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Controlling of Load Elevators by the Fuzzy Logic Method

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***Abstract*—**In this study, a fuzzy-logic based control system was designed to ensure that time and energy is saved during the operation of load elevators which are used during the construction of tall buildings. In the control system that was devised, for the load elevators to work more efficiently, the energy interval where the motor worked was taken as the output variable whereas the amount of load and the building height were taken as input variables. The most appropriate working intervals depending on the characteristics of these variables were defined by the help of an expert. Fuzzy expert system software was formed using Delphi programming language. In this design, mamdani max-min inference mechanism was used and the centroid method was employed in the clarification procedure. In conclusion, it is observed that the system that was designed is feasible and this is supported by statistical analyses..

***Keywords*—**Fuzzy Logic Control, DC Motor, Load Elevators, Power Control.

I. Introduction

We are always in a position to question where and how we use energy in our world which has limited energy resources. It is necessary to take into account conservation of energy and energy consumption in every product that is manufactured in the world. Today, the principle that how the best yield can be obtained spending the least energy is the main drive behind all production efforts.

There is a steady increase in the use of energy, which is needed to meet all kinds of comfort requirements of users in ever increasing numbers of buildings that are constructed to meet one of the most basic needs of mankind, i.e. accommodation. Uninformed use of energy resources and natural environment in order to raise living standards in buildings upsets the natural balance of the world irrevocably. It is necessary, in the face of environmental and energy problems, to use energy resources in maximum efficiency, respect future generations' right to benefit from these resources and create healthy environments without doing damage to natural cycles. This necessity caused an environment-friendly and energy-efficient building design approach to be adopted by a large majority of people. Such an approach involves dealing with design stage, construction stage, usage stage, post-usage and demolition stages of buildings or settlement groups that can be considered a product in a manner that will not do damage to ecosystems [1].

Rapid progress of today's technology confronts us, as in all fields, in the construction stage of buildings. Elevator systems that have the capacity to do more work with less energy are used in the construction stage of high rise buildings. For this purpose, Lutfi AI-SHARIF summarized energy consumption as follows. A series of different methods and techniques are used in elevators in connection with energy consumption. Four methods come to the foreground among them:

1. Calculation from first principles,
2. Calculations using formulate and tables,
3. Measurement only,
4. Hybrid (Measurement and Calculation).

In contemporary energy consumption studies, on the other hand, modelling and analogy are used. All these energy consumption models are intended to meet different needs such as design improvement and improvement of parts and/or environmental problems. [2].

This study intended to provide control by fuzzy logic system in order to use the motor power that is used in rope load elevator systems in a controlled manner with a view to saving energy. The purpose here is to use the amount of energy to be used in a controlled manner and so much as is needed.

II. DC Motors

It is quite difficult to control motors working with alternative current due to the changeable qualities of alternative current. Therefore, the use of motors working with direct current (DC) is quite widespread in industrial fields.

DC motors are generally preferred in industrial applications such as electric trains, cranes and load elevators. As they have a high start-up moment, they start with heavy current initially. This high start-up current need to be reduced definitely as it does damage to motor winding and increases power consumption. This procedure can be performed using an appropriate driving and controlling system. Since fuzzy logic has controlling and adaptable features, it can yield powerful results in systems that have uncertainties and changeable parameters and load distributions [3].

III. Fuzzy Control

Fuzzy logic basically uses decision and logic mechanism used by humans that is characterized by a lack of definite borders rather than machine logic or absolute logic [4]. It has become possible to express very many phenomena through the use of fuzzy logic which we cannot express via classical logic. Fuzzy logic has found area of use in very different fields from automatic control systems to information systems, from image

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identification to optimization etc. [5]. Fuzzy logic control systems do not require full knowledge of the system as in known PID control designs. It replaces this knowledge with the experience and mastery of man, who is called expert [6-8]. General structure of the fuzzy decision-making system is given in Fig. 1 [7], [8].

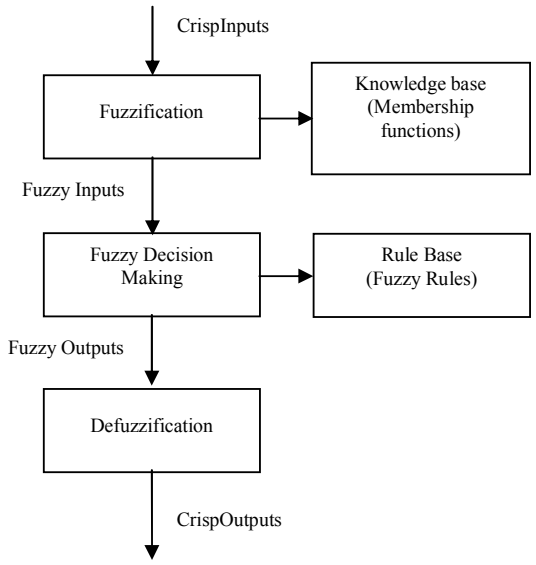

Fig. 1 General structure of the fuzzy decision-making system

IV. Controlling of the Load Elevator Motor

Elevators are described as electromechanical facilities that are used for carrying load and people in mobile cabins or platforms in a vertical direction between guide rails [9].

As an indispensible part of modern life, elevators constitute an important topic title in terms of electric drive systems. The developments that have taken place in electric drive systems, which is one of the fastest developing branches of Electrical Motorizing, and electric motor systems led to the emergence of newer and superior choices in elevator systems as well as industrial applications instead of classical solutions [10].

DC motors are used in load elevators because they are controllable. These motors spend high quantities of energy no matter what the amount of load they are going to carry is. Therefore, they constantly draw high amounts of current. What height the load will be elevated to is not important for these elevators.

In our world, where energy conservation is very important, we should pay attention to the fact that each product that we produce is manufactured in accordance with the principle of energy conservation. For this purpose, a fuzzy control system was developed for a more efficient use of energy in motors that are used in load elevators. The basic structure of this system is shown in Fig. 2.

In the designed system, two input variables were defined, namely by taking the weight of the objects put on the load elevator as Load Weight (LW) and the height where the elevator will be elevated to as Building Height (BH). The input variables obtained here were sent to the fuzzy control mechanism, the most appropriate result was found from among the defined rules system and the amount of power that the motor would spend was transferred to the output variable as Motor Power (MP). Parameters and linguistic expressions formed for fuzzy logic are given in Table I.

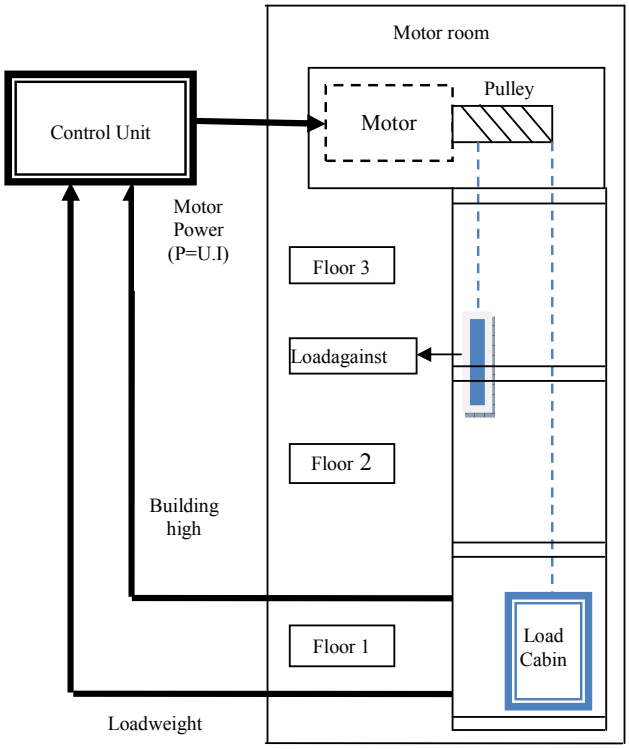

Fig. 2 Designed control system

Triangular clouding agent was used for the linguistic expressions given in Table I. Moreover, limit values for each fuzzy expression were given in Table I. Membership functions and membership function degrees were defined in the software that was prepared using Delphi programmer. Membership functions formed for each parameter are shown in Fig. 3, 4 and 5.

TABLE I
Input-Output Parameters and Linguistic Expressions

BuildingHeight*(m)*		**LoadWeight*(Kg)***		**Motor Power *(Kw)***	
Very Low	VL	Very Light	VL	Very Few Powerful	VFP
Low	L	Light	L	Few Powerful	FP
Middle	M	Middle	M	Middle Powerful	MP
Very High	VH	Heavy	H	Very Powerful	VP
Very Very High	VVH	Very Heavy	VH	Very Very Powerful	VVP

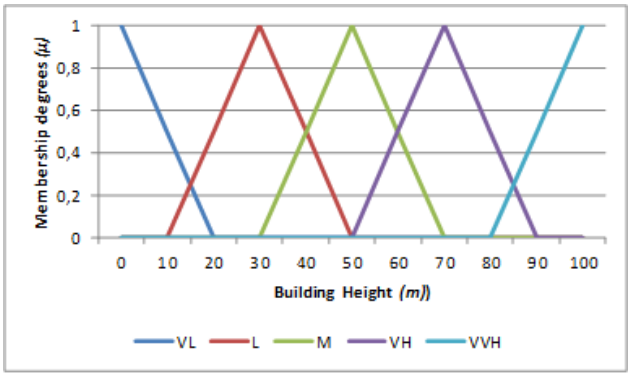

Fig. 3 The membership functions of Building Height (BH)

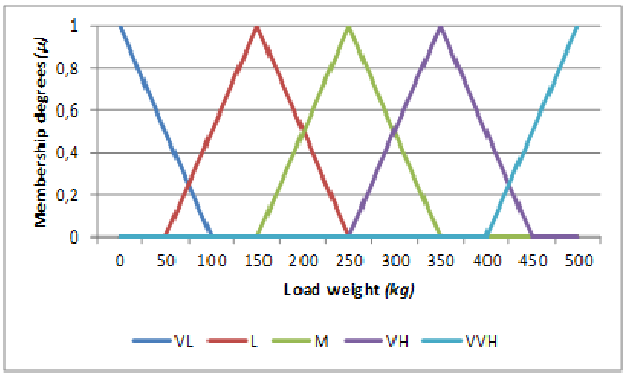

Fig. 4 The membership functions of Load Weight (LW)

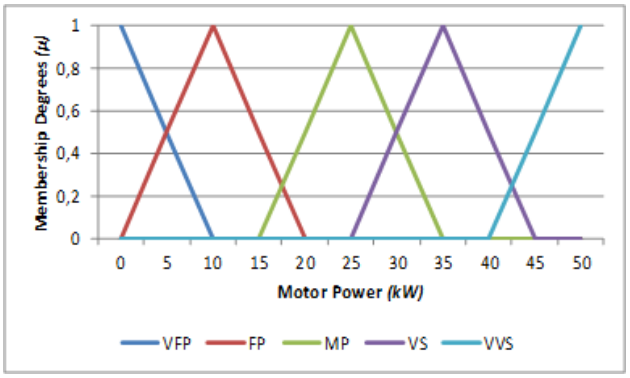

Fig. 5. The membership functions of Motor Power (MP)

Rules obtained from membership functions are given in Table II.

The software belonging to the system design determined in Fig. 2 was developed using Delphi software and the same results were checked on Matlab using fuzzy logic toolbox. The software belonging to the software that was formed is shown in Fig. 6.

TABLE II
RULE BASE

Rule Number	BH	LW	MP
1	Very Low	Very Light	Very Few Powerful
2	Low	Light	Very Few Powerful
3	Very Low	Middle	Few Powerful
…	…	…	…
12	Middle	Light	Few Powerful
13	Middle	Middle	Middle Powerful
…	…	…	…
23	Very Very Height	Middle	Very Powerful
24	Very Very Height	Heavy	Very Very Powerful
25	Very Very Height	Very Heavy	Very Very Powerful

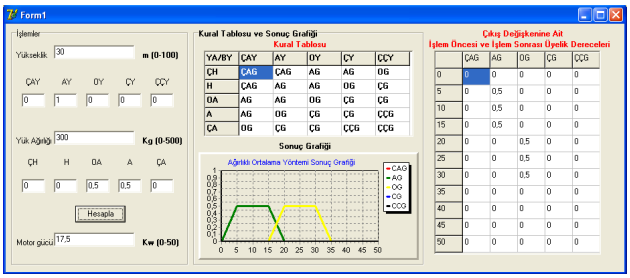

Fig. 6 Software of Designed System

V. Conclusions And Future Work

A great majority of load elevators used in the industrial field are designed using DC (direct current) motors. The control systems used in the design of these elevators are not sufficiently developed. Therefore, energy conservation was not given proper attention in the systems that were used. This study intends to save both energy and time by using fuzzy logic in the design stage of load elevators. The amount of load that the motors which are used in load elevator systems and use up much of the energy and to what height these motors will elevator the load were taken as input parameters and the amount of power that the motors will draw from the system depending on these variables was taken as the output parameters. The amount of energy that the motor spent was brought under control thanks to the system that was designed (Fig. 7).

If the power that the motors used in load elevators spend (P=I.V) is taken into consideration, it will be seen that the motor will draw high quantities of current for the high quantities of power it will spend. This will both increase the amount of energy spent and reduce the lifespan of the motor. Therefore, a system designed using intelligent systems will spend less energy. The motor used in the system will not be exposed to unnecessarily excessive current (I). Thus, lifespan of the motor will be prolonged and problems arising from the motor will be reduced to a minimum.

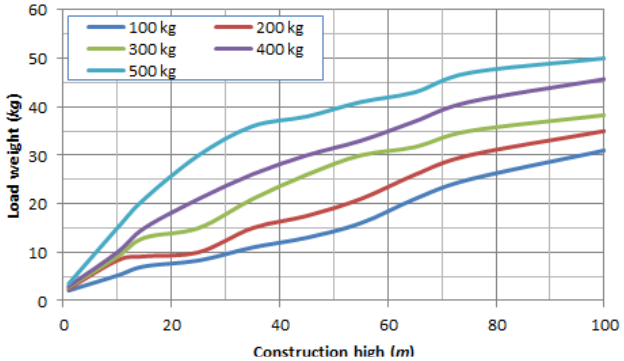

Fig. 7 Variation of Motor Power according to Building Height and Load Weight

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