OPTIMIZATION OF THE LOCATION OF CAMERA IN TWO DIMENSIONAL FLOOR LAYOUT

SITI MUSLIHA BINTI NOR-AL-DIN

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Universiti Teknologi Malaysia

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To my beloved husband, Mohd Khairul Faizal bin Ramli,
father, Nor-al-din bin Md. Lela, mother, Salihah Jusoh, sisters, brothers
and all of my dear friends
for their advices, love and support.

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ABSTRACT

Installation of the security cameras is increasing rapidly in our society that required a secure environment. It motivates us to discover an optimum camera placement in order to improve the coverage of a camera network. It is a significant design problem in order to have a proper camera placement in a distributed smart camera network by considering the number of cameras required. Thus, a method was proposed in order to determine the camera placement by using C and FORTRAN language. Besides that, it is advantageous to maximize the coverage area by using a minimum number of cameras. Hence, in order to reduce the number of cameras used, we divide the area of polygon into grid points. Then, we calculate the camera locations which can cover the grid points as much as possible. We formulate the above problem as a set of maximizing coverage problem.

Moreover, the optimal camera problem was solved by developing a general visibility model for visual camera networks through Binary Integer Programming (BIP). Extensive performance analysis is exhibited using FORTRAN programming. Based on the results of this study, we found that by using a minimum number of cameras, it is sufficient to cover the entire area. Finally, the current results and future recommendations are presented in the report.

ABSTRAK

Pada masa kini, pemasangan kamera keselamatan semakin meningkat dikalangan masyarakat kita yang memerlukan jaminan keselamatan yang efisien. Ini mendorong kita untuk membentangkan penempatan kamera yang optimum untuk meningkatkan liputan rangkaian kamera. Ianya merupakan reka bentuk masalah yang penting untuk menempatkan kamera yang berada dalam rangkaian kamera pintar yang teragih dengan mengambil kira bilangan kamera yang diperlukan. Oleh itu, satu kaedah telah dibentangkan bagi menentukan penempatan kamera dengan menggunakan pengaturcaraan C dan FORTRAN. Selain itu, ianya juga wajar untuk memaksimumkan keluasan yang dilitupi oleh bilangan kamera yang minimum. Oleh yang demikian, untuk mengurangkan penggunaan bilangan kamera, kami membahagikan keluasan poligon kepada titik grid. Kemudian, kami mengira lokasi kamera yang mampu melitupi titik grid sebanyak mungkin. Kami memformulasikan masalah di atas sebagai satu set masalah dalam memaksimumkan pelitupan.

Tambahan pula, masalah penggunaan kamera yang optimum telah diselesaikan dengan cara menghasilkan model penglihatan umum untuk rangkaian kamera visual melalui Pengaturcaraan Integer Perduaan (BIP). Analisa pengaturcaraan yang lebih meluas dipamerkan menggunakan pengaturcaraan FORTRAN. Berdasarkan keputusan kajian ini, kami mendapati dengan menggunakan bilangan kamera yang minimum, ianya mencukupi untuk melitupi seluruh kawasan. Dan akhirnya, keputusan kajian semasa dan cadangan masa depan juga dibentangkan dalam laporan ini.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS/ABBREVIATIONS

P_e	-	Polygon
P_i	-	Simple polygon
P_k	-	Simple polygon holes
∂	-	Boundary operator
P_v	-	Visibility polygon
Π	-	A set of candidate camera
FoV	-	Field of view
BIP	-	Binary Integer Programming

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Enlarging the vision of the surveillance camera has become a very hot research topic in recent years. The social demand for the security system is highly required to perform variety tasks such as general surveillance in various type of industry. Mathematics in Industry Study Group (MISG) is a well-known collaborative problem-solving workshop which involving the expert applied mathematicians. MISG will give the best solution for the real life problems shared by local companies, and also provide an opportunity for the mathematicians to be exposed in industrial problems. Having a link between industry and university will encourage the greater use of mathematical modeling and analysis in industry. One of the problems in MISG workshop is the camera replacement problem which was proposed by MIMOS Berhad.

There are various areas of research related to security monitoring, especially efficient equipment placement. The placement of surveillance sensor on a surface, like telecommunication relay towers, fire and watch towers, prison watch towers, has been undertaken for Art Gallery guard placement. The Art Gallery problem is one of the problems which have been widely discussed in the computational geometry

literature. The aim of the findings is to minimize the number of guards for a polygon such that every point in the polygon is visible by at least one guard. The problem was developed in addressing restricted guard visibility, but generally unrealistic guard capabilities are assumed (Erdem & Sclaroff, 2004).

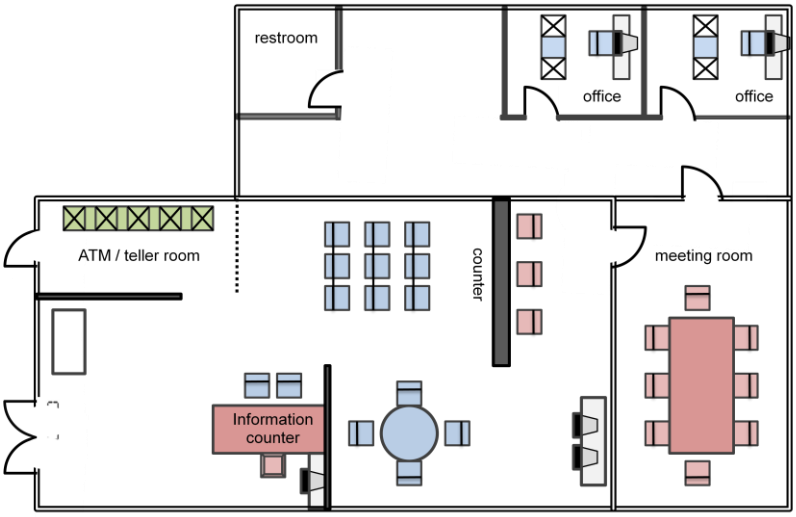

Figure 1.1: Sample of the two-dimensional floor plan layout

If we desire to provide an efficient security vision to the floor layout (Figure 1.1), the system required to perform variety tasks such as general surveillance (detection of loitering behavior, detection of unusual or suspicious behaviors, detection of abandoned objects, monitoring of crowd movements, etc.), subject tracking, activity classification, gesture recognition, etc. Each of these tasks may have different requirements and features of interest. As a result, optimal camera placement may vary from task to task. In addition, task location will vary throughout the area since people are free to move throughout the area of interest in any direction they like (Bodor & Schrater, 2005).

1.2 Problem Statement

It is reported that security at numerous public places such as hotel, bank, hospital need to be further enhanced. Most of the criminal acts were happened while they were there because the traffic at these locations helps the criminals to act upon their illegal activities such as robberies, grazing, stealing, etc. Public places that demand a very tight security system such as banks, hotel lobby, exhibition centre, mosque, etc. were using the camera surveillance in order to observe and monitor the places. But, in a practical scenario, the cameras are randomly scattered in a wide area and each camera may adjust its orientation but cannot move in any direction. Thus, the surveillance cameras are failed to fully utilize because of the blind area.

Blind area is the area where the cameras are not able to provide a security vision because of the presence of obstacles that obstructed the camera views. As applied in cellular telephone networks, the aim of the application is to have as much coverage as possible within a predefined region, with an acceptable level of quality-of-service. In this paper, we pose the problem of optimal camera placement for a given region and vision task. We focus on the camera placement problem where the goal is to determine the optimal positioning and minimize the number of camera used for a region to be observed, given a set of task-specific constraints and a set of possible cameras to use in the layout. Maximizing the field of coverage tends to tighten the security system, and also contribute to minimize the cost spent in security vision.

1.3 Objective of the Study

Installation the surveillance cameras with the effective vision system is the most significant optimization task in the operation of the security systems. Solving the problems related to surveillance cameras is computationally expensive. Meanwhile, the complexity of this problem grows exponentially in order to make sure that it is satisfying the demand and reserve requirements. Several solution strategies have been proposed to provide quality solutions to the problem and increase the potential approach among researchers. The objectives of the study are as follows:

- To tighten the security system of public places by using the minimum cost.
- To minimize the total number of surveillance cameras used.
- To place the cameras at the best location where give the maximum viewing coverage area.
- To introduce the region of interest and apply it in solving the problem.
- To develop and introduce C and FORTRAN program that will be the effective solution which satisfying the demand and reserve requirements.

1.4 Scope of research

This study will focus on how to appreciate the use of C language in solving the optimization of the camera placement in two-dimensional layout. Most of the problems in two-dimensional that has been effectively solved through C endows with a new avenue for solving other challenging problems that is the problem in three-dimensional. Furthermore, mathematical approach will be beneficial to use in solving complex and intractable problems by availability of the fast and inexpensive

computer. However, in this research, we will only restrict our scope of the camera placement problems in two-dimensional layout.

1.5 Significance of the Study

The result of this study will help engineers in positioning the cameras at the best location. It will automatically assist the engineers in reducing the use of time in finding the solution. It is not manageable for engineers to spend too much time in doing the research to get the best camera placement, but still need to take into account the technical aspects. Therefore, it must be recognized that the use of C and FORTRAN language are very helpful in various aspects such as in security system, financing, economics, etc. Advancement in computer technology also enables us to formulate and solve complex system as well as the visualization of solutions quickly and accurately.

Minimizing the cost is one of the main objectives of this study. The installations of the surveillance cameras are among the inexpensive approach in order to tighten the security system. However, this study will able to minimize the cost of installation because the numbers of cameras used are also in optimum level.

The increasing crime rates shows that the security system should be tighten in order to ensure the safety of all. This study also significant in fulfilling the increasing practical need and social demand for the security system in industry. We choose the most inexpensive approach, which the use of C programming could be an effective way to reduce the criminal acts in our society.

1.6 Outline of the report

This report consists of three chapters. Chapter 1 is the introduction of camera placement, describing background of the problem, statement of the problem, objectives of the study, significance and outline of the report.

Chapter 2 states about the literature review done for this project. It explains generally about the surveillance camera, explanation of methods used in binary integer programming in order to minimize the number of cameras while increasing the coverage. It focuses more on the combination of the Branch-and-Bound technique and also the Boolean method.

Chapter 3 provides more exposure and further discussion on the research methodology which consists of the visibility algorithm, camera placement algorithm, layout configuration, and the optimization model and research framework. This report ends with the expected outcomes and also the conclusion of the project.

Chapter 4 discusses about the results that obtained from C and FORTRAN. The first draft of polygon was draw out by using Microsoft Excel. We can solve the problems from the ratio view of internal nodes to the total number of internal nodes using C programming.

Finally, chapter 5 concludes the study and some related and useful recommendations are suggested for further research.

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