OPTIMIZING CCTV PLACEMENT FOR INDOOR BUILDING USING GENETIC ALGORITHM

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JUDUL : OPTIMIZING CCTV PLACEMENT FOR INDOOR BUILDING USING GENETIC ALGORITHM

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OPTIMIZING CCTV PLACEMENT FOR INDOOR BUILDING USING GENETIC ALGORITHM

MUHAMMAD NABIL AKIF BIN NOR AZMAN

This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Artificial Intelligence) with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I hereby declare that this project entitled
OPTIMIZING CCTV PLACEMENT FOR INDOOR BUILDING USING GENETIC ALGORITHM
is written by me and is my own effort and that no part has been plagiarized without citations.

STUDENT : ______________________ Date : 18 Sept 2023
(MUHAMMAD NABIL AKIF BIN NOR AZMAN)

I hereby declare that I have read this project report and found this project report is sufficient in term of the scope and quality for the award of Bachelor of Computer Science (Artificial Intelligence) with Honours.

SUPERVISOR : ______________________ Date : 18 Sept 2023
(DR. NORHAZWANI BINTI MD YUNOS)

DEDICATION

I would like to dedicate this project to all the individuals who strive to enhance security and surveillance systems.

To my supervisor, Dr. Norhazwani Binti Md Yunos, whose guidance, expertise, and unwavering support have been instrumental in the successful completion of this project. Your mentorship and valuable insights have shaped my understanding and approach, and I am grateful for the opportunity to learn from you.

To the technicians and engineers who work diligently to ensure the safety of buildings and the people within them. Your expertise and dedication are instrumental in creating effective surveillance solutions.

To the researchers and innovators in the field of artificial intelligence and optimization algorithms. Your contributions have paved the way for new possibilities and advancements in CCTV camera placement.

To my family and friends, for their unwavering support and encouragement. Your belief in my abilities has been a constant source of motivation.

And finally, to all those who believe in the power of technology to create a safer and more secure world. May our efforts contribute to the continuous improvement of surveillance systems and help protect communities worldwide.

This project is dedicated to all of you.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude and appreciation to the following individuals and organizations who have contributed to the successful completion of this project.

First and foremost, I would like to extend my heartfelt thanks to my supervisor, Dr. Norhazwani Binti Md Yunos, for her invaluable guidance, continuous support, and unwavering belief in my abilities. Her expertise, insightful feedback, and encouragement have been instrumental in shaping this project and my personal growth as a researcher.

I would like to acknowledge the assistance and cooperation extended by the faculty members and staff of Universiti Teknikal Malaysia Melaka, who provided me with access to resources, facilities, and support throughout the duration of this project. Their willingness to share knowledge and expertise has been instrumental in enriching my understanding and enhancing the quality of this work.

I am grateful to the participants who willingly participated in the data collection process, providing valuable insights and feedback that greatly contributed to the success of this study. Their cooperation and willingness to share their experiences have been crucial in shaping the findings and conclusions of this project.

I would like to extend my appreciation to my colleagues and friends who provided valuable suggestions, feedback, and support during the course of this project. Their discussions, brainstorming sessions, and encouragement have been immensely helpful in overcoming challenges and refining the ideas presented in this report.

Lastly, I would like to express my deepest gratitude to my family for their unconditional love, unwavering support, and patience throughout my academic journey. Their encouragement and belief in my abilities have been a constant source of inspiration and motivation.

I am indebted to all these individuals and organizations for their contributions, and I recognize that without their support, this project would not have been possible.

Thank you all for your invaluable contributions and for being a part of this journey.

ABSTRACT

The placement of CCTV cameras in indoor buildings played a crucial role in ensuring effective security and surveillance. However, the previous system often suffered from inefficiencies, resulting in areas with blind spots and excessive camera usage, leading to increased costs and maintenance requirements. Hence, the project aimed to address these challenges by developing a genetic algorithm-based solution for optimizing the placement of CCTV cameras in indoor buildings. The proposed solution aimed to optimize camera placement using a genetic algorithm, taking into account factors such as coverage area, field of view, and the minimum number of cameras required. The system also provided evaluation and comparison functionalities to assess the improvements achieved compared to the previous methods. The expected outcome of the project was a genetic algorithm-based solution that optimized CCTV camera placement in indoor buildings, resulting in improved security and surveillance. The solution was validated using real-world examples, and recommendations for optimal camera placement were provided. The project's significance lay in its contribution to efficient resource utilization, improved security, and the application of artificial intelligence techniques in solving real-world problems. Thus, a user-friendly interface was also provided to allow technicians and engineers to input data and view the optimized camera placement results.

Keywords: CCTV cameras, indoor buildings, genetic algorithm, optimization, security, surveillance.

ABSTRAK

Penempatan kamera CCTV di bangunan dalaman memainkan peranan penting dalam memastikan keselamatan dan pengawasan yang berkesan. Walau bagaimanapun, sistem sebelumnya sering mengalami ketidakcekapan, menyebabkan kawasan dengan titik buta dan penggunaan kamera yang berlebihan, membawa kepada peningkatan kos dan keperluan penyelenggaraan. Oleh itu, projek ini bertujuan untuk menangani cabaran-cabaran ini dengan membangunkan penyelesaian berasaskan algoritma genetik untuk mengoptimumkan penempatan kamera CCTV di bangunan dalaman. Penyelesaian yang dicadangkan bertujuan untuk mengoptimumkan penempatan kamera menggunakan algoritma genetik, dengan mengambil kira faktor-faktor seperti kawasan liputan, bidang pandangan, dan bilangan kamera minimum yang diperlukan. Sistem ini juga menyediakan fungsi penilaian dan perbandingan untuk menilai penambahbaikan yang dicapai berbanding dengan kaedah sebelumnya. Hasil yang diharapkan dari projek ini adalah penyelesaian berasaskan algoritma genetik yang dioptimumkan penempatan kamera CCTV di bangunan dalaman, menghasilkan peningkatan keselamatan dan pengawasan. Penyelesaian ini disahkan menggunakan contoh dunia sebenar, dan cadangan untuk penempatan kamera yang optimum disediakan. Kepentingan projek terletak pada sumbangannya kepada penggunaan sumber yang cekap, keselamatan yang lebih baik, dan penerapan teknik kecerdasan buatan dalam penyelesaian masalah dunia sebenar. Oleh itu, muka mesra pengguna juga disediakan untuk membolehkan juruteknik dan jurutera memasukkan data dan melihat hasil penempatan kamera yang dioptimumkan.

Kata kunci: Kamera CCTV, bangunan dalaman, algoritma genetik, pengoptimuman, keselamatan, pengawasan.

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LIST OF ABBREVIATIONS

FYP	-	Final Year Project
PSM	-	Projek Sarjana Muda
USA	-	United States of America
CCTV	-	Closed-circuit Television
AI	-	Artificial Intelligence
DSS	-	Decision Support System
GUI	-	Graphical User Interface
DBMS	-	Database Management System
IoT	-	Internet of Things
ML	-	Machine Learning
RFID	-	Radio Frequency Identification
API	-	Application Programming Interface
OCR	-	Optical Character Recognition
GPS	-	Global Positioning System
HTTPS	-	Hypertext Transfer Protocol Secure
UI	-	User Interface
UX	-	User Experience
HTML	-	Hypertext Markup Language
CSS	-	Cascading Style Sheets
JSON	-	JavaScript Object Notation
SQL	-	Structured Query Language

CPU	-	Central Processing Unit
GPU	-	Graphics Processing Unit
RAM	-	Random Access Memory
SSD	-	Solid State Drive
HDD	-	Hard Disk Drive
LAN	-	Local Area Network
WAN	-	Wide Area Network
ISP	-	Internet Service Provider

CHAPTER 1: INTRODUCTION

1.1 Introduction

The use of closed-circuit television, for short CCTV, cameras has become increasingly common in building security systems, as it provides real-time monitoring and recording of activities. However, the placement of CCTV cameras can be a challenging task, as it requires a balance between minimizing the number of cameras used and maximizing the field of view. In this project, we aim to optimize the placement of CCTV cameras in indoor buildings using genetic algorithm, as shown in Figure 1.1. The figure shows a floor plan with a number of coordinates and area coverage for CCTV cameras. The coordinates represent the locations of the cameras, and the area coverage represents the area that each camera can see. According to Erdem & Sclaroff (2006), Gonzalez-Barbosa et al. (2009), van den Hengel et al. (2009), Heyns (2021), the system will use these coordinates and area coverage to generate a set of candidate solutions for CCTV placement.

The use of closed-circuit television (CCTV) cameras has become increasingly common in building security systems, as it provides real-time monitoring and recording of activities. However, the placement of CCTV cameras can be a challenging task, as it requires a balance between minimizing the number of cameras used and maximizing the field of view. In this project, we aim to optimize the placement of CCTV cameras in indoor buildings using genetic algorithm.

Figure 1.1: Proposed CCTV placement system

1.2 Problem Statement

The current system for CCTV placement in indoor buildings is inefficient, resulting in areas with blind spots and excessive camera usage. This leads to higher costs and maintenance requirements. Moreover, the current system fails to consider important factors such as line-of-sight obstruction, camera coverage efficiency, and optimal distance between cameras. As a result, there is a need to investigate the existing approaches and techniques employed for CCTV camera placement in indoor buildings to identify their limitations and shortcomings according to Erdem & Sclaroff (2006).

Additionally, the current methods lack an optimized approach for CCTV camera placement. They do not consider factors such as camera coverage efficiency, line-of-sight obstruction, and optimal camera placement to minimize blind spots and excessive camera usage. To address this issue, a genetic algorithm-based solution needs to be designed and implemented. This solution will optimize the placement of CCTV cameras in indoor buildings by considering factors such as camera coverage, line-of-sight obstruction, distance between cameras, and any specific requirements or constraints of the indoor environment.

Furthermore, it is necessary to evaluate the effectiveness and efficiency of the proposed genetic algorithm-based solution by comparing it with the existing methods used for CCTV camera placement. The current methods often result in areas with blind spots, excessive camera usage, and higher costs for maintenance. The evaluation should consider metrics such as coverage efficiency, camera redundancy, computational complexity, and overall performance. By conducting this evaluation, the superiority of the proposed solution over the existing methods can be determined, providing valuable insights for optimizing CCTV camera placement in indoor buildings.

By addressing the limitations of the current system and providing a more optimized approach to CCTV camera placement in indoor buildings, it is anticipated that the proposed genetic algorithm-based solution will enhance the overall effectiveness, efficiency, and cost-effectiveness of surveillance systems in indoor environments.

1.3 Objective of the Study

This project embarks on the following objectives:

1. To investigate the current methods used for CCTV camera placement in indoor buildings.
2. To design and implement a genetic algorithm-based solution to optimize the placement of CCTV cameras in indoor buildings.
3. To evaluate the effectiveness and efficiency of the proposed solution.

1.4 Scope of the Study

The scope of this project is limited to indoor buildings, and the proposed solution will not involve any image processing or computer vision techniques. The focus of the project is to optimize the placement of CCTV cameras with a minimum number of cameras used and maximum field of view according to Erdem & Sclaroff (2006).

1.5 Significance of the Study

This project is significant because it provides a solution to the problem of optimizing the placement of CCTV cameras in indoor buildings. The proposed software will assist technicians and engineers in identifying the ideal locations for cameras, based on various factors such as camera quantity and coverage area. This will lead to a more efficient use of resources and improved security in buildings. Additionally, the use of genetic algorithm in this project demonstrates the application of artificial intelligence techniques in solving real-world problems according to Erdem & Sclaroff (2006), Altahir et al. (2017).

1.6 Expected Output

The expected outcome of this project is a genetic algorithm-based solution for the optimization of CCTV camera placement in indoor buildings. The solution will provide a trade-off between the number of cameras used and the field of view, with the aim of maximizing the overall security and surveillance of the building. The solution will be validated using real-world examples, and the results will be compared with the current methods used for CCTV camera placement. The proposed solution will also provide recommendations for the optimal placement of CCTV cameras in indoor buildings according to Erdem & Sclaroff (2006), Gonzalez-Barbosa et al. (2009), van den Hengel et al. (2009), Heyns (2021).

1.7 Conclusion

In conclusion, the proposed project aims to provide a more efficient and effective approach to the installation of CCTV systems in indoor buildings. By utilizing genetic algorithms and considering various constraints such as coverage area and camera placement, the proposed system can optimize the placement of cameras to enhance the security of indoor spaces while minimizing installation costs. The outcome of this project can potentially contribute to the development of more intelligent and automated security systems in the future.

CHAPTER 2: LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

In this section, we will review the existing literature on the optimization of CCTV placement in indoor buildings, as well as the proposed methodology for our project. We will examine the various approaches and techniques used in previous studies and discuss their effectiveness in solving similar problems. Furthermore, we will outline the proposed methodology, which will involve the use of a genetic algorithm to optimize the placement of CCTV cameras in an indoor building, taking into account factors such as coverage area, camera overlap, and placement distance.

2.2 Facts and findings

2.2.1 Domain

The domain related to this project is the field of surveillance system and optimization techniques. The project aims to optimize the placement of CCTV cameras in an indoor building by considering various factors such as coverage area, number of cameras used, and distance between cameras. This domain involves the use of advanced mathematical algorithms and optimization techniques to achieve the most efficient and effective surveillance system possible. The project also draws upon principles from the field of computer vision, as the cameras will be used to capture and analyze visual data.

2.2.2 Existing System

The placement of CCTV cameras in surveillance systems has been a topic of research in computer vision and image understanding. Several studies have focused on optimizing camera layout to satisfy task-specific and floor plan-specific coverage requirements according to Erdem & Sclaroff (2006). Other research works have explored optimal camera placement strategies to achieve total coverage according to Gonzalez-Barbosa et al. (2009) and automatic camera placement for large-scale surveillance networks according to van den Hengel et al. (2009).

In the context of multi-camera coverage, modeling and optimization techniques have been employed to determine optimal camera sites for maximizing coverage in specific areas of interest according to Altahir et al. (2017). Moreover, recent studies have tackled the challenge of determining optimal camera placement considering multiple objectives and constraints, such as rotational cover during the day and fixed direction cover at night according to Heyns (2021).

To address the need for an automated CCTV placement system, the following ideas have been proposed. First, the system should be able to read a floor plan image from the directory and extract its width and height. Using computer vision techniques, unwanted areas in the floor plan can be identified and marked, ensuring they are not considered for CCTV placement. This can be achieved by utilizing functions like cv2.selectROI and implementing a loop to select unwanted areas until none are left.

To assign values to different areas of the floor plan, a 2D array representing the coordinates in the resulting image can be created using the area valuer function. This function iterates through all the coordinates and assigns values of 0 for available areas and 1 for walls and unwanted areas.

To determine the quantity of CCTV cameras required, the cctv quantity initializer function can be implemented. This function calculates the estimated total CCTV coverage and initializes the CCTV quantity accordingly. The quantity of CCTV cameras can be used as the number of genes in the chromosome for a genetic algorithm to generate random coordinates only on available areas.

Next, the rand coords function can be used to draw the CCTV coverage on the floor plan. This function generates random coordinates within the available areas and marks them with a specific color, such as (0, 191, 0).

To update the values in the 2D array based on the generated CCTV coverage, the update value function can be implemented. This function compares the color of the image with the value array and updates the corresponding coordinates. Coordinates with a value of 1 will turn the pixel black, while coordinates marked with the color (0, 191, 0) will have a value of 2. Only coordinates with a value of 0 can be changed to 2 based on the color in the image.

The fitness value of the generated CCTV placement can be evaluated by considering the values assigned to each pixel in the value array. Additionally, a penalty function can be implemented to increase the distance between CCTV coordinates and walls if they are below a minimum distance. This penalty function can be used in the genetic algorithm to guide the optimization process.

The genetic algorithm can be implemented using functions such as select mating pool, crossover, and mutation to create an initial population of CCTV placements. A decision-making function can be employed to evaluate the fitness value of the best population and determine whether to decrease, increase, or maintain the initial CCTV quantity. If a change in the quantity is required, the genetic algorithm can be rerun to find the best population with the updated CCTV quantity.

By incorporating these ideas into the existing literature on CCTV placement, we can develop a comprehensive system that automates the process of CCTV placement while considering task-specific requirements, floor plan constraints, and optimization objectives.

2.2.3 Technique

The techniques employed in the existing research include binary optimization, genetic algorithms, occupancy grid maps, surface-projected workspace models, and imaging techniques. These approaches aim to address the camera placement problem by considering coverage requirements, building layouts, surveillance conditions, and specific application constraints.

In this project, a similar methodology will be adopted, taking into account the existing techniques and adapting them to meet the specific requirements of the proposed camera placement optimization system.

2.3 Project Methodology

The methodology selected for this project is the Agile methodology, specifically the Scrum framework. Agile methodologies are known for their flexibility and adaptability, making them well-suited for projects developed by a single person, where requirements may evolve during development.

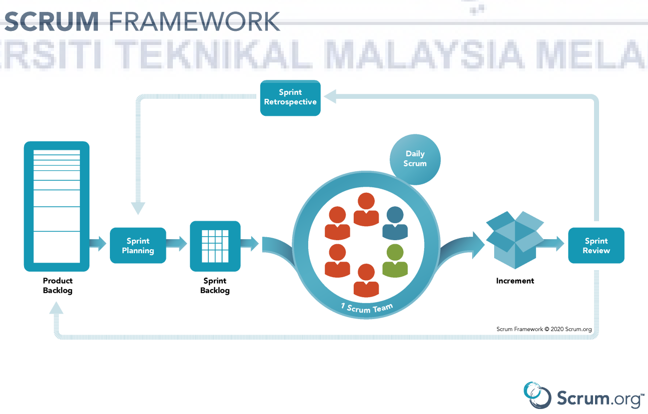

Figure 2.1: Scrum Framework in Agile Methodology

The Agile approach emphasizes iterative development, frequent collaboration with stakeholders, and the ability to respond to changing requirements. In this project, it allows for continuous improvements and adjustments as needed, ensuring that the final result aligns closely with the project's goals and objectives.

The Scrum framework, as illustrated in Figure 2.1, provides a structured approach to Agile development, dividing work into manageable time-boxed iterations known as "sprints." These sprints allow for regular reviews, feedback, and adjustments to the project's direction. Daily stand-up meetings, backlog management, and sprint planning are integral parts of the Scrum framework, ensuring effective project management and communication.

By adopting the Agile methodology with the Scrum framework, this project aims to deliver a well-structured and adaptable solution that meets its evolving requirements efficiently.

2.4 Project Requirements

2.4.1 Software Requirement

1. Operating System:
    - The software should be compatible with major operating systems such as Windows, macOS, and Linux.

2. Programming Language:
    - The project is being developed in Python, so the software should be implemented using Python.

3. Libraries and Dependencies:
    - The software should utilize relevant libraries and dependencies, such as OpenCV for image processing and visualization, NumPy for numerical operations, and any additional libraries used in your existing code.

4. User Interface:
    - The software should have a user-friendly interface that allows users to input the floor plan image and interact with the application.

- Provide an option for users to draw rectangles on the image to mark the available area for camera placement.
- Display the progress and results of the optimization process, including the generated camera coordinates and coverage areas.

5. Input and Output:

- The software should allow users to input the floor plan image in a common image format, such as JPEG or PNG.
- Provide options for users to specify parameters such as the minimum distance constraint and the number of cameras to be placed.
- The output should include the optimized camera coordinates and the coverage areas, which can be displayed on the floor plan image.

6. Optimization Process:

- Implement the genetic algorithm-based optimization process for determining the optimal camera coordinates.
- The software should include functions to calculate the fitness value for each solution, perform selection, crossover, and mutation operations, and track the progress of each generation.

7. Visualization and Analysis:

- Include features to visualize the floor plan image with the optimal camera coordinates and coverage areas.
- Display relevant metrics such as the coverage percentage and any other performance indicators.

8. Error Handling and Validation:

- Implement proper error handling to catch and handle exceptions during image loading, input validation, and other critical processes.
- Validate user inputs to ensure they meet the required format and constraints.

9. Performance and Scalability:
   - Ensure the software is efficient and capable of handling large floor plan images and a significant number of cameras.
   - Optimize the code for speed and memory usage to provide a responsive and scalable application.
10. Documentation and Help:
    - Provide clear documentation on how to install and use the software, including instructions for running the code and setting up the required dependencies.
    - Include inline comments and/or a separate README file to explain the code structure, functions, and algorithms used.

2.4.2 Hardware Requirement

1. Processor:

   The software should be compatible with modern processors, preferably with multi-core capabilities to take advantage of parallel processing. A processor with a clock speed of at least 2.0 GHz or higher is recommended for optimal performance.

2. Memory (RAM):

   The software should be able to run smoothly with a minimum of 4 GB of RAM. However, depending on the size of the floor plan images and the number of cameras, more memory may be required for efficient processing.

3. Storage:

   Sufficient storage space is necessary to store the software, its dependencies, and any input/output files. At least 500 MB of free disk space is recommended.

4. Graphics Card (Optional):

If you plan to incorporate real-time visualization or advanced image processing techniques, a dedicated graphics card with CUDA support can significantly improve performance. Check the requirements of the specific libraries and frameworks you are using to determine if a graphics card is recommended.

5. Display:

   A standard monitor or display with a resolution of 1280x800 or higher is sufficient for running the software. If you plan to perform detailed visualizations or work with large images, a higher resolution or multiple displays may be beneficial.

6. Input Devices:

   A standard keyboard and mouse or touchpad are required for interacting with the software. If you plan to incorporate any specialized input devices or sensors, ensure they are compatible and provide the necessary drivers or interfaces.

7. Internet Connection:

   An internet connection is not essential for running the software, but it may be required for installing dependencies, downloading updates, or accessing online resources for documentation or support.

2.4.3 Other Requirements

1. Operating System:

   The software should be compatible with Windows 10 (version 1903 and above) and macOS Mojave (version 10.14 and above).

2. Third-Party Libraries and Dependencies:

   The software requires the following dependencies:

   - OpenCV version 4.5.2 for image processing.

3. Network Connectivity:

   The software needs internet access to connect to an external REST API for fetching additional data.

4. Permissions and Access Rights:

   The software requires read and write access to the local file system for saving and loading images.

5. User Accounts and Authentication:

   The software needs user authentication via username and password combinations to access certain features and store user preferences.

6. Performance and Scalability:

   The software should process floor plan images within 3 seconds on a standard desktop computer. It should support up to 100 concurrent users without significant performance degradation.

7. Documentation and User Guides:

   The software should include installation instructions, usage guidelines, and a troubleshooting guide in both PDF and online HTML formats.

8. Testing and Quality Assurance:

   The software should have comprehensive unit tests for the core functionalities using the PyTest framework. It should undergo performance testing using tools like Apache JMeter to ensure it meets the specified performance requirements.

2.5 Project Schedule and Milestones

The project schedule outlines the timeline for completing various tasks and milestones. The estimated durations mentioned below are based on the information provided. Please note that the actual schedule may vary depending on factors such as resource availability and unforeseen challenges.

PSM 1:

- Milestone 1: Proposal Submission

  Duration: 5 days (March 20, 2023 - March 24, 2023)

  Tasks:

  – Prepare the project proposal document, including sections such as project background, problem statements, objectives, scope, and proposed solution.

  – Complete the proposal form and submit it for review.

  – Ensure all required documentation, including the log record and completed proposal form, are included.

- Milestone 2: Report Writing Progress 1

  Duration: 5 days (April 10, 2023 - April 14, 2023)

  Tasks:

  – Make progress on writing Chapter 1, Chapter 2, and Chapter 3 of the project report.

  – Maintain a log record of the writing progress and any challenges faced.

- Milestone 3: Project Progress 1

  Duration: 5 days (May 1, 2023 - May 5, 2023)

  Tasks:

  – Focus on the development progress of the application/system.

  – Ensure punctuality, commitment, and effort are maintained.

  – Maintain a log record of the project progress and any challenges faced.

- Milestone 4: Project Progress 2

  Duration: 5 days (May 22, 2023 - May 26, 2023)

  Tasks:

  – Continue monitoring the development progress of the application/system.

  – Maintain punctuality, commitment, and effort in project work.

  - Maintain a log record of the project progress and any challenges faced.

- Milestone 5: Report Writing Progress 2

  Duration: 5 days (May 29, 2023 - June 2, 2023)

  Tasks:

  - Focus on writing Chapter 4 of the project report.
  - Keep a log record of the writing progress and any challenges faced.

- Milestone 6: Report Evaluation

  Duration: 5 days (June 19, 2023 - June 23, 2023)

  Tasks:

  - Submit the PSM1 Draft Report for evaluation by the assigned evaluator.
  - Ensure all required documentation, including the log record and PSM1 Draft Report, are included.

- Milestone 7: Demonstration

  Duration: 5 days (June 26, 2023 - June 30, 2023)

  Tasks:

  - Prepare and deliver a demonstration of the project results.
  - Keep a log record of the demonstration process and any challenges faced.

- Milestone 8: Presentation

  Duration: 5 days (June 26, 2023 - June 30, 2023)

  Tasks:

  - Prepare and deliver an effective and engaging presentation to the evaluator.
  - Focus on aspects such as presentation structure, slide design, audiovisual tools, tone of voice, appearance, and body language.
  - Keep a log record of the presentation process and any challenges faced.

PSM 2:

- Week 1: Meeting 1

  Duration: 5 days (July 31, 2023 - August 4, 2023)

  Tasks:

  - Updating Chapter 4
  - Discussion with supervisor – PSM 1 correction, PSM 2 planning

- Week 2: Meeting 2

  Duration: 5 days (August 7, 2023 - August 11, 2023)

  Tasks:

  - Updating Chapter 5
  - Project Progress 1 [PRJ-1]
  - Log Record – ePSM
  - Progress Presentation 1 (KP1)

- Week 3

  Duration: 5 days (August 14, 2023 - August 18, 2023)

  Tasks:

  - Updating Chapter 5
  - Report Writing Progress [PRJ-3]
  - Log Record – ePSM

- Week 4: Meeting 3

  Duration: 5 days (August 21, 2023 - August 25, 2023)

  Tasks:

  - Updating Chapter 6
  - Project Progress 2 [PRJ-2]
  - Log Record – ePSM

  - Progress Presentation 1 (KP2)

- Week 5: Meeting 4

  Duration: 5 days (August 28, 2023 - September 1, 2023)

  Tasks:

  - Updating Chapter 6
  - Report Writing Progress [PRJ-3]
  - Updating Chapter 7
  - Log Record – ePSM

- Week 6: Meeting 5

  Duration: 5 days (September 4, 2023 - September 8, 2023)

  Tasks:

  - Updating Chapter 7
  - Report Writing Progress [PRJ-3]
  - PSM2 Draft Report preparation
  - Log Record – ePSM

- Week 7: Final Presentation

  Duration: 5 days (September 11, 2023 - September 15, 2023)

  Tasks:

  - Report Evaluation [PRJ6] [PRJ-10]
  - DEMONSTRATION Supervisor [PRJ-4] [PRJ-5]
  - DEMONSTRATION Evaluator [PRJ-9]
  - Log Record – ePSM

2.6 Conclusion

This chapter provides a comprehensive overview of the relevant literature and the chosen methodology for the project. Through an extensive review of existing research and studies, we have gained valuable insights into the subject matter, identified key trends, and identified gaps in current knowledge.

The literature review has laid the foundation for our project by highlighting the existing theories, frameworks, and technologies related to our research area. It has helped us establish a strong theoretical background and understand the context in which our project will be conducted.

Additionally, the chapter outlines the project methodology that will guide our approach and implementation. By carefully selecting and justifying the chosen methodology, we ensure that our project follows a systematic and logical path towards achieving its objectives.

Overall, this chapter sets the stage for the remainder of the project by providing a solid theoretical foundation and a clear methodology. The insights gained from the literature review will inform our decision-making process, while the project methodology will serve as a roadmap for the project's successful execution.

CHAPTER 3: ANALYSIS

3.1 Introduction

In the analysis phase, the proposed system will be thoroughly evaluated and examined to ensure that it meets the required specifications and objectives. This phase will involve gathering and analyzing data on the current system, identifying the system requirements, and designing a feasible solution that addresses the identified problems. The methodology used in the analysis phase will involve the use of data collection tools such as interviews, surveys, and observation. The data collected will be analyzed to identify patterns, trends, and potential issues that may arise during the implementation phase. This analysis will form the basis for the design and development of the proposed system.

3.2 Problem Analysis

The problem statement highlights the inefficiencies and limitations of the current CCTV placement system. To conduct a thorough problem analysis, we need to delve deeper into the key issues and factors contributing to the problem. Here are three aspects to consider:

- Inefficient coverage: The current system often results in areas with blind spots and excessive camera usage. This leads to inefficient coverage, compromising the overall security and surveillance effectiveness. The problem analysis should explore the causes of these blind spots and excess camera usage, such as inadequate planning, lack of proper analysis of the surveillance area, or improper camera placement strategies.

- Cost and maintenance implications: The sub-optimal CCTV placement not only affects coverage but also incurs higher costs and maintenance requirements. The problem analysis should investigate the financial impact of the current system, including the expenses associated with purchasing, installing, and maintaining unnecessary cameras. Additionally, it should consider the operational costs and efforts required to manage the system effectively.

- Lack of consideration for relevant factors: The current system overlooks crucial factors that can affect CCTV placement, such as the distance between cameras. Ignoring these factors can lead to redundant camera coverage or inadequate surveillance in certain areas. The problem analysis should assess the consequences of not considering such factors, including compromised security, limited field of view, and compromised evidence gathering capabilities.

By conducting a comprehensive problem analysis, we can gain a deeper understanding of the issues associated with the current CCTV placement system. This analysis will serve as a foundation for developing an optimized solution that addresses the identified problems effectively.

3.3 Requirement analysis

3.3.1 Data Requirement

The data requirement for this project includes the following:

- Floor plans of the indoor buildings: To optimize the placement of CCTV cameras, the project requires access to the floor plans of the buildings where the cameras will be deployed. These floor plans will serve as the basis for analyzing the layout and identifying potential camera locations.

- Camera specifications: Information regarding the specifications of the CCTV cameras to be used is necessary. This includes details such as camera type, resolution, field of view, and any other relevant technical specifications that will influence the optimization process.
- Building constraints and specifications: Knowledge about the building constraints and specifications is essential to ensure the feasibility and practicality of camera placement. This may include information about building structures, available mounting points, areas with restricted access, and any other factors that may affect camera placement decisions.

3.3.2 Functional Requirement

The functional requirements for the project are as follows:

- Camera placement optimization: The proposed solution should be able to optimize the placement of CCTV cameras in indoor buildings using a genetic algorithm. The algorithm should consider factors such as coverage area, field of view, and the minimum number of cameras required.
- User interface: The project should have a user-friendly interface that allows technicians and engineers to input the necessary data and view the optimized camera placement results. The interface should provide clear visualizations of the camera positions and coverage areas.
- Result evaluation and comparison: The system should provide the ability to evaluate and compare the optimized camera placement with the current methods used. This will enable a quantitative analysis of the improvements achieved by the proposed solution.

3.3.3 Non-functional Requirement

The non-functional requirements for the project include:

- Performance: The solution should be capable of processing the input data and generating optimized camera placements within a reasonable time frame. The performance should be efficient and scalable to handle different building sizes and complexities.
- Reliability: The system should be reliable, ensuring that the optimized camera placements are accurate and consistent. It should also be able to handle any unforeseen errors or exceptions gracefully.
- Usability: The user interface should be intuitive and easy to navigate, even for users with limited technical expertise. Clear instructions and prompts should be provided to guide users through the process of inputting data and interpreting the results.

3.3.4 Others Requirement

Other requirements for the project may include:

- Compatibility: The solution should be compatible with commonly used operating systems and platforms, ensuring accessibility for a wide range of users.
- Documentation: Comprehensive documentation should be provided, including user manuals, installation guides, and technical specifications. This will aid in the understanding, implementation, and maintenance of the solution.
- Security: The project should prioritize data security and confidentiality. Measures should be implemented to protect sensitive information and prevent unauthorized access to the system.

3.4 Conclusion

In conclusion, the analysis phase of the project has provided insights into the current system's limitations and inefficiencies in CCTV camera placement. The problem analysis has identified issues such as inefficient coverage, cost implications, and the lack of consideration for relevant factors.

Based on the problem analysis, the project's requirements have been identified. The data requirements include floor plans, camera specifications, and building constraints. The functional requirements involve camera placement optimization, user interface, and result evaluation and comparison. The non-functional requirements encompass performance, reliability, and usability. Other requirements include compatibility, documentation, and security.

The analysis phase has set the foundation for the design and development of a feasible solution that optimizes CCTV camera placement in indoor buildings. By addressing the identified problems and fulfilling the requirements, the proposed solution aims to improve security, minimize costs, and enhance surveillance effectiveness.

The next phase of the project will involve the design and implementation of the solution based on the analysis conducted.