ENGINEERING A POST COVID-9 FUTURE

SMART CITIES AND INTELLIGENT INFRASTRUCTURE

CAPACITIVE SENSING CAR-CALL IN ELEVATORS

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ABSTRACT

Currently, the world is facing a global pandemic. However, recent research has found that coronavirus can remain infectious on certain metals like stainless steel for up to four days hence the need to reduce touching buttons. In this paper, the elevator control system is programmed and simulated using TIA POARTAL V15.1. The simulation program is used to manage a two floors elevator building.

Keywords: Programmable Logic Controller (PLC), Touchless, Elevator, Capacitive Proximity, Weight Sensor, Signal

INTRODUCTION

High-touch surfaces have long been a cause of hygienic concern. Naturally, this issue has takes on special consideration in light of the ongoing Coronavirus pandemic. Though experts are still refining their understanding of the virus that causes COVID-19, one way we can protect ourselves is to avoid high-touch surfaces such as door handles, public countertops, and elevator buttons.

Considering that Covid-19 is primarily spread through contact transmission, be it direct contact with an infected person or contaminated surfaces or objects, it is not surprising that we are seeing a sharp rise in the adoption of contactless technologies. While the use of these technologies has been on the rise in recent years, the current pandemic has accelerated their uptake and it's likely that this will change the way we live on an ongoing basis.

BACKGROUND

We've long known that elevator buttons are dirty. Studies have found more bacteria on elevator buttons than toilet seats.

Modeling shows that the risk of catching the virus from people traveling in elevators is relatively low, as the cars are typically well-ventilated and passengers spend a short time inside.

However, as the virus is believed to survive on some surfaces for up to 72 hours, it's not surprising that people feel anxious about touching buttons.

The pandemic has led to some creative solutions. In Thailand, a shopping mall has installed pedals so patrons can choose their floor with their feet. And in Japan, one toothpick company is marketing "noncontact sticks" for pressing the buttons. In the US, the Centers for Disease Control and Prevention recommends that people avoid touching the buttons directly and instead "use an object (such as a pen cap) or their knuckle."

PROPOSAL

Call Buttons are used to request an elevator. They are mounted 42" above the finished floor and consist of an up button and a down button that illuminate to indicate the request has been received and an elevator is on the way.

A Capacitive proximity sensor can be used to detect metallic and non- metallic targets without physical contact. The purpose of this project is to design a contactless car call system for an elevator to accompany the contactless floor button inside the elevator. A capacitive sensor would be installed preferably two inches from the door of the elevator so as to differentiate between those using an elevator and by passers. Just as the call button, the design has lights inside that turn green and red to indicate signal reception and arrival of the elevator respectively.

Considering that elevators are found in areas with high traffic and movement, a capacitive sensor when used on its own will result to a HIGH signal all the time. So as to counter that, a Weight sensor is proposed to be used to work together. This works on the principle of force application so as to transmit a signal. With this in mind, for a "call" signal to be transmitted, both sensors have to give a HIGH signal.

JUSTIFICATION

Touchless elevators come with both financial and practical benefits for businesses reopening during the COVID-19 pandemic. In addition to preventing disease spread, touchless push-button solutions solve business challenges by:

- **Lowering cleaning costs:** With a contactless elevator, you can limit the number of times employees must disinfect the elevator cab per day, lowering the cost of cleaning.

Touchless solutions will continue to provide benefits even after the current health crisis has passed. Implementing touchless elevator technology now will prevent day-to day disease spread in the future and facilitate a frictionless visitor experience throughout your facility.

METHODOLOGY

PLC CONTROLLER (COMPUTER-BASED TECHNOLOGY)

a) USER PRESENCE

A capacitive proximity sensor senses the presence of both metallic and non-metallic objects in either 1st and 2nd floor to energize output Q0.0.

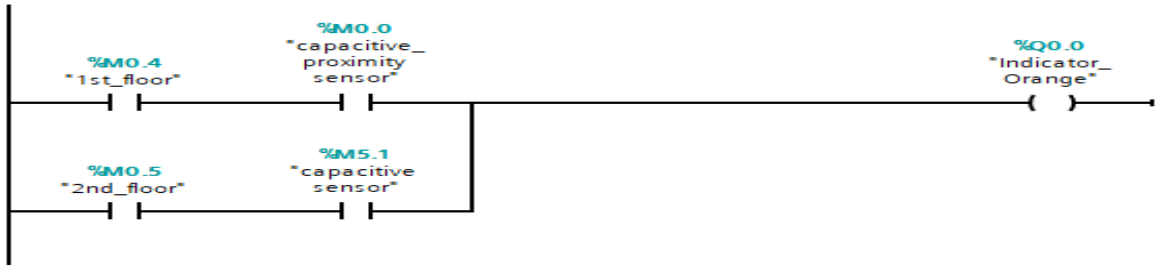


Figure 1

b) LIFT CALL

A user on either floor triggers the capacitive and weight sensors which send a signal to call the lift hence Q0.2. The call signal triggers the output Q0.7 green indicator.

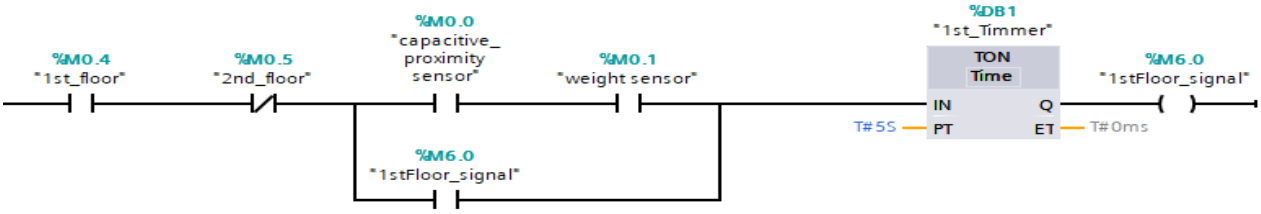


Figure 2

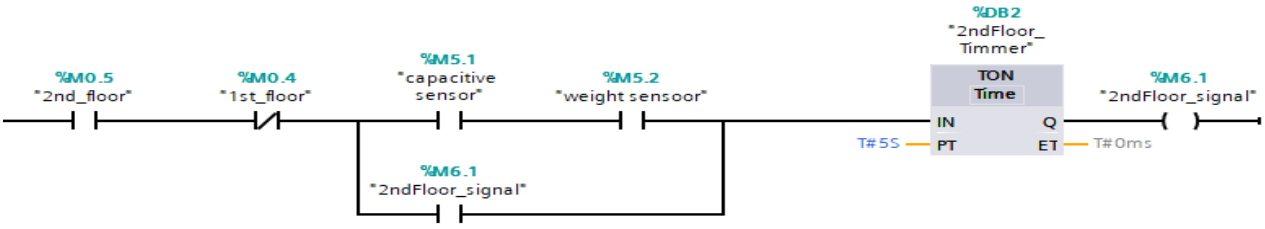
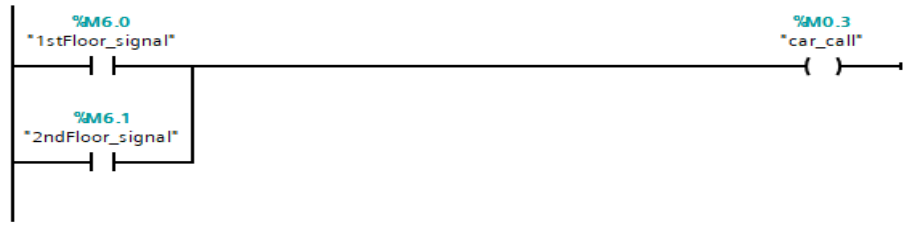


Figure 3



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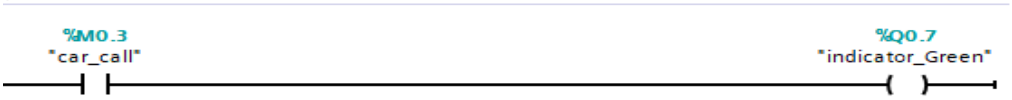

Figure 5

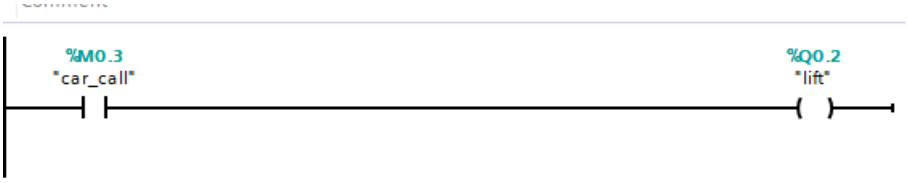

Figure 6

c) LIFT ARRIVAL

Lift arriving at the floor triggers an indicator output Q0.6.

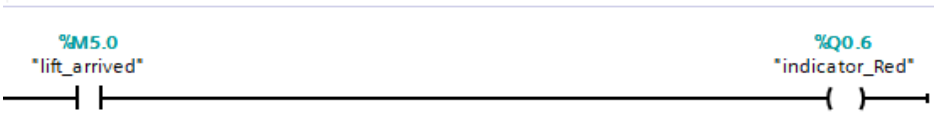

Figure 7

Figure 8

d) OFF INDICATOR

As long as no user calls the lift from any floor and no sensor is triggered, the indictor will remain off.

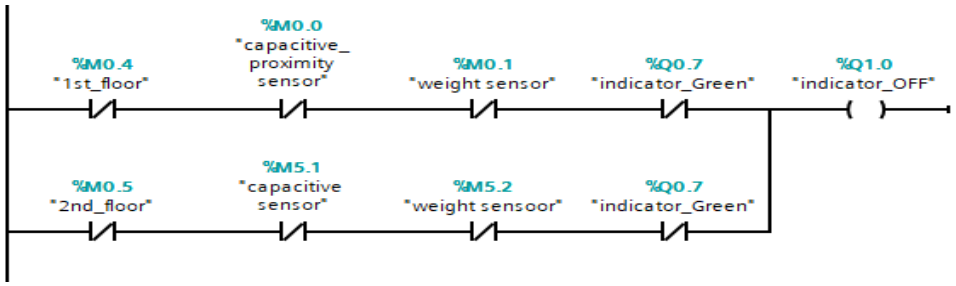

Figure 9

TECHNICAL DESIGN

There are several key design criteria that must be considered when deciding on the final design for the system;

- The positioning of the sensor; capacitive proximity sensor and weight sensor since they are going to be installed on the floor.
- The traffic of users and passers- by so as not have a situation where the lift will not always have a signal transmitted.

MECHANICAL DESIGN

Using Siemens Nx and Inventor, a representation of the elevator system was developed to simulate the intended operation.

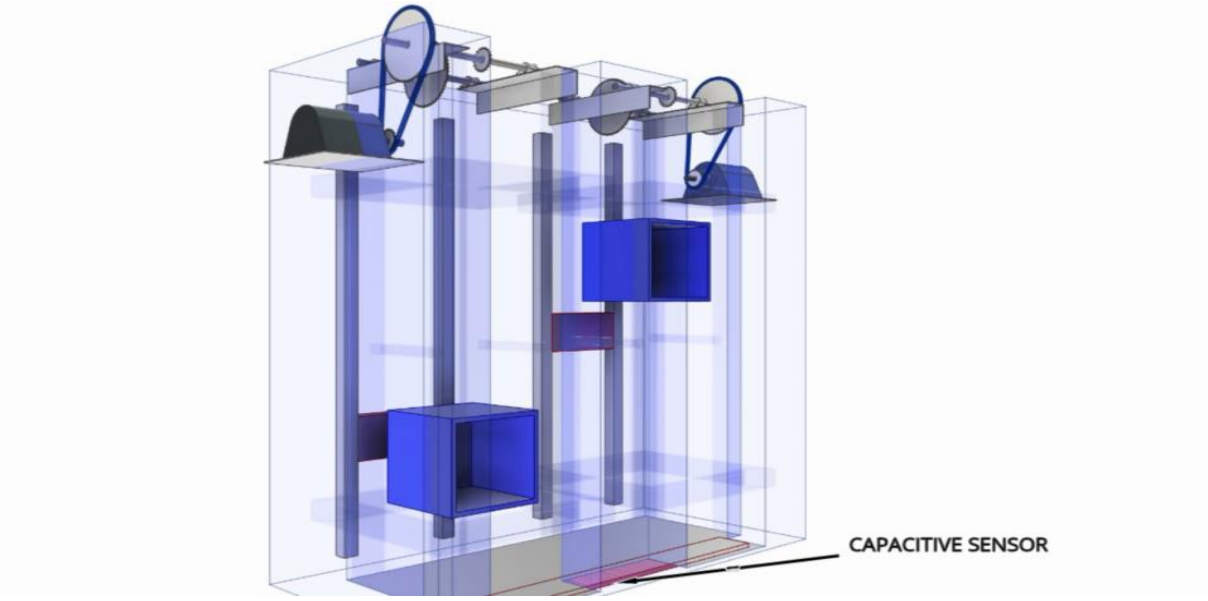

Figure 10: Mechanical design of lift showing the proposed position of the weight and capacitive sensor

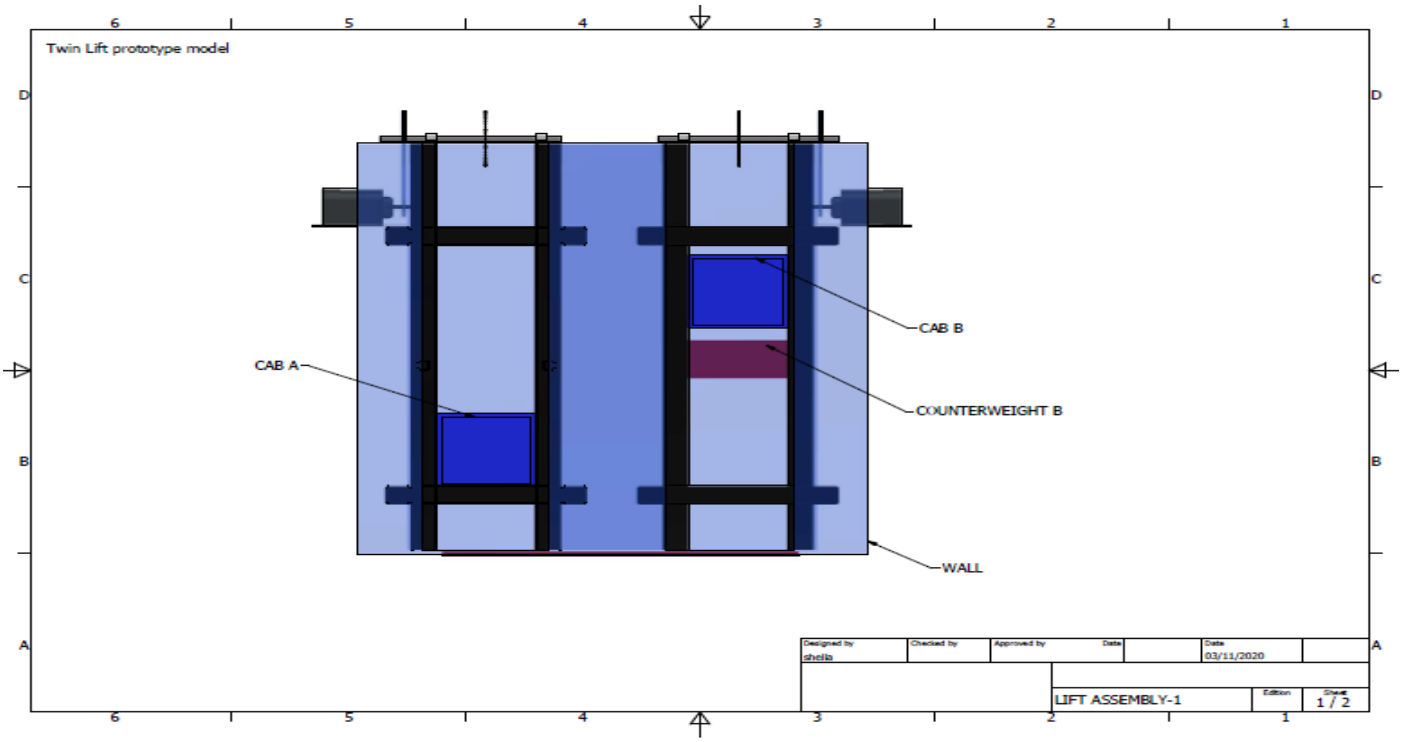

Figure 11:Top view of the elevator system

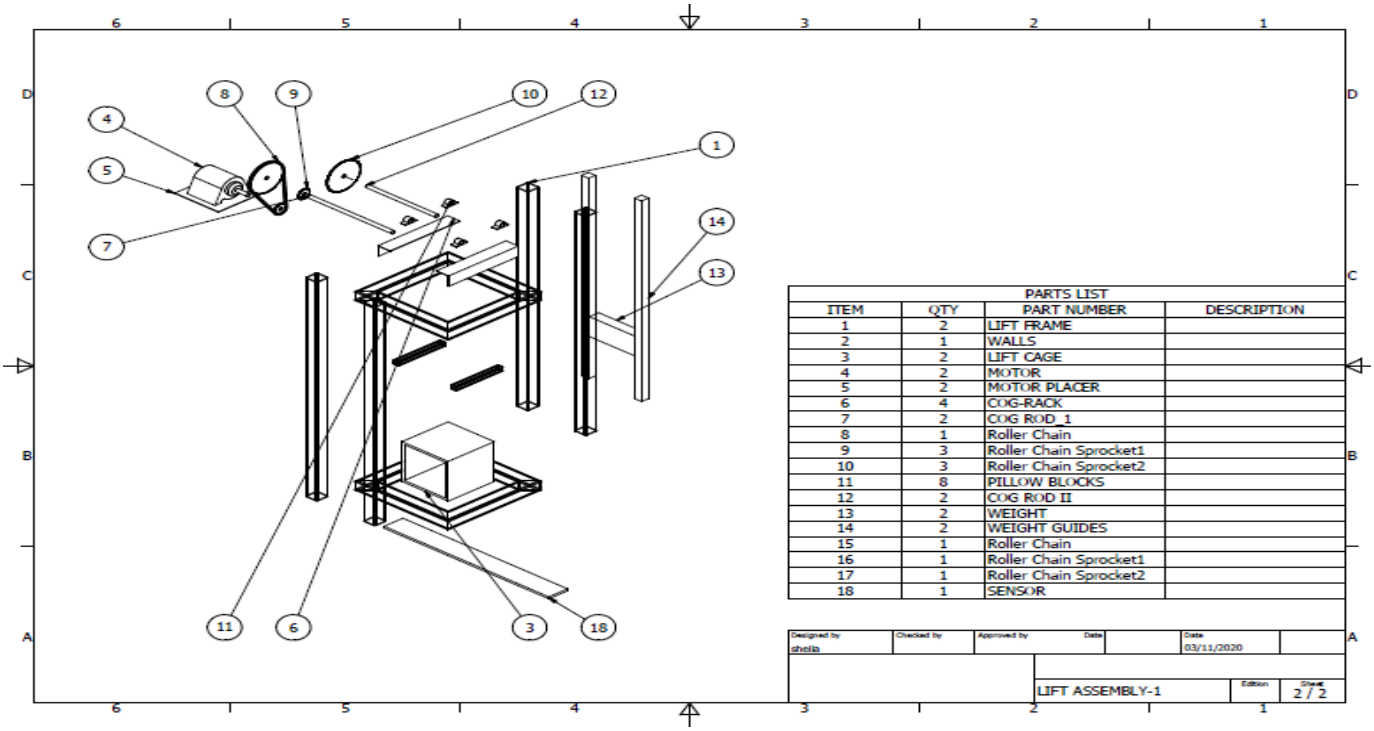

Figure 12:components of the lift system

RESULTS AND DISCUSSIONS

FEASIBILITY ASSESSMENT

SKILLS AND RESOURCES

There are a number of skills that will be essential to complete the project:

1. Knowledge of digital signal processing techniques.
2. Knowledge of PLC Programming.
3. Knowledge of electrical termination.

There are a number of resources which will be required:

There will be a need to obtain person(s) knowledgeable in the installation of elevators to wire the new control system.

As of writing this report, none of the required resources have been secured.

RISK ASSESSMENT

While a proximity capacitive sensor intends to sense presence of an object, this will mean that the call button will always be HIGH. To avoid it, a weight sensor will be strategically placed so as to differentiate between a passer-by and an elevator user.

There are also risks that it may take longer to convert the existing control system.

CONCLUSION

In this project, the elevator control system program is designed and simulated using TIA POARTAL V15.1. A ladder diagram language is chosen to build the complete program. The weight and capacitive sensors are placed on each floor. This project is relevant as it mitigates the spread of COVID-19 and integrates technology from digital systems to a system that links and connects with the environment.

ACKNOWLEDGEMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals. I would like to express my gratitude towards my parents, friends, family and industry persons for giving me such attention and time to enable me complete this project.

REFERENCES

1. Larry K. Baxter, “Capacitive Sensors Design and Applications”, IEEE Press Series on Electronics Technology, Robert J. Herrick, Series Edition, 1996.
2. Jon S. Wilson, “Sensor Technology Handbook”,2005.
3. Robert H. Bishop, “Mechatronics Systems, Sensors, and Actuators: Fundamentals and Modeling,2007.
4. https://mechstuff.com/how-do-elevators-or-lifts-work/, last accessed 11/16/20202 time 6:23 AM.