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A Review On: Optimization of Elevator Usage By Image Processing For Optimal Energy Conservation

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ABSTRACT: This study describes the study on efficiency and passenger convenience are the main design goals for a four-story building's two elevator system. When a floor's lift call button is hit and someone is standing in front of the door, the lifts are designed to stop. In order to minimize delays and ensure intentional pauses, a sensor system counts the number of passengers waiting in front of the door. By staying inside its predetermined parameters, the system improves safety and avoids crowding. These criteria are coded using MATLAB software and Image Processing Technique, which makes it possible to integrate sensor data with the lift control system seamlessly. By maximizing both passenger safety and time efficiency, this system offers a dependable and convenient mode of transit inside the building structure using Image processing. In the future, this system may be integrated with smart building management to optimize elevator usage according to demand and traffic in real time. It's similar to giving the elevators even greater intelligence and reactivity to the demands of the building's residents!
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KEYWORDS: Elevator, MATLAB, Efficiency, Optimization, Image Processing, Design

I. INTRODUCTION

This study suggests a unique algorithm for controlling lifts that makes use of data from fictitious security cameras placed in lift cars and building corridors. The cameras count people, kids, things in lifts, and those waiting for them, with corresponding accuracy probabilities. To calculate an effective passenger number, this data is represented using a Bayesian network. By allocating lifts in an efficient manner in accordance with passenger demand, the algorithm seeks to reduce average travel, journey, and waiting times.

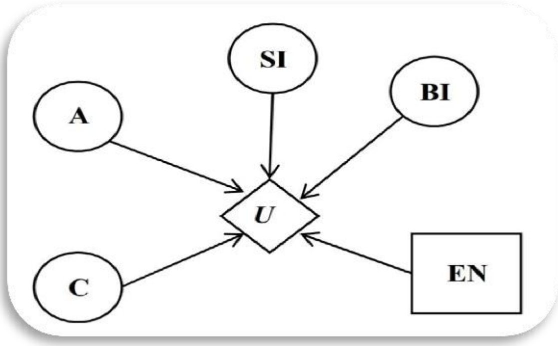

Fig.1. Bayesian network for effective no. of people

In comparison to traditional methods, the suggested algorithm slashed trip times by as much as 39.94% in a case study of a 10-story building with five elevators. When there was little or no traffic, performance was at its worst.

- Number of Adults (A): 21 states, ranging from 0 to 20, for the cameras on each floor; 11 states, ranging from 0 to 10, for the cameras inside a lift car.
- Number of Children (C) - for the cameras on each floor-21 states from 0 to 20; - for the cameras inside an elevator car-11 state from 0 to 10.
- Number of Small Items (SI): 21 states, ranging from 0 to 20, for the cameras on each floor; 11 states, ranging from 0 to 10, for the cameras inside a lift car.
- Number of Big Items (BI): 21 states ranging from 0 to 20 for the cameras on each floor and 11 states ranging from 0 to 10 for the cameras inside a lift car.[1]

This document describes how lift energy efficiency is measured using the ISO25745-2 standards and how motor losses are modelled. The standard makes use of a straightforward constant efficiency model in which output power is directly correlated with motor losses. However, torque and operating speed determine a motor's true efficiency.

International Journal of Engineering, Management and Humanities (IJEMH)
Volume 1, Issue 1, pp: 01-05 www.ijemh.com

Two different approaches to computing motor losses are presented in the paper: one based on motor efficiency and the other on copper and iron losses. In a mock lift system, it uses these techniques on sample induction and permanent magnet motors. The findings demonstrate that the constant efficiency approach understates losses, particularly for induction motors where operating variables have a greater impact on losses. This suggests that the standard might not be able to distinguish between PM and induction motors' energy consumption variations with accuracy.[2]

This work analyses the use of four optimization techniques (Simulated Annealing, Genetic Algorithm, Particle Swarm Optimization, and Whale Optimization Algorithm) to solve the Elevator Dispatching Problem (EDP). The objective of the EDP is to reduce the mean travel time for passengers who utilize a lift system.

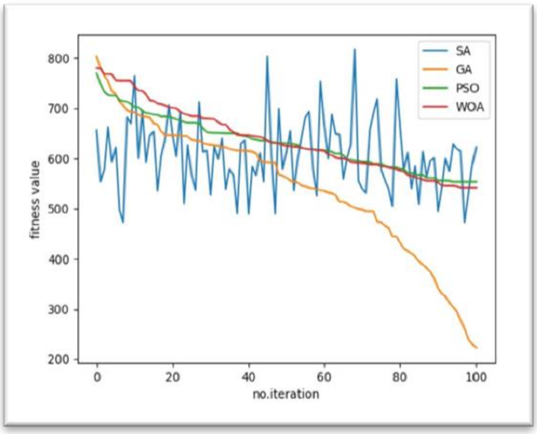

Fig.2. Convergence Plot of SA (Blue), GA(Orange), PSO(Green), WAO(Red) respectively

To optimize the path a lift would follow, the algorithms are put into practice and tested on a case study. The Genetic Algorithm outperformed the other techniques in identifying high-quality solutions across a number of iterations, according to the data.[3]

The paper outlines a digital image processing technique for identifying people in digital photos. It entails segmenting the image into regions, identifying areas with different skin tones, identifying regions with faces, and creating a human figure by assembling regions close to the face using a graphical model.

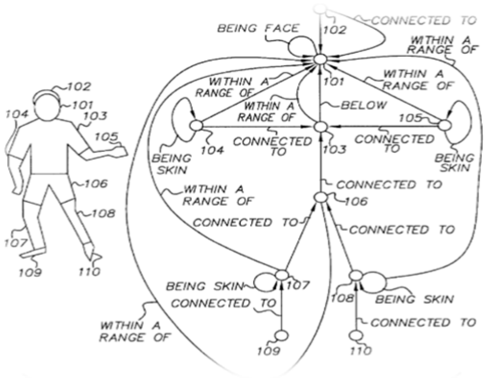

Fig.3. Object detection algorithm

The technique makes use of statistical skin colour models for skin detection, adaptive colour segmentation, and a straightforward face detection algorithm that fits ellipses and finds valleys. Next, potential bodily parts are connected based on limitations derived from an anthropological graphical model that depicts the connections between components. Finding dressed, unknown human individuals in a variety of positions and scenarios is the aim; no presumptions on attire, stance, etc. are made.[4]

Elevator group control (EGC) optimization is discussed in this study as a limited multi-objective issue. EGC entails giving lift cars moving and stopping policies, which can be difficult because of competing goals like energy efficiency and passenger happiness. While the majority of earlier research integrated objectives into a single function, this study presents the problem as a true multi-objective problem.

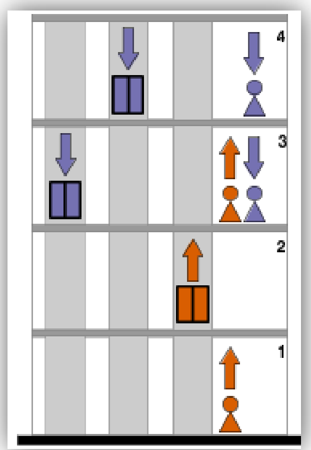

Fig.4. Graphical representation

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Volume 1, Issue 1, pp: 01-05 www.ijemh.com

It simulates EGC using the S-Ring model and finds Pareto front approximations for nine lift system test cases using five multi-objective optimization techniques.

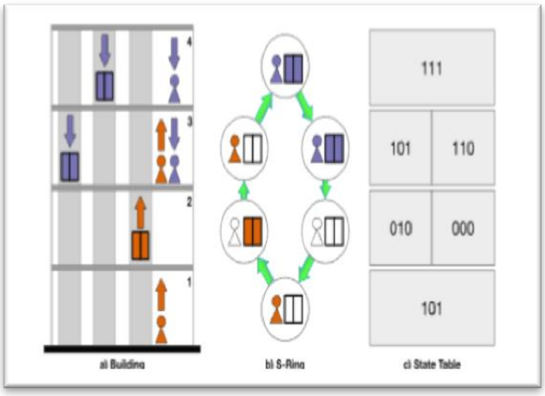

Fig.5. S-Ring model with related building and state table. (a) shows a building with three elevator cars, four floors, and two waiting passengers for each direction. Upwards and downwards direction is possible for elevators and passengers and are colored red and blue, respectively. (b) illustrates the S-Ring model for this building, with a single node for the first and the top floors and two nodes for the rest. (c) displays the state encoding for each of the S-Ring nodes

The study demonstrates that NSGA-II coupled with restricted domination performs best on the test scenarios and validates the approach's scalability.[5]

The development, traits, substance, and applications of digital image processing technology are covered in this document. It illustrates how computers are used in digital image processing to enhance, segment, restore, and remove noise from photos. It has evolved in tandem with mathematics, computer networks, and the rising demand for applications. Compression, picture acquisition, and enhancement and recovery are the main content topics covered. Among the application domains covered are engineering, manufacturing, medical, and more. With ongoing technological advancements, digital image processing is now widely employed.[6]

This paper details the Verilog HDL-based design and implementation of a twin lift controller system. It covers the fundamentals of lift operation as well as the architecture of a lift controller, including design assumptions. The controller, sensors, door operator, timer, and request buttons are important parts. For verification and implementation, the design is synthesized and simulated on a Xilinx FPGA.

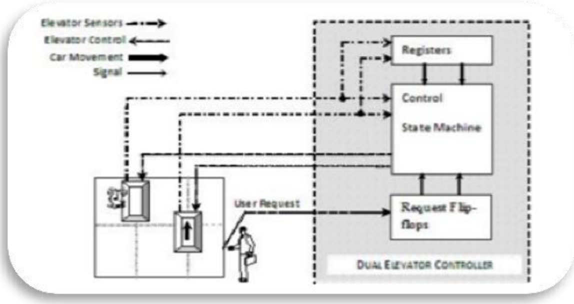

Fig.6. Block diagram of Dual Elevator

The block diagram and operation of the suggested dual lift controller is shown above figure. [7]

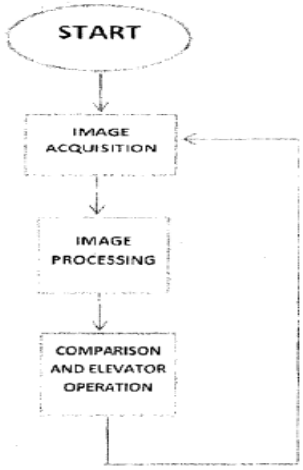

Fig.7. Stages of Image Process

The invention describes an image-processing-based intelligent lift management system. It consists of many call button methods, an image processing method, a data warehouse for image comparison, a data structure with proximity modules and comparison tables, and at least one picture capture method. The system runs the appropriate lift to reduce waiting times and energy consumption [8].

In lieu of the conventional dual stator winding the line-supplied lift motors, this study describes the implementation and performance analysis of a lift electric motor drive system using a variable frequency converter (VFC) driving a three-phase induction motor coupled to a gearbox. For this investigation, a scaled prototype lift is created and produced. A lift PLC is used to carry out the motion control algorithm. In order to evaluate the prototype system's performance and contrast it with traditional systems, a number of measurements are made. Measurements of the motor parameters are made at various supply frequencies in order to examine the impact of frequency variation.[9]

The steady state and dynamic approaches for motor sizing for lifts and escalators are described in this paper. While the dynamic approach verifies the motor's ability to accelerate masses, the steady state method guarantees the motor can move loads at its rated speed. There are formulas available to compute motor power depending on efficiency, speed, and passenger load.
The formula for sizing the motor for a lift is as follows:

$$M = \frac{p*75*9.81*S \times (1-CF)}{\eta}$$

Where:
P is the rated passenger number in the car;
75 stands for 75 kg/passengers;
9.81 is the acceleration due to gravity; s is the rated top speed; CF is the counterweight factor (a factor less than 1); η is the total efficiency of the installation (taken around 85%).
Techniques for derating motors that are utilized with VVVF or AC drives are also covered. It is advised to use energy-efficient motors with a 6% loss reduction.[10]

The goal of the smart lift system covered in this paper is to increase the transportation efficiency of lifts. The proposal suggests utilizing various technologies such as RFID readers, smoke sensors, infrared sensors, keypads, and microcontrollers to create a system that can function in both regular and emergency modes.

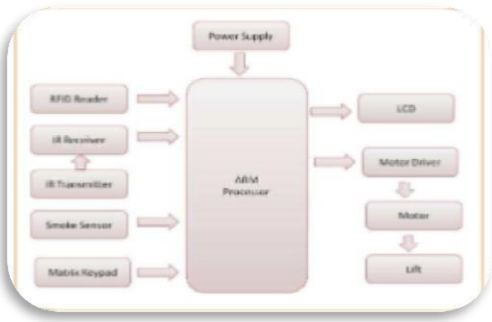

Fig.7. Block diagram of System

In standard mode, the lift travels to the floor closest to the passenger's entered destination. When in emergency mode, all elevators will travel more quickly to the smoke-filled floor if smoke is detected. The device is meant to be used in multi-story buildings to cut down on passenger transit and wait times.[11]

The goal of this research is to optimize the waiting time, journey time, and car trip duration in a group lift system using genetic algorithms (GAs). It takes into account two systems: one in which passengers can choose only their direction of travel, and another in which they can choose the floors of their destination. In contrast to the standard duplex algorithm and the earlier GA1 algorithm, the suggested GA3 technique for the first system reduces the average passenger waiting time.

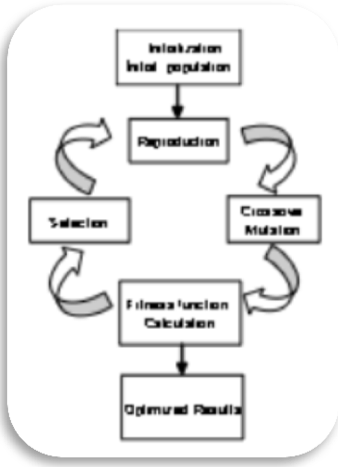

Fig.8. Genetic Algorithm steps

The suggested GA4 algorithm outperforms earlier algorithms in optimizing waiting time, journey time, and car trip time for the second system where destinations are known. It discovers trade-offs between maximizing certain characteristics, such as lengthening waiting times while cutting down on car trips.[12]

The study addresses the use of image processing methods to estimate lift car occupancy, such as the polygon function and Kalman filter tracking system.

Fig.9. Human tracking with lift car

Tracking people and items entering the lift and determining if they are people or objects is done with the help of the Kalman filter. The polygon function creates polygons to estimate the amount of overlapping floor space occupied if an object is present. This makes it easier to see if the lift is full without going above weight restrictions. By reducing pointless stops, occupancy determination in this manner may help shorten wait times.[13]

II. CONCLUSION

In this paper, we have analyzed about the elevator optimization by image processing techniques in MATLAB software, basics of image processing, elevator motor sizing, human tracking image processing, dual elevator control techniques. Thus, we aim to improve the overall efficiency, performance and convenience by analyzing the above papers and trying to implement the gap analysis in our project.

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