A Glimpse of the Inner Cogs of Elevators

It's not just a box with ropes

Part A

Dedications

To the people who chose UTM and

low-key regret it

but

lower-key don't

Acknowledgements

Dr Nor Shahida Hasan

For your guidance

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Background and Introduction

Elevators: a simple part of our daily life. We have all used it, it's nothing new. But elevators and elevator technology has been pivotal every time humans have pushed the limits of constructions. In other words, the Burj Khalifa would never have been possible if someone did not think of how to transport hundreds of people over the 160 floors fast.

Today we hope you share with you just a glimpse of the technology behind elevators. Upon this simple idea, engineers and scientists have assembled more blocks of ideas and technology to build modern elevators. However, in order to understand what we are about to present, some background is required. We need to know about a few components.

After we have knowledge of those components we can understand the proposed design.

The Idea

What does an elevator do? Anybody can answer that. But it gets difficult if we ask you to answer that in a way that machines can understand. If we want to accomplish that, first we must ask what do machines understand? Which of these understandings are relevant to an elevator?

Machines know how to compare two numbers, and how to count. Turns out you can explain elevators with only those two functions. When you press a button on an elevator, it tells the machine to start counting up. It keeps counting and comparing the count with your signal number. When they match, the counting stops, i.e. the elevator stops.

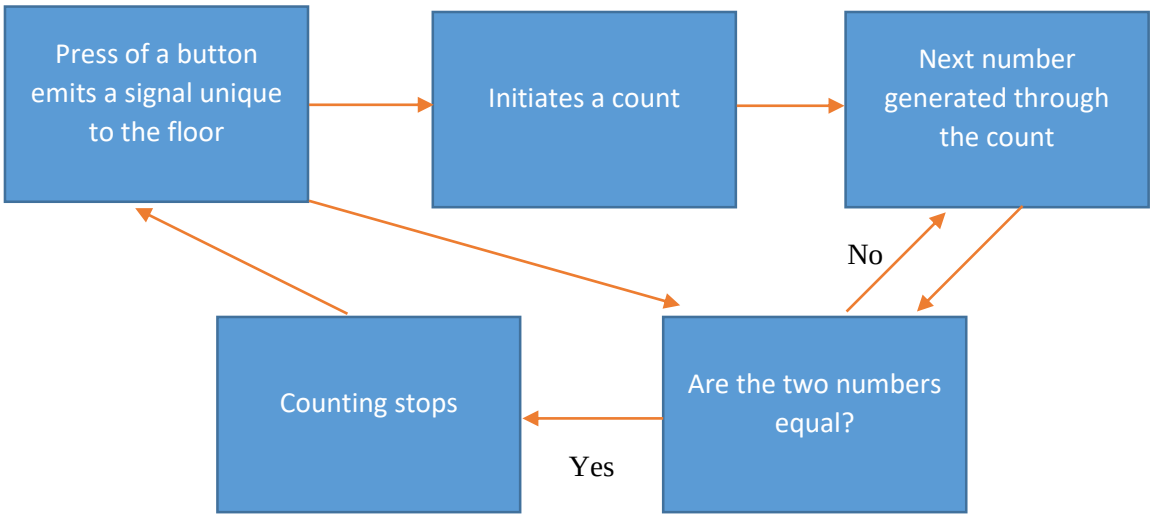

Fig: Block diagram of an elevator's concept

Components

Comparator: Comparator serves one of the most basic logic functions: comparing two binary numbers. Some comparators find equality or inequality; some find if numbers are bigger or smaller or equal.

Clock and clock disabler: A clock simply produces periodic digital waves of electric pulses. Clock disabler disables the clock when it is told to.

Counters: Counters are machine's way of counting in the binary number system. It is made up of flip-flops that can hold bits and update them according to their counts.

7 Segment Decoder: A 7 segment decoder translates data from a button pressed into a display of 7 lines to show digits.

Combinational or sequential?

To recap, the main difference between combinational and sequential circuits is the clock. Sequential work in a pattern according to the clock pulses it receives. So as a whole, an elevator works like a sequential system: you press a button, the elevator crosses floors one by one to reach you- it cannot fly to you at one go. However, some of the parts and components of the systems are dependent upon combinational circuits. For example:

- Comparators and 7 segment decoders
- The call input and storage systems

The Design

Now time for the star of the show-

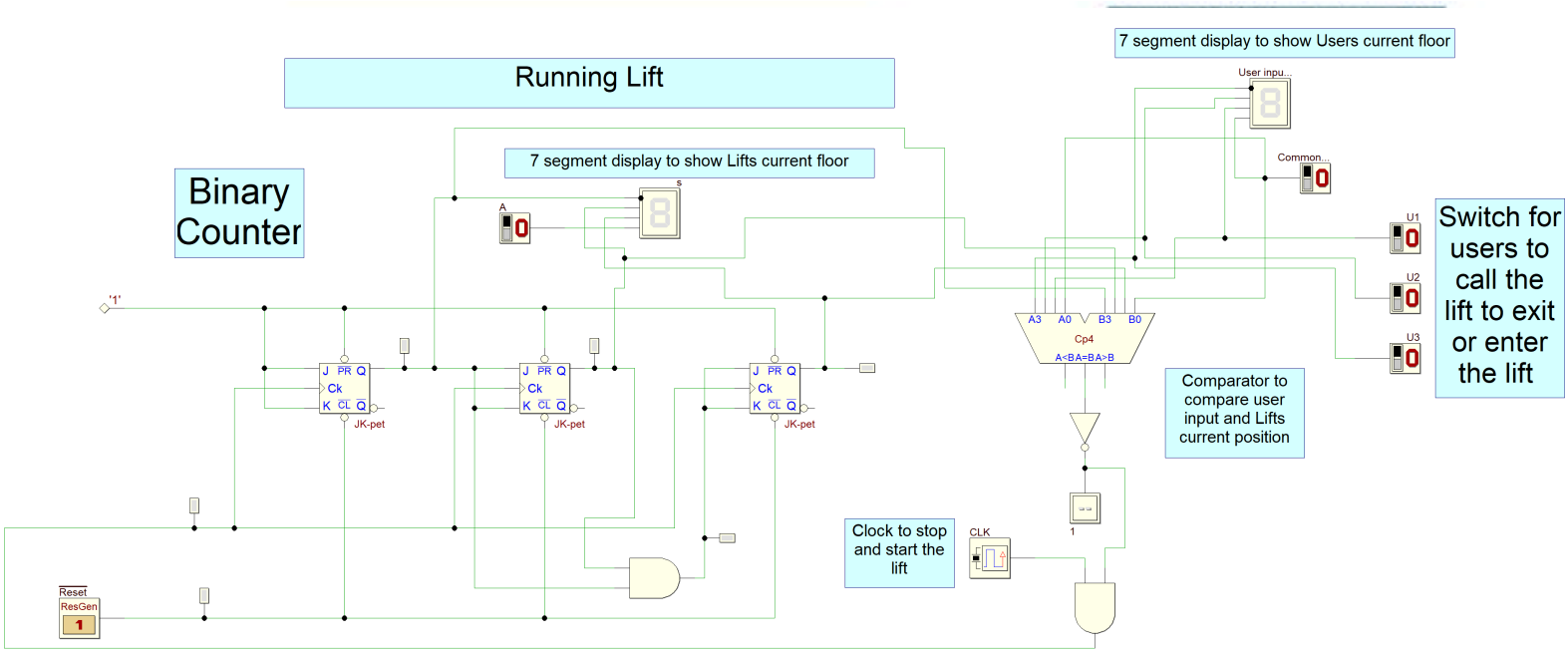

Fig: Circuit design of the elevator controller system

This is the basic skeleton a digital elevator's controller system. The marked switches emulate the inputs from different floors. The floor number of the call shows up on the rightmost 7 segment decoder. This call ripples through the circuit initiating the clock, the counter, and feeding input into the comparator. The lift's floor position increases with the count and the position number is input into the same comparator we fed our call signals. When the lift's position is equal to the call's, our comparator gives us the signal to stop the clock. Hence, the counter stops, the lift stops, and gates open. When idle this elevator uses its counterweights to go down slowly.

The counter used here was built with JK flip-flops, and the clock disabler was implemented with a combination of basic gates.

Please note that this part of the elevator only simulates the outside call. For part B, we shall add more blocks to shape it into a complete elevator.

Features

The full model after the completion of part B will hopefully include the following features-

- Authenticates launch of the elevator with a key
- Responds to calls from inside and outside the elevator
- Compares its position with the position of the call to know when to stop
- Displays its position to users

Conclusion and Reflections

This project is an example of how simple ideas can solve complex problems. And sometimes, solving problems simply is more difficult than the problem itself. For us, we hope to proceed with another project idea. But now, it seems like this was the better choice, as it forced us to overcome that hurdle and push us beyond our comfort zones. We hope to push those limits even further with the next part.

References and Further Readings

- Digital Fundamentals – Eighth Edition – Thomas L. Floyd
- Digital Logic Module – Fifth Edition – School of Computing, Faculty of Engineering, Universiti Teknologi Malaysia
- New Designs Going Up-Working Knowledge on Elevators by Mark Fischetti https://www.scientificamerican.com/article/how-do-elevators-work/

Appendices

i) List of members and responsibilities

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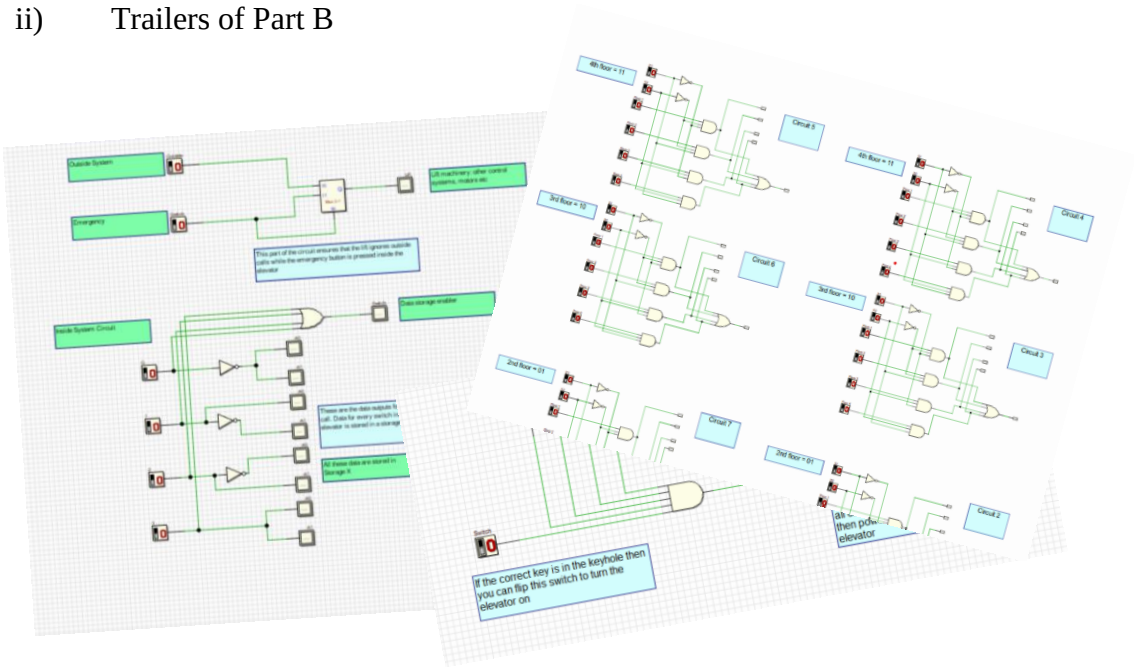
ii) Trailers of Part B



The best is yet to come