CSE241 Final Lab Midpoint
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Problem Statement:

This document describes the proposed implementation for a two-input security keypad that is to be installed on a square desktop safe. This means that the safe is a small metal cube with four small rubber legs with pressure sensors with a wire to go to a power outlet, a level sensor, and a keypad with two buttons: a button labeled “ZERO” and a button labeled “ONE.” These will be represented as the inputs **BUT0** and **BUT1**, respectively. These inputs will be sanitized through a combonational logic 2:4 decoder before entering the sequential logic section. In order for the keypad to function at all, the safe must be plugged in at all times, represented as the input **ENBL** (E). If the system is disabled while the door is open, it will still lock as the process of locking is a mechanical issue. The level and the pressure sensor are part of the definition for the fourth input, **SECI** (S) which represents a security violation.

The passcode for the lock will be the number eight represented in binary: 0b1000. In order for the safe to open, this exact passcode must be entered in order. Anything else will cause a reset. If a security violation occurs while the passcode is being entered, the passcode buffer will reset. If the system is ever disabled, the buffer will be reset.

Four LEDs will be used to display the system’s response. Two LEDs represent whether the safe is locked or unlocked, represented by the outputs **LOCK** and **ULCK**. A third LED represents whether a reset has occurred, called **RSTO** for RESET-OUT. If the input buffer is being reset for any reason, including but not limited to cosmic rays or a electromagnetic pulse, this LED will trigger. The fourth and final LED will only trigger if a security violation has occurred. This output will be called **SECV** for Security Violation.

Security Violation Definition:

If the safe is ever moved even slightly, the pressure sensors’ output will change and thus cause a security violation. The pressure sensors must remain at a constant value for at least one minute after a change in order to stop triggering a security violation. If the safe is set down at an angle, such that the level sensor sends a bad output, a security violation will be triggered again. In order for this security violation to stop triggering, the safe must be set down on a flat, level surface. The final security violation triggers when the keypad lock is trying to be bypassed, such as someone trying to force the door open with a crowbar. This will trigger a security violation.

State Diagram and Explanation

For the purposes of the state diagram, “trigger” will be defined as going from the binary state of 0 to 1, or in the case of the output LEDs, remaining at 1. By default, the input **ENBL** and the output **LOCK** will be set to 1, and every other input and output will be set to 0. Each state will send an output to all four output LEDs. There will be a total of eight states which describe the rules above.

For the purposes of maintaining clarity of the image, there will be some inputs omitted on transitions from one state to another. These inputs are to be treated as a DONT-CARE. This transition will happen if the displayed condition are met, regardless of the other inputs. For example, going from the **OPEN** state to the **RSTS** (reset state) will happen if **ENBL is** 1, regardless of any other input. Those other inputs are unimportant for the purpose of this state transition.

Finally, the input buffer described above will be represented by four states: **DIG0**, **DIG1**, **DIG2**, and **DIG3**. These states will "read" the input buttons to the system and change states accordingly. If a incorrect digit has been entered on any of these states, a transition will occur to the **RSTS** state, which represents a reset of the buffer. This state will send a 1 to the **RTSO** LED and then transition to reading the first digit of the passcode. If the passcode is entirely correct, a transition to the **OPEN** state will occur. This will turn on the **ULCK** LED and represents the door to the safe being unlocked and able to be opened. A transition out of **OPEN** into **RSTS** will only occur on a posedge clock update if the door is closed and the system is enabled. If the system is disabled at any time, a transition to **_OFF** will occur. During the **_OFF** state, all the LEDs will be turned off.

With all of the above context in mind, here is the complete state diagram. Please note transitions that happened because of a security violation are colored in red and transitions that occur when the system's enable is 0 are colored in blue.