other is for software. Within each section, you could add as much subsections as needed, according to the number of tools and platforms that you use in your project.

In this space, before the first section, write an introductory paragraph to the appendix

**A.1. Hardware Platforms**

A description of any used hardware platforms/kit should be written in this section. Each platform/kit is better described in a separate subsection. (A1.1..)

**A.2. Software Tools**

A description of any used software tool/package should be written in this section. Each tool/package is better described in a separate subsection (A2.1,..)

**Appendix B: Use Cases**

Include all your use cases

**Appendix C: User Guide**

Prepare a user guide for your project. Ensure that the guide is clear, detailed and easy for an ordinary customer to use your project. Employ figures and charts as needed to facilitate the use of your guide

**Appendix D: Code Documentation**

Your code or parts of the code you feel necessary could be included here (optional) however for one copy of this report an attached CD with all of the code is a must.

Remember you will deliver three copies of this report.

**Appendix D: Feasibility Study**

Give a detailed feasibility study of your project