Elevator Technology Improvements: A Snapshot

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Efficient vertical transportation is vital to a skyscraper's functional operation and the convenience and satisfaction of its tenants. This review complements the author's previously published research by updating the readers on innovative hardware and software-based solutions. It lays out, organizes, and combines extensive and scattered material on numerous aspects of elevator design in a straightforward and non-technical narrative. Rope-less elevators, the MULTI, artificial intelligence (AI), the Internet of Things (IoT), and extended reality technologies are some of the developments and advancements this article examines. The analysis also contextualizes current technical developments by reviewing how they are used in significant projects such as the One World Trade Center in New York City. Lastly, the paper examines innovative technologies, such as holographic elevator buttons and ultraviolet rays that disinfect elevators, in response to the COVID-19 pandemic.

basic systems advanced systems long distances smart solutions

Background

One hundred fifty years ago, cities appeared significantly different than they do today. Often, the cityscape was flat and uniformly patterned. The heights of residential and commercial structures were rarely as tall as flagpoles. However, today, cities are growing vertically. Population increases, rapid urban regeneration, rising land prices, active agglomeration, ego, and globalization drive building upward. Indeed, the race to build the world's highest skyscraper seems to go on forever, reaching ever-impressive heights. Around the beginning of the new Millennium, in 1998, Kuala Lumpur, Malaysia, built the 452 m (1483 ft) Petronas Towers, snatching the title of the world's tallest building from the 442 m (1450 ft) Sears Tower (renamed Willis Tower) constructed in 1973 in Chicago. In 2004, Taipei, Taiwan, erected the 508 m (1667 ft) Taipei 101. In 2010, Dubai, UAE, built the 828 m (2717 ft) Burj Khalifa, the world's tallest. As such, in just 12 years, the height of the tallest building almost doubled [1][2].

Besides globalization and land prices, the rapid increase in urban population forces cities to build upward. The United Nations predicts that 70% of the world population in 2050, about 9.7 billion, will live in urban areas, up from 51% in 2010. Such an increase entails adding almost a quarter million urban dwellers globally every week. To expand cities horizontally to accommodate urban population increase, researchers will face sprawl problems. Sprawl has caused numerous economic, social, and environmental crises and is an unsustainable way to grow. After learning the hard lessons of urban sprawl ills, planners have reverted to the vertical and compact model [3]. As such, since the turn of the century, many cities have been erecting high-rises worldwide.

High-rise buildings consume more energy than low-rise buildings for many reasons, including the employment of vertical transportation. Elevators use between 5 and 15% of a high-rise building's power, so efforts to reduce their energy consumption are worthwhile. Further, elevators use significant valuable space in a skyscraper. Sometimes, they may occupy 25–40% of the floor plans. Of course, this figure includes all elevators (e.g., passenger, freight, emergency, and shuttle). Therefore, reducing the required space and number of shafts is a sought-after goal in elevator design [1].

New Elevator Systems

Like automobiles and rail transport, elevators are becoming increasingly high-tech, pushing manufacturers to improve elevator speed and safety. The development of elevator speed has been astounding. If you compare the speed of the first passenger elevators (12 m per minute) to that of the world's fastest elevators (1200 m per minute) located at the CTF Finance Center in Guangzhou, China, the speed has increased one hundredfold. For improving passenger flow, destination dispatching systems are most efficient. When passengers click buttons corresponding to their desired floors, the system directs them to the elevators with the shortest travel times. Enhanced routing will result in more efficient passenger transfer, especially during peak traffic in hotels, residences, and offices. Further, new systems allow building managers to program elevators to correspond most efficiently to passengers' demands throughout the week, day, night, and holidays.

As time passes, elevators are becoming more intelligent and safer. Modern elevators provide smooth, comfortable journeys for passengers while covering greater distances, reducing the need to use transfer or sky lobbies. They are also energy-efficient; some produce energy, such as the regenerative drive. New design promises to make elevators move not only up and down but also sideways and diagonally. Such innovative design will revolutionize the architecture and layout of high-rise developments. It will allow buildings to achieve more excellent connectivity and improve people flow.

However, building elevators are not an exception to the harsh reality that everything eventually wears out and must be replaced. Even with routine maintenance, old machinery always requires updates. Modernizing elevators is a feasible way to increase the value and appeal of a tall building. Intelligent elevator systems provide enhanced travel comfort and the flexibility to adapt to changing building requirements, thereby enhancing performance [4][5].

Internet-connected elevators represent the cutting edge of elevator maintenance. This technology notifies building managers in real-time when a problem is beginning to develop. This is intended to reduce maintenance expenses and save time. Sensors gather data on variables, such as usage, that can impact the deterioration of components. The data are sent to a cloud-based platform for processing and analysis, enabling building managers to apply proactive measures, preventing problems from occurring.

Goals and Objectives

Any elevator design and production improvement will significantly impact expenditures, customer satisfaction, and the natural environment. This explores contemporary advancements in the elevator sector to educate the wider community of engineering and architectural students and professionals. It explores the development of elevator technology and considers how it affects their construction and upkeep. It compiles and organizes detailed and fragmented knowledge on various elevator design topics in a clear and non-technical discourse.

The specific goals are to answer important questions concerning elevator design and development as follows:

- What are the essential components and operational systems of an elevator?
- What are the new advances in elevator systems?
- What are project examples of mega- and supertall buildings that incorporate sophisticated elevator systems?
- What are the retrofitting and modernization options for elevators?

Overall, researchers aims to simplify complex engineering concepts and make them accessible to a broad audience, a fundamental objective of the *Engineering Encyclopedia*.

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