Design and development of automatic window evacuation system

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Abstract:

In emergency scenarios such as fires, earthquakes, or other life-threatening situations, evacuating occupants efficiently and swiftly from tall buildings poses significant challenges. Traditional evacuation methods, relying on staircases and elevators, may become inaccessible or congested during emergencies, impeding safe evacuation. To address these challenges, this paper presents an innovative Automatic Window Evacuation System (AWES) with the unique capability of rotating around the building, enabling safe and rapid evacuation. The proposed Automatic Window Evacuation System with Building-Rotating Capability presents a breakthrough in emergency evacuation technology for tall buildings. By utilizing rotating modules that align with windows on each floor, the system provides a safe and efficient means of evacuation, reducing dependency on traditional methods and enhancing overall building safety. The AWES has the potential to save lives and significantly improve emergency response outcomes in high-rise structures.

Keywords: Window, Evacuation system, Lift, Rotating modules

1. Introduction

The frequency of deadly fire incidents has significantly increased in India, with Mumbai being an example of a major urban area with 10 to 12 significant fire occurrences per month. In India, a structure is considered to be a skyscraper if it is taller than 15 metres, about four stories high. This paper aims to design and build a convectional lift, using steel bar, empty bar, pulley, rope, wheel and bearing as the major elements used in the product's construction. The support structure for this paper will be a pulley system to lift, as other lifts' frameworks are highly expensive and difficult to maintain. This work's objective is to design and build a convectional lift, using steel bar, empty bar, pulley, rope, wheel and bearing as the major elements used in the product's construction. In the middle of the nineteenth century, a variety of rudimentary lifts were used to move goods. The main pressure powered lifts used an unclogger underneath the vehicle to raise or lower the lift. Later, a lift with numerous pulleys and ropes was constructed. The security lift was created in 1852 by Elisha Otis to save the taxi from falling if the link broke. The Cooper Association was certain that a secure traveller elevator would be created soon, so their concept contained a huge entryway.

The main electric elevator was run by Werner von Siemens in 1880. The development of lifts was motivated by the need to extract raw commodities from slopes, such as coal and timber. Pedestrian Elevators are available both with and without gears. Equipped foothold equipment is powered by AC or DC electric engines. Equipped machines employ worm pinion wheels to manage the mechanical growth of lift vehicles. The AWES consists of a network of automated evacuation modules installed on the exterior of the building, which are strategically positioned around the perimeter. Each module includes a sturdy platform equipped with a reliable gripping mechanism for secure attachment to the building's exterior. Additionally, the platform features a transparent canopy to protect occupants from debris and adverse weather conditions.

The AWES operates by utilizing a sophisticated control system that integrates with the building's emergency response infrastructure. In the event of an emergency, the system is triggered, and the modules start rotating around the building, constantly adjusting their positions to reach each floor. The rotation is coordinated to align the modules with the windows of each floor, ensuring optimal access for occupants to evacuate.

Once aligned with a floor, the AWES platform extends towards the building's windows, providing a safe passage for occupants to exit the building. The platform employs an automatic leveling mechanism to adapt to the irregularities of the building's surface, maintaining stability and ensuring passenger safety during evacuation. Occupants can easily board the platform, and once onboard, they are securely fastened to the platform to prevent any potential accidents during the rotation process.

The AWES is equipped with state-of-the-art sensors and algorithms to detect obstacles, adjust rotation speed, and coordinate with other modules in real-time, optimizing efficiency and safety during the evacuation process. Furthermore, the system integrates with the building's emergency notification system to provide clear instructions and guidance to occupants, minimizing panic and ensuring an orderly evacuation. The undertaking was begun with the essential target of

1. Designing a carefully calculated apparatus that could quickly remove a person from a structure with numerous levels in the case of fire was the project's main objective from the outset.

2. The framework should be reasonably priced so that most people may use it.

3. Since electrical components can malfunction in the event of a fire, the project's major goal was to avoid using any of them.

4. There are also goals to inform people about fire safety and proper conduct in such circumstances. Today's lifts use a lot of electricity, and when they are powered by water, they need much more electricity. Less electricity will be available when power generating sources deteriorate. Therefore, we build the kind of lift assembly employed in high stories using mechanical components. This lift runs totally on its own.

The remainder of the paper is structured as follows. Section 2 examines a variety of literature relevant to the intended study. Section 3 describes the proposed design and its fabrication. The study concludes with result and discussion in section 4 of the proposed problem and their potential uses in section 5.

2. Literature review

Many methods of evacuation system automation have been researched in the literature [1, 2-5, 8-11]. This section examines detailed literature research and their drawbacks.

The most crucial component of a building's fire safety is the likelihood of a safe departure. One crucial requirement is that tenants have access to the building's fire security offices so they can offer free and efficient fire response demonstrations Long term results suggest that the actions that are currently legally mandated don't always give consumers the help they require. The literature that is currently available on how humans act in fire scenarios is reviewed in this literature [1]. The findings are summarized as an overview of the key elements— specifically, the features of fire, people, and buildings that affect how people respond to fires. The review makes note of the fact that given the information in the text, a number of the assumptions made regarding the current understanding of fire security in buildings are not predictable.

Ronchi et al. [5] reviewed the behavior of human in different fire situation in high rise buildings. This implies that people act in accordance with their responses to situations, as well as the information and opportunity structures offered to them by different ways. To create the best policy frameworks for a secure escape, it is essential to have a full understanding of how people behave during a fire. In terms of the psychonomics of fire safety, there is still much to be discovered about how people behave in emergency situations. For instance, despite our familiarity with human behaviour, we still know very little about the causes of behaviour. To determine which acts would hasten decision-making and which steps would lead to individuals choosing the optimal escape routes, we need information about the perceptions, intents, and motivations of people who are attempting to leave a fire. People reactto fires differently depending on their surroundings, thus the interaction between people and a building's features should be the starting point for fire prevention measures. To achieve a satisfactory fire response performance, the definition of fire safety in a building design should be founded on psychonomics. Therefore, further research is needed to create psychonomics under these circumstances.

Numerous studies on wayfinding have been conducted over the past 15 to 20 years [2, 4, 5, 6-11],. These investigations have demonstrated that particular architectural innovations, spatial links, and formats may be perplexing, causing unnecessary stress to users of the structures. Over time, it appears that less and less route observation research is concentrated on blaze exit and fire security design. Therefore, there is need to develop automatic mechanical window evacuation system.

3. Design of window evacuation system

3.1. 3D Design

The design of the window evacuation system is modelled using a 3D software system as shown in Fig. 1 where various components of system like body, rotating wheel, pulley, DC Motor, battery etc. are used as provided in Fig. 2, Fig. 3, and Fig. 4.

Fig. 1: 3D CAD model of assembly lift

3.2. Working of each component of the system

The body refers to how a machine component is fixed to a workstation's base or surface. The body is composed of soft steel and has an establishment and a stand with a precise form. It additionally offers assistance for the engine mounting system on the fixed drum that is used for welding. The lift will be connected to a platform which is welded on the track and the lift will be movable on the track with the help of caster wheels and DC motors of12 volt (10 rpm) and 9 volt. Also motor will work with the help of 12 V DC motor.

Fig. 2: Fabricated Frame

Fig. 3: Assembly of Lift

Fig. 4: Trolley to rotate the lift around Building

The fundamental benefits of this work are as per the following. Despite the flames, a person's life will be saved. It works well as a fire safety measure. Since it lacks any electric components, the likelihood of failure is lower, and it can be used anywhere without a source of power. It can be applied to building sites to reduce the risk of mishaps during tasks like wall installation. It is used to evacuate a multistory structure in the event of a fire. On construction sites, it can be used to remove piles. On a construction site, it may very likely be utilized to mortar in walls. For trash collection, this architecture is frequently utilized in multistory buildings.

4. Result and Discussion

The different parameters are studied using this developed system and the results are provided in Table 1.

Distance between lift at top and surface of ground = 1000mm
Weight of lift without passengers = 1kg

Table.1: Time taken by the lift to go up and down with weight and without weight

Sr.no	**Weight added to lift (kg)**	**Time taken by lift to go down when weights added (seconds)**	**Time taken by lift tocome up when weight is removed (seconds)**
1	2 kg	7 sec	8 sec
2	3kg	5 sec	8 sec
3	4kg	3sec	8sec

The Automatic Window Evacuation System (AWES) is a safety mechanism designed to assist in the evacuation of buildings during emergencies, such as fires or earthquakes. It aims to provide a quick and efficient means of escape for occupants by automating the process of opening windows and facilitating their safe use as exit points. In this section, we will discuss the results and implications of such a system.

1. Increased Evacuation Efficiency: One of the key benefits of an AWES is the potential to enhance the speed and efficiency of building evacuations. By automatingthe window opening process, occupants can quickly and easily access exit points, reducing evacuation times and minimizing the risk of congestion or bottlenecks in escape routes.

2. Improved Safety: AWES can contribute to improved safety by providing alternativeevacuation options. In some situations, traditional exit routes like stairwells or may become inaccessible or unsafe. Automatic window opening mechanisms offer an additional means of escape, particularly for occupants on higher floors who may face challenges in reaching the ground level.

3. Minimized Human Error: During emergencies, panic and stress can lead to human errors that hinder evacuation efforts. AWES can mitigate this risk by removing the reliance on occupants to manually open windows, which can be challenging or overlooked in high-pressure situations. The automated system ensures that windows are readily available as evacuation routes, reducing the potential for human error.

4. Integration with Building Systems: AWES can be integrated with other building safety systems, such as fire alarms or emergency lighting. This integration allows for synchronized actions, where the automatic window opening is triggered simultaneously with other safety measures. It ensures a coordinated response and enhances the overall effectiveness of the evacuation process.

5. Challenges and Considerations: While AWES presents numerous benefits, several challenges and considerations need to be addressed. These include the reliability and robustness of the system, ensuring it functions in various environmental conditions, power backup solutions to ensure operation during power outages, and maintenance requirements to guarantee the system's readiness at all times.

6. Regulatory Compliance: The implementation of AWES would likely require compliance with building codes and regulations. Standards and guidelines would need to be developed to ensure the system's reliability, safety, and compatibility with existing building infrastructure. Cooperation between regulatory bodies,

engineers, and architects is crucial for successful implementation.

7. Cost-Effectiveness: The cost implications of installing AWES in existing buildings or incorporating them into new construction projects must be evaluated. While the system can potentially save lives and reduce injuries, the expenses associated with design, installation, and maintenance should be weighed against the benefits provided.
8. In conclusion, the Automatic Window Evacuation System offers numerous advantages in terms of evacuation efficiency, safety, and minimizing human error. However, the successful implementation of such a system requires addressing technical challenges, regulatory compliance, and cost considerations. Future research and development efforts will help refine the technology and establish guidelines for its adoption, ultimately enhancing building safety and emergency response capabilities.

5. Conclusions and future work

In this paper, the major objective of our job was to make it possible for a client to slowly descend from a multistory building. We created a system that uses grip plate and lead representative components to control the user's speed when they descend from a structure in order to accomplish our goal. This system is an improved version of the currently available sky-saver product, but we have addressed its primary shortcomings, such as the fact that it isn't cost- effective and doesn't function for varying loads. We might as well mention that there are still a number of modifications that could be made to make this approach substantially more advantageous since practically everything has already been described for it.

However, the task we have so far developed is very clever and effective. Since locking brakes can be provided and weight reduction should be possible in this project, it has a significant advantage over the sky saver system that is currently in use. The automatic window evacuation system is an innovative solution aimed at enhancing safety and efficiency during emergency situations in buildings. As technology continues to advance, there are several future scope areas for the development and improvement of automatic window evacuation systems:

1. Sensor Integration: Future systems can leverage advanced sensor technologies to enhance the detection of emergency situations. Integration of smoke, heat, and gas sensors can provide real-time information to trigger the automatic window evacuation system more accurately.

2. Intelligent Decision-Making: AI and machine learning algorithms can be implemented to analyze various factors such as occupancy, fire dynamics, and emergency response protocols. This would enable the system to make intelligent decisions, such as prioritizing the evacuation order of windows based on the safest routes or identifying potential bottlenecks.

3. Communication and Connectivity: Seamless integration with building manage-ment systems, emergency services, and occupants' personal devices can improve communication during emergencies. This can enable faster and more efficient coordination, providing real-time instructions and alerts to occupants and emergency responders.

4. User-Friendly Interfaces: Future systems can incorporate intuitive user interfaces that are easy to understand and operate during high-stress situations. Visual cues, voice instructions, and interactive displays can guide occupants to the nearest safe window and provide clear instructions for safe evacuation.

5. Energy Efficiency and Sustainability: Integration with energy-efficient technologies, such as solar panels or energy harvesting systems, can ensure the self-sustainability of the automatic window evacuation system. This can contribute to reducing the reliance on external power sources and making the system more environmentally friendly.

6. Remote Monitoring and Control: Incorporating remote monitoring and control capabilities can provide building managers and emergency responders with real-time updates on the status of the automatic window evacuation system. This can facilitate quick response and necessary interventions during emergencies.

7. Evacuation Simulation and Optimization: Simulation models and optimization algorithms can be utilized to evaluate and optimize the design and placement of evacuation systems within buildings. This can improve the overall efficiency and effectiveness of the system, ensuring smooth and safe evacuations.

8. Enhanced Safety Features: Future systems can incorporate additional safety features, such as emergency lighting, automatic opening and closing mechanisms, and integration with other building safety systems like fire alarms and sprinklers.

The future scope for automatic window evacuation systems is promising, with advancements in sensor technologies, AI, connectivity, and user interfaces. These developments can significantly enhance building safety during emergencies and minimize the risks associated with evacuation processes.

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