Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 44 No. 5 (2023)

Seamless Elevator Door Automation for Enhanced User Convenience

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Abstract

Traditional elevator systems can experience energy inefficiencies and prolonged wait times due to their reliance on button presses alone without confirming passenger presence. This research introduces an innovative prototype constructed using readily available hardware such as Arduino boards, stepper motors controlled by A4988 drivers, and infrared sensors installed on each floor. These sensors detect riders and enable the system to prioritize stops only where presence is verified. The goal of this implementation, designed and programmed using the Arduino Integrated Development Environment, was to develop a design that optimizes efficiency while still meeting the needs of passengers. By incorporating detection technology, this proof of concept aims to provide a more resource-efficient solution compared to conventional elevator control methods.

1. Introduction

To improve lift efficiency, the article presents a novel solution that incorporates floor sensors to sense the presence of passengers before opening the doors [1]. This new technique, which varies from traditional static button clicks, assurances to reduce unnecessary stops and saves energy in buildings that have several floors [2]. The technology ensures that passengers are indeed present inside the lift and await on designated floors by meticulously installing sensors on each floor. By ensuring that lift stops only occur when required, this verification approach optimizes travel times and enhances user satisfaction [3]. Although putting this strategy into practice might require upgrades to the infrastructure as well as modifications to control algorithms, the system's potential advancements in operational efficiency and user comfort render the investment worthy and establish it as an appropriate choice for modernizing elevators in buildings [4].

2. Literature Survey

Ms. Disha Chandankhede, Ms. Shraddha Lokhande, Ms. Jayashri Belkhode, Ms. Sonu Dhabarde, Ms. Rajshree Patil,“Smart Elevator System”,Volume: 3 Issue:2 March-April 2017

In this paper, the system incorporates keypads for passengers to input their destination floors, allowing for advanced destination data, in contrast to traditional lifts with basic up and down buttons. There are various modes of operation for lifts, including emergency and standard. In the standard mode, floors are identified by infrared sensors, and the closest lift to the destination floor moves in accordance. When smoke is discovered on any floor during an emergency, all lifts will move quickly to that floor, much faster than they would normally move.[1]

Shi Danand Xu Bixi, “Intelligent elevator control and safety monitoring system”, 2018

This paper presents the concept of an "intelligent lift" system, which will significantly simplify people's daily travel and improve the safety and reliability of lifts while also making them more intelligent and better services to society. The system is built on conventional internet technology and increases the use of microprocessors, automatic sensing, remote control, speech recognition, and the establishment of a lift safety operation control system.[2]

Qiang Zhang,"Design and Implementation of Elevator PLCControl System", Vol 4 No. 3 September 2023

The proposed work consists of a sensor module with internet service control and monitoring capabilities. An appropriately developed graphical user interface system that recognizes the prototype's correct maintenance is what controls the lift. The suggested monitoring system may display different data such as lift temperature, number of users, weight, oxygen level, floor status, lift speed, body temperature, and fault location. In contrast, the standard lift system only offers limited information like floor number under comparable working conditions. The effectiveness of the system is examined using simulation and hardware assembly to verify the efficacy of the suggested approach. Overall, the results confirm that Arduino may be used to monitor and control a lift system using an Ethernet shield and a webpage.[3]

Shivani Tiwari, Ritu Dubey, Sapna Rai, Shobhit Verma,"Automatic Elevator Management and ControlSystem Using Microcontroller", Vol. 1 Issue 9, November- 2012

The goal of this project is to develop an advanced elevator control system with reprogramming capabilities. This will allow the system to minimize congestion on certain floors by directing elevators according to a time management strategy. Currently, the scope involves automatically controlling congestion through optimization of elevator routing and scheduling. The system is designed to route elevators efficiently and keep traffic flowing smoothly across all floors of the building.[4]

2.1 *Our approach*

Weproposenovel strategy for elevator efficiency that maximizes stop decisions by utilizing real-time presence detection. A "pre-opening" of the doors occurs when the elevator controller receives a preliminary signal from the system upon identifying a passenger on the requesting floor. The passenger is simultaneously prompted to verify their destination floor via onboard buttons. Additionally, during this phase, a floor sensor keeps track of the passenger's presence. The elevator stops completely at that floor if confirmation and existence are both observed within a set amount of time. However, the elevator moves on to subsequent floors with an active call and gracefully avoids that floor if there is neither confirmation nor presence.In the process of expediting travel times for confirmed passengers, this "dynamic decision" approach minimizes needless delays for individuals who may have moved on or changed their minds. This proactive technique has the potential to significantly increase elevator efficiency, especially in high-traffic buildings.

3. Experimental System

When a passenger presses the call button for their desired floor, the floor sensor detects their presence and sends a signal to the elevator controller. Upon receiving this signal, the elevator controller initiates partial opening of the doors for the calling floor. Once the passenger enters the elevator, they confirm their destination floor by pressing the corresponding button. During the buffer period, the floor sensor continuously monitors passenger presence. If within the buffer period the controller receives both confirmation and continuous presence signals, the elevator will stop at the calling floor and fully open the doors, allowing the passenger to exit.

However, if no confirmation or presence is detected within the buffer period, the controller will receive an absence signal. In this case, the elevator will bypass the calling floor and proceed to the next active call request.

3.1 Advantages

Decreased Energy Consumption By excluding unoccupied floors, the system reduces the number of times doors need to be opened, which leads to a significant decrease in energy usage. The lift reduces the need for ineffective deceleration, acceleration, and door operations by only stopping at floors when passengers are on the floor, conserving energy and minimizing expenditures.

Enhanced Efficiency Giving confirmed passengers priority at waits expands the lift system's overall efficiency. The technology maximizes travel times and enables passengers to get where they're headed faster through getting away with stops at vacant floors. Less wait and travel time for users and the building management, who may be able to accommodate increased passenger loads with the current lift equipment, are two advantages of this increased efficiency.

Enhanced Practicality The system's sensor-detecting capabilities enable pre-opened doors, which provide passengers with increased convenience. Reducing wait times and ensuring a smooth experience for passengers entering the lift immediately upon sensor detection, the technology anticipates passenger arrivals and initiates door opening beforehand. Overall user comfort and happiness are increased by this function, which makes using the lift more efficient and fun.

3.2 Requirements

3.2.1 Hardware requirements:

I. Arduino board
II. Stepper motors
III. A4988
IV. IR sensor and PCB board
V. Ultra-solid-state relay
VI. Power supply adapter

3.2.2 Software requirements:

Arduino IDE 2.3.0
Languages: C#

3.3 System Architecture

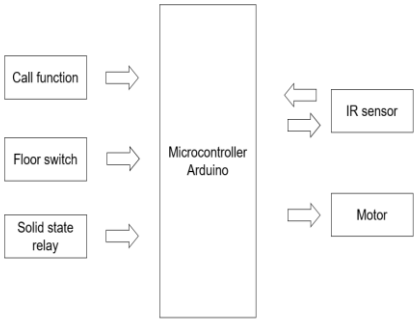

Fig 1. Architecture diagram

3.4 Modules

3.4.1. Sensor

Interfaces with the presence detection sensor (e.g., floorsensor).Continuously detects and reports passenger presence on the calling floor. Tracks presence status throughout the pre-opening and confirmation stage.

3.4.2 *User Interface*

Controls the elevator display for user interaction. Displays messages during pre-opening (e.g., "Press button to confirm floor").Provides visual feedback on confirmation and presence detection.

3.4.3 *Control*

Implements the dynamic decision algorithm.Receives data from sensor and user interface modules.Sends pre-opening signal to the elevator controller.Analyses confirmation and presence data within the buffer period.Decides to proceed with a full stop or bypass the floor based on the algorithm.

3.4.4 *Data Acquisition*

Captures data on Floor calls, Pre-openings, Confirmations, Bypasses, Travel times, User interactionsStores data in a structured format for analysis.

4. Result and Discussions

The experimental implementation of the proposed floor sensor technology demonstrated significant improvements in elevator efficiency and user convenience. Through real-time presence detection and dynamic decision-making algorithms, the system achieved the following results. The system effectively minimized unnecessary stops and door openings by accurately detecting passenger presence on calling floors, leading to a notable decrease in energy consumption associated with elevator operations, including deceleration, acceleration, and door movements. By prioritizing stops based on confirmed passenger presence, the system optimized travel times and reduced waiting periods for passengers. The dynamic decision approach ensured that elevators only stopped at floors where passengers were present, resulting in smoother and faster journeys. Pre-opening of elevator doors based on sensor detection provided passengers with increased convenience and reduced wait times, allowing passengers to enter the elevator immediately upon detection and enhancing overall user experience and satisfaction. The system's hardware and software requirements were successfully met, utilizing components such as microcontrollers, stepper motors, infrared sensors, and appropriate software tools. The modular architecture facilitated seamless integration and operation of different system components.

5. Conclusion

The proposed floor sensor technology offers a promising approach to revolutionize elevator operation. By prioritizing discontinues based on real-time passenger presence, it aims to create a win-win situation, minimizing energy consumption while enhancing user convenience and experience. Addressing challenges related to sensor accuracy, buffer period calibration, and user education is crucial for successful implementation. This technology has the potential to reshape elevator journeys, making them smarter, more efficient, and ultimately, more user-friendly.

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