SOFT COMPUTING APPROACH FOR SOLVING ELEVATOR SCHEDULING PROBLEM

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SOFT COMPUTING APPROACH FOR SOLVING ELEVATOR SCHEDULING PROBLEM

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LIST OF ABBREVIATIONS

CT	-	Call Time
DNA	-	Deoxyribonucleic Acid
ESP	-	Elevator Scheduling Problem
EC	-	Evolutionary Computing
ETA	-	Estimated Time Arrival
FL	-	Fuzzy Logic
GA	-	Genetic Algorithm
GP	-	Genetic Programming
GUI	-	Graphic User Interface
HC	-	Hard Computing
HDTV	-	High-definition Television
Matlab	-	Mathematics Laboratory
MIQ	-	Machine Intelligent Quotient
MSPCLASS	-	Computer Program for an Automatic Classification of Scheduling Problem
Multiobj	-	Multiobjective
NN	-	Neural Network
NP-Hard	-	Non-deterministic Polynomial-time Hard
PEI	-	Performance Evaluation Index
SC	-	Soft Computing

ABSTRACT

Elevator scheduling problem involves finding an optimal path of certain number of elevators movement in a building with certain number of floors. It is formulated as an integer programming problem. In order to solve the scheduling problem on elevator, a genetic algorithm as part of soft computing is used in a real time system. It becomes an option because the minimum optimization can be counter through this method where some specific criteria have to be fulfilled that will result in the minimization of passengers travelling and waiting time in or for an elevator. In order to manipulate the scheduling problem solution, designed and developed simulation software for the optimization of elevator scheduling problem is introduced and presented by using soft computing methodology.

ABSTRAK

Masalah penjadualan lif melibatkan keputusan mencari laluan yang paling berkesan bagi bilangan lif yang tertentu yang bergerak dalam sesebuah bangunan dengan bilangan tingkat tertentu. Ini dirumuskan sebagai masalah pengaturcaraan integer. Untuk menyelesaikan masalah tersebut, algoritma genetik yang merupakan sebahagian daripada perisian pengkomputeran digunakan dalam sistem operasi sebenar. Kaedah ini menjadi pilihan kerana minima pengoptimisan boleh dikira melalui kaedah ini dengan memenuhi kriteria yang spesifik sebagai penyelesaian yang minima bagi pengguna yang menaiki dan menunggu untuk menggunakan lif. Bagi memanipulasi masalah penjadualan ini, rekabentuk dan perisian simulasi diperkenalkan bagi meminimakan masalah lif tersebut dengan menggunakan kaedah pendekatan perisian pengkomputeran.

CHAPTER 1

INTRODUCTION

1.1 Project Overview

Optimizing routes of an elevator group is the generalization of the model of the elevator scheduling problem (ESP). After the development of soft computing (SC) method, an elevator problem can be solved using this way. SC is a concept that was introduced by Zadeh [1], the discoverer of fuzzy logic (FL). SC refers to modes of computing in which the solution is turn to trade for tractability, robustness and ease of implementation [2].

Modern elevators are the crucial element that makes it practical to use and work dozens of stories above ground. High-rise cities even in smaller multi-storey buildings totally depend on elevators [3]. An elevator system is a system that transports passengers from one floor to another in a building. Passengers are transported in respond to their requests, which consists of hall calls and car calls. A passenger who wants to go to another floor from the current floor presses a hall call button and waits for an elevator to reach at the destination, then enters the elevator and presses a car call button in the elevator to go to the desired floor [4].

In high-rise buildings, a group of elevators provides the passenger traffic [5]. Therefore, a careful design is required to give good elevator service even though the task to provide good quality of elevator service is complex. Mathematical methods to control an elevator group have been studied quite frequently. While, an element approached in solving elevator problem using SC is not widely used and applied in order to minimized the problem in elevator and optimized the ESP.

In general, ESP represents a class of scheduling problems [6]. The ESP involves finding an optimal path, or it can say that it is about a research of finding the shortest elevator travel path of a building to go through with certain number of elevators and floors. Since SC method is suitable to solve combination of mathematical problems, an ESP is an option as a benchmark to be improved using this computing technique. Certain criteria need to be fulfilled for the problem solution such as initial elevator position, its destinations and hall calls made for an elevator [7].

Genetic algorithm (GA) method is developed to solve the optimization problem in a real time method [8]. In GA, not only the optimal path of elevators is considered. But also the method can be generalized easily to control scheduling problem as well by minimize the passengers and waiting time in or for an elevator. Since elevator serves both calls which is car and hall calls, SC approach by using GA method will provide a solution for solving ESP. It can be done by minimizing the time spent by passengers waiting for service, time spent by passengers to travel from one floor to another, and also to serve as many passengers as possible in a given time.

1.2 Elevator Descriptions with Humans Interacting

Most buildings are equipped with an elevator group installation comprising two to eight cars. Humans interact with these systems by pressing a call button, which issues a car call at the floor in question. In many cases, there are two call buttons which going up and down which created for humans to indicate their desired travel direction.

In larger buildings, a display might give the waiting passenger information about where the cars are at this time located in the building. Usually, passengers do not know where the elevators are, which direction the cars are going, or which car will serve them. Thus, while waiting, users typically scan the elevator doors. If they have to wait too long, they often become impatient and press the call button again, sometimes even in both directions in their uncertainty whether the system has recorded their call. People have been observed to press all possible buttons again and again, in fact in the unreasonable belief that pressing all the buttons will make an elevator arrive sooner.

When the elevator arrives, passengers enter the car and press the desired floor buttons, which issues a car call from the particular car. Sometimes passengers change their minds and press additional floor buttons, or they might hold doors open for other passengers, or they get off.

The software of elevator control faces the same scenario but from a different perspective. It considers the cars, each having a number of hall calls and the car calls to serve, the current floor position, and the current travel direction of each car. Some

of the floors to be served might lie ahead of the car given the current travel direction, and others might lie behind it, requiring the car to turn around and head in the opposite direction.

1.3 Problem Statements

The problem that has been encountered for elevator system in scheduling problem are selection of destination or called as car calls and the second one is request an elevator or hall call.

1.3.1 Car Calls

The point focused in this problem stated in [9] where the user in the elevator presses an up or down elevator button to select a destination floor to which it wants to move. There is a problem where the user is in the elevator. When the user presses an elevator button to go up, the elevator button sensor will sends the elevator button request to the system, and it will recognize the destination floor the user needs to go. Unluckily, at the same time, there is a new call is added to the list of floors to visit.

If the elevator is fixed, the system determines in which direction the system should move in order to service the next request. As the elevator moves between floors, the arrival sensor detects that the elevator is approaching a floor and notifies the system. If there are other exceptional requests, the elevator will visit these floors on the way to the floor requested by the user. In time, the elevator arrives at the

destination floor chosen by the user. Next, the movement of the system is elevator has arrived at the destination floor selected by the user. But this destination will take a few minutes to arrive where the elevator system has sends the request and move to take it.

1.3.2 Hall Calls

This problem also studied in [9], the user at a floor presses an up or down floor button to request an elevator. This is the case where a user at a floor and wants to an elevator. When the user is at floor, there is only the direction represented by the elevator which is either move up or down. This condition is called hall calls. Thus, for example, user presses an up floor button. Then, the floor button sensor sends the user request to the system, identifying the floor number. The system selects an elevator to visit this floor and also at the same operation, there is a new request added to the list of floors to visit. If the elevator is fixed, the same operation goes like the case before. The system determines in which direction the system should move in order to service the next request. If there are other outstanding requests, the elevator visits these floors on the way to the floor requested by the user following the above sequence of dispatching and stopping. In the end, the elevator arrives at the floor in order to response the user request.

1.4 Motivations and Objectives

Since Tyni and Ylinen [10] has developed a real-time problem solution using optimization, a variety of combinatorial problem researches has been solved using GA approach where it is formally occur in real science and mathematics world. Although SC approach which turns to GA is mainly used in science and mathematics while it is one of the most suitable methods to solve mathematical problem, it is still not satisfied in solving scheduling problem. This is because, GA cannot gives an exactly significance reaction of the solutions.

Therefore, through of this limitation, this research is particularly using GA with based on optimization for solving ESP. This can help in solving engineering problem occurred where it is always relates to mathematical solutions. In this research, the minimum path and travelling time will be considered by minimizing the passengers and waiting time. This method solution is proved by applying the algorithm of finding the optimal path with the minimum time travel. The following are the objectives of the project:

1. Able to understand the SC approach for solving the ESP.
2. Finding and capable to design the optimal path of certain number of elevators movement in a building with certain number of floors.
3. To design a simulation software for an optimization of passengers waiting time.
4. Able to solve/ improve/complement the problem stated.

1.5 Scope of the Project

The following is the scope of the project:

1. To develop a technique for an ESP by using GA approach.
2. To simulate coding for the optimal path travelling with a certain number of elevators and certain number of floor by using Matlab tools.

1.6 Thesis Structure

This project is represented in five chapters. Each chapter will represent their scope which has been focus on. In Chapter 1, it represents about the overview of the project where the problem in elevator is introduced, SC approach for solving ESP and the method that will be used in this project. It is also the motivation on why this project is doing, the objective to achieve, and also the research scope.

In Chapter 2, it represents what is SC about and why it is used as an approach to solve problem. Then, it continues with the discussion about the tools that are going used as a solution of the problem of this project. The tool used for solving ESP is GA where it involves numerical solution.

In Chapter 3, the methodology of the research is explained. This chapter will shows and represents the method of mathematical solutions used in GA and how this method works. The possible path is also calculated to find the optimal path of minimum time to be travelled by an elevator.

Next, in Chapter 4, it will continue to display all the results of solving the elevator problem using mathematical laboratory (Matlab) tools. Analysis and discussion on how the result is obtained is represented in this chapter. Each tables and figures are shown and explained in this chapter.

Finally, after all the parts are completed, the conclusion of this project will be summarized in Chapter 5 to review from the beginning on how the problem of elevator is defined until the results is obtained. Besides, some recommendation for future works will also be discussed for further improvement for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This part starts first with the brief description of what is SC which become as an approached in solving scheduling problems. An overview of the component of SC techniques which is GA approaches as a method that used is presented and an instance of these in ESP research are discussed. An approaching into the possible structure of GA data, for current and future systems is presented. The description of scheduling problem is also discussed and related explores in the ESP by previous research is being reviewed in order to propose the solution of the scheduling problem using this method.

2.2 What is Soft Computing?

SC is dedicated to system solutions based on SC techniques. It provides rapid dissemination of important results in SC technologies [11]. Over the last twenty years, SC has developed rapidly as a discipline and method for the analysis and diagnosis in science and technology fields. The aims of SC become as a key methodology to encourage the integration of SC techniques and tools into both

advanced applications [11]. Since the artificial intelligence (AI) has existed about 40 years as a science, reproduction of human reasoning processes and behavior has become the main problem. This problem performance is together with the help of computers and other artificial devices making by humans in inaccurate and uncertain environments [12]. A fixed models, methods and algorithms for solving problem in most cases of various areas are not available which characterize with uncertainty [1].

Therefore, SC technology is develop as a guide to provide and solving for approximate reasoning and search tasks with a set of flexible computing tools. Soft computing also implies cooperative activity rather than independent one for such new computing paradigms as FL, neural networks (NN), GA, evolutionary computation (EC) and others [12]. Each of these components has their own advantages and disadvantages as it is used in mathematics and science applications. Different with hard computing (HC) schemes, which attempt for exactness and full truth, SC techniques utilizes the given tolerance of imprecision, partial truth, uncertainty and a particular problem. In fact, it provides an attractive opportunity to represent the ambiguity in human thinking with real life uncertainty [13].

SC uses soft techniques contrasting it with classical artificial intelligence HC techniques [14]. Generally, it can be said that SC techniques resemble biological processes more closely than traditional techniques. It is largely based on formal logical systems, such as sentential logic and predicate logic, or rely heavily on computer-aided numerical analysis (as in finite element analysis).[15] SC is often robust under noisy input environments and has high tolerance for imprecision in the data on which it operates. One of the SC approach is GA which designed for global optimization and search.