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# ELEVATOR CONTROLLER USING FPGA

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Abstract:
The lift control framework is one of the most crucial elements of the hardware control modules used in automotive applications. Most of the time, elevators are specifically designed with a certain building in mind. A particular aspect to consider is that with predetermined information inputs and outputs, the FPGA may run across any number of floors while controlling utilization. However, by simply altering a control variable in the HDL code, this controller can be utilized for a lift with the needed number of floors. To achieving a good response time without including any additional logic circuits, a simple plan is adopted in the design! A revolutionary elevator controller using FPGA, addressing the drawbacks of conventional single-chip microcomputer-based elevators, is a significant advancement in the field.
Keywords: Elevator, FPGA, Verilog HDL, Reconfigurable, FSM, Altera Quartus II, Modelsim.

## 1. Introduction

The global demand for the Very Large Scale Integration has risen significantly due to the semiconductor industry's tremendous growth over the past 20 years. The fundamental concepts of digital logic theory and methodologies can be easily understood using VLSI-based designs. The fundamental concepts behind complex, fast digital circuitry. Every single day, technology continues to progress. Hence, the designs need to be made simpler to reap the benefits. The goal of an integrated circuit is to create an eight-floor elevator controller that can work as a part of an elevator controller. The elevator determines where to take passengers by comparing the current floor with the desired floor and providing instructions. Subject to the conditions that the weight is less than 4500 lbs. and the door closes in three minutes. If the weight goes beyond that limit, the elevator already got you covered! When the door has been open for more than three minutes, the Door Alert signal, which is typically quiet, becomes exponentially louder. If the elevator has passed the current floor then it is determined by a sensor on each floor [1].

The sensor's signal contains an encoding on the floor that was previously traversed. This paper offers an amazing approach for enhancing the reliability of a reconfigurable FPGA-based elevator controller with predetermined inputs and outputs. Any elevator, regardless of how many floors it has, can totally use this controller[4]. Historically, steam and water hydraulic pistons, or human labour, were used to power the driving systems for elevators. In a "traction" elevator, vehicles are raised by totally rolling steel ropes over a sheave or pulley; having a deep groove! The car's weight is definitely balanced by a counterweight. Sometimes two elevators are built to move simultaneously in opposite directions and balance one another. This specific kind of elevator gets its name from the traction produced by the friction between the ropes and the pulley. Overall, the focus on reliability and innovative approaches on the elevator technology is crucial for the future advancement of this vertical transportation industry. By exerting pressure on an above - or below-ground piston using the principles of hydraulics (as in hydraulic power), hydraulic elevators raise and lower the car. Recent innovations, like, include gearless machines mounted on tracks, no machine room needed, permanent magnet motors, microprocessor controllers, and more and whatnot. The technology used in new installations is, like, impacted by several factors, bro. Although it is, like, impractical to, you know, construct cylinders longer than a certain length for very high lift hoist systems, hydraulic elevators are, like, less expensive. For structures, like, taller than seven stories, traction elevators are, like, required and stuff. Hydraulic elevators often move, like, more slowly than traction elevators. Elevators could be, like, mass-customized. Cost savings can be achieved by, like, mass-producing the components; however, each construction has unique requirements, like different floor counts, well diameters. In conclusion, the imperfections in elevator technology play a crucial role in the vertical transportation industry's future advancements, like, and stuff. Let's, you know, keep pushing boundaries and, like, embracing the errors along the way [5].

## 2. ELEVATOR CONTROLLER

"Elevators were created as a convenience, but they have surprisingly developed into an absolutely necessary and indispensable part of modern urban life." A machine that takes people or products up and down to different levels in a building or mine," is the definition of an elevator. One master controller can control and coordinate the activities of several separate elevator units that make up an elevator system. Each elevator unit is a straightforward electromechanical machine that does the job efficiently. The apparatus utilizes the floor level as an input and produces control signals to manage lift activity.

## 3. LITERATURE SURVEY

Survey-I Dumbwaiters and workplace elevators both operate in essentially the same ways. One such application is studied and simulated in this piece of work using a five-story elevator controller as an example. Because it can be reused, can be reprogrammed, and allows for quicker and less expensive prototyping, a Field Programmable Gate Array (FPGA) was selected for this study. To move the elevator from its present state to the intended next state, the elevator control system uses a Finite State Machine (FSM), which gathers floor inputs from inside the elevator as well as up and down calls from outside.

Survey-II To sustain 23 buildings at the dawn of an era of highly varied new technology. The elevator in a high-rise structure enables residents to move vertically between floors. This study includes a four-phase lift controller that uses finite state machines and Verilog HDL code (FSM) [11].

Survey-III An essential component of the hardware control modules utilised in automotive applications is the lift control framework. Often, when designing a lift, a particular building is taken into account. Use is managed by the FPGA, which has predetermined information inputs and outputs and may function across any number of levels. Just changing a control variable in the HDL code will enable this controller to work with a lift that has the necessary number of floors.

## 4. PROPOSED WORK

Throughout the coding phase, we used a variety of techniques to keep the program running. To avoid using the same variable name for both the input current floor and the output current floor, we first gave them different names. Additionally, we add two new input pins to the code called Over time and Overweight. These signals will be delivered to the controller by the mechanical device. When the controller receives a signal from a weight alert or door alert, the elevator won't move while it's on the Out Current Floor.

Then, everything will come together as one. Lastly, create the Out Current Floor, Direction, Complete, Door Alert, and Weight Alert regs and assign equal values to the output. The variables will so serve as an output and register. The variables Complete, Door Alert, and Weight Alert are initialized to zero when the Reset switch is not depressed. The variable In Current Floor is similar only once set to equal Out Current Floor when the Request Floor is enabled. Even when the Out Current Floor equals the Request Floor, it still updates and compares with it. Mention three if statements about elevators as a final point. When an elevator is working properly, it compares the Request Floor and Out Current Floor to determine which way to move; however, it activates the Door Alert if a door is left open for longer than three minutes, and it activates the Weight Alert it transporting obese passengers[5].

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## 5. BLOCK DIAGRAM

The inputs and outputs of the elevator controller are shown in the block diagram below

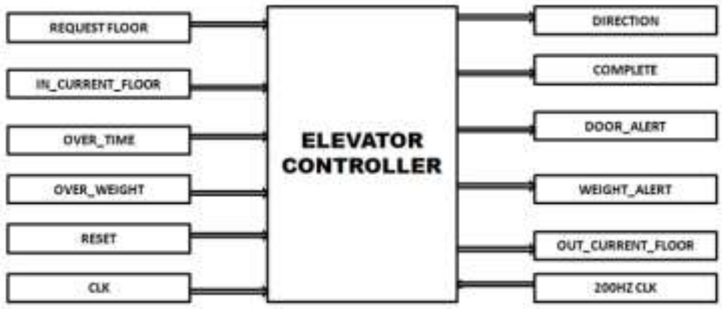


Fig: 1. Block diagram of Lift controller inputs

Define Request Floor as an input variable of type 8-bit. The numbers from 00000001 to 10000000 correspond to the first through eighth floors. (The second story has the designation 00000010, while the third floor has the number 00000100. For In Current _Floor, add a definition for an 8-bit input variable. Instead, the Out Current_Floor that has reached the target floor may be used to specify the top floor and every floor below it. It will be helpful to define the clock (clk) as an input variable. Clocks with low frequency are made. To create a reset, make Over Time an input variable. The number "1" in the Verilog code denotes that the waiting duration exceeds three minutes. The signal from the timer will be Input Over Time (machinery part). Overweight should be used as the definition of the input variable. In Verilog code, the number "1" denotes an elevator overload. A signal from the weight detector will be input overweight (machinery part).

## 6. OUTPUTS

Provide the name Direction to the output variable. The numbers "1" and "0" in the Verilog code represent upward and downward motion, respectively. Provide the value Complete to the output variable. The elevator that enters the designated floor is represented by the number "1" in the Verilog code. In cases when the Over Time or Weight Warning is enabled, it can also be used in place of stopping (remaining stationary on the Out Current Floor). It is necessary to set a Door Alert output variable. Output Door Alert will also be functional. Choose Weight Alert as the desired output parameter. The number "1" represents a busy elevator. When Over Weight is active, Input Weight Alert also becomes active. Define the output variable Out Current _Floor as an 8-bit value. This specific variable will be utilized[9].

## 7. THREE CASES OF ELEVATOR

Case I- An example of how the elevator usually operates. The elevator will move up if the Request Floor is higher than the R Out Current Floor. If the Request Floor is below the R Out Current Floor, the elevator will depressurize. If the Request Floor equals the R Out Current Floor (it reaches the Request Floor), the R Complete is on, and the elevator stops traveling. The "1" and ">>1" represent shift registers. By one, the desired orientation is introduced into the data. In this case, "1" will transform "00000001" into "00000010."

Case II- About three minutes had passed since I last shut the door. Both the R Door Alert and R Complete are set to ON when the Reset is disabled but Over Time is enabled. Off is an option for both the R Weight Alert and R Direction. Information is maintained there by the R Out Current Floor. The elevator will halt (or pause) and the door alarm will cease to operate once the countdown has ended.

Case III- Almost 4500 pounds of weight may be supported by the elevator. The R Weight Alert and R Complete are set to be ON if Over Weight is enabled but Reset is disabled. R Door Alert and R Direction are ineffective. To R Out Current Floor, the R Out Current Floor keeps its data. As a result, if an elevator is too full, the weight alert ring will ring and it will stop (or pause) moving.

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## 8. IMPLEMENTATION USING FPGA

The term "FPGA" refers to a field-programmable gate array.

Fig: 2. FPGA

An FPGA is essentially a collection of interconnected digital subcircuits that can be extremely flexible while carrying out several related activities. An FPGA does not consist just of a Boolean gate array[3]. This would be a far inferior method of enabling adjustable logic because it would not benefit from the fact that common operations can be carried out much more successfully as fixed modules. The same principle underlies discrete digital integrated circuits. Hence, an FPGA is considerably more than just a gate array. It is composed of numerous well-constructed and interconnected digital subcircuits that cooperate to carry out essential tasks while also enabling a great deal of flexibility. Customizable logic blocks (CLBs), which are digital subcircuits, are used to build programmable logic by the FPGA. Previously known as Altera Quartus II, Intel Quartus II is a program used to design programmable logic devices. Quartus Prime enables developers to compile, run timing analyses, view RTL diagrams, simulate a design's response to various stimuli, and analyze and synthesize HDL designs. Quartus Prime also enables developers and programmers to collaborate on setting up the target device [4]. Quartus Prime offers a VHDL and Verilog implementation for hardware description, visual logic circuit editing, and vector waveform simulation[10].

## 9. RESULTS

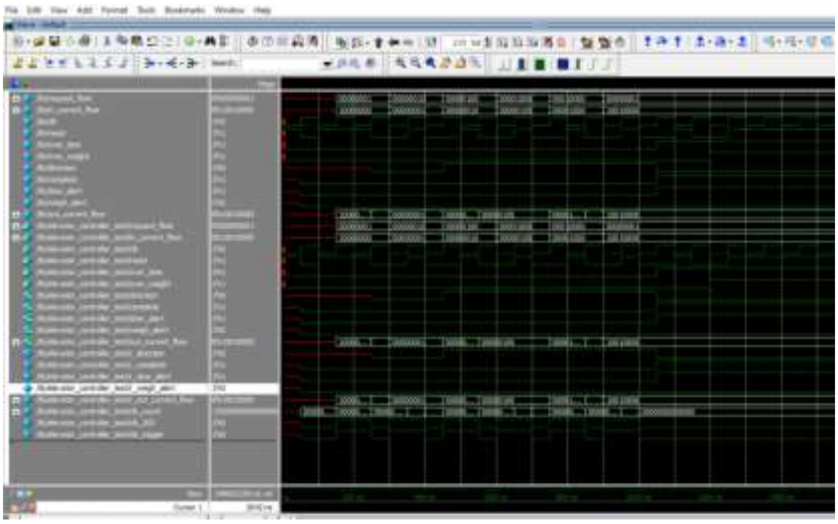

Fig: 3. Simulation Result 1

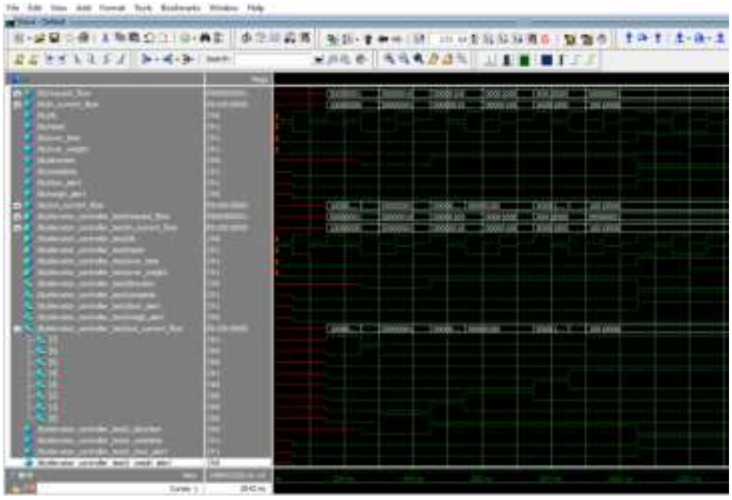

Fig: 4. Simulation Result for request floor and current floor for various conditions


Fig: 5. RTL Schematic

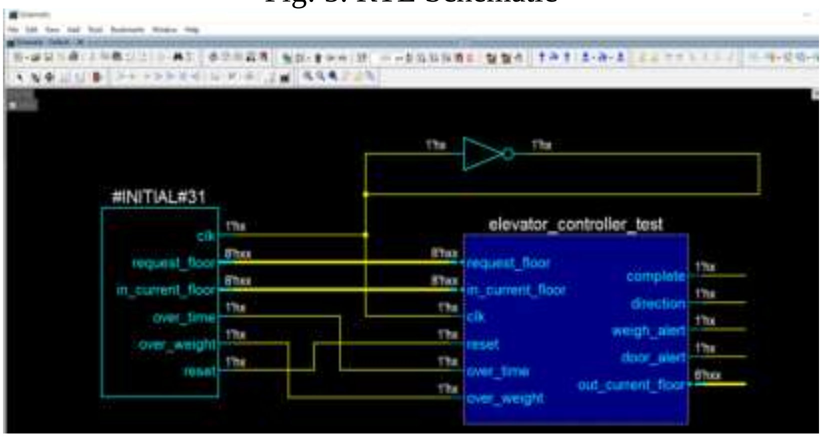


Fig: 6. RTL Schematic

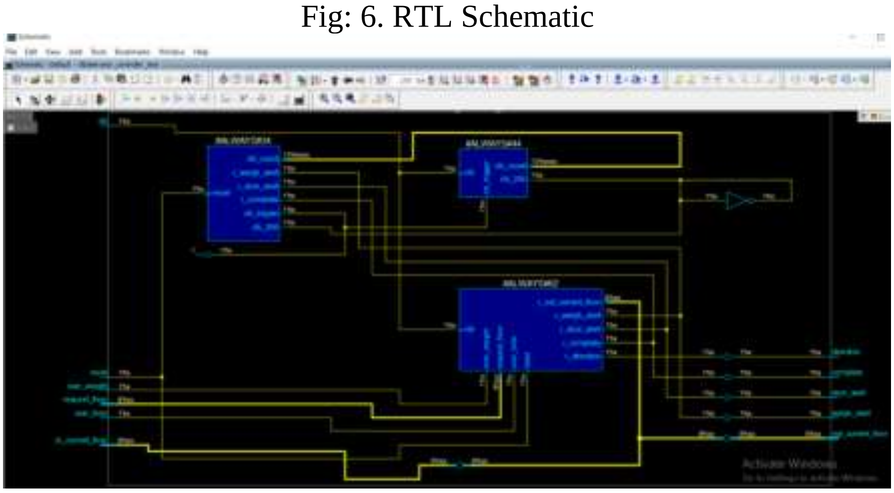

Fig: 7. RTL Schematic Elevator Controller

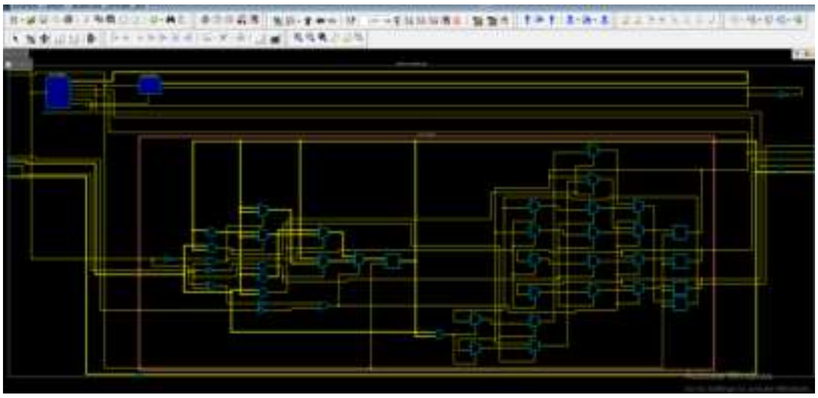

Fig: 8. RTL schematic

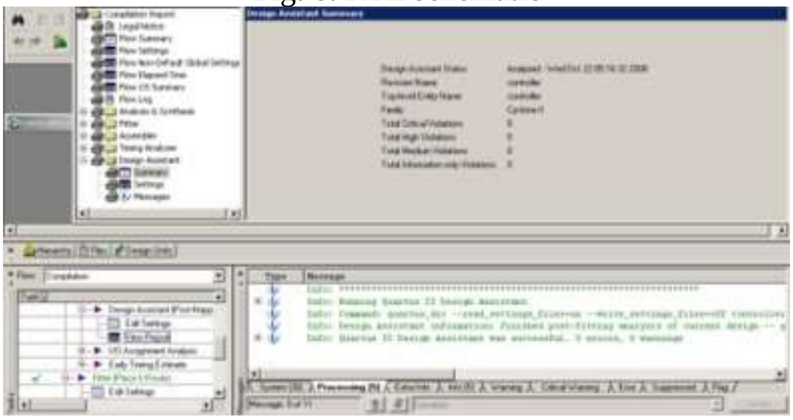

Fig: 9. Synthesized Reports


Fig: 10. Implementation

## 10. Conclusion

An efficient lift control system is designed and implemented in an FPGA using Verilog. The elevator controller inputs the required floor and then outputs what the user has asked for. The modelsim tool simulates this lift movement from the current floor to the desired floor, and the results are generated as a waveform. The Verilog code is then implemented using the FPGA Cyclone 2 (ep2c35f67236). In the Register Transfer Level view, the implemented verilog code is reviewed, reported on, and shown.

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