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Project 2: Key Planning
10/15/21

Ask:
1. Purpose/Goal
   a. To create a count-down and alarm system that takes a user-input time (up to 9m 59s).
   b. Extra credit
      i. Design a count-up toggled option that displays time passed, otherwise the same
2. What are the inputs?
   a. Keypad
      i. use to read time value from the user
      ii. Sets state of the timer - start/stop/input
3. What are the outputs?
   a. LED(s)
      i. Lights up when a value is entered
      ii. Many turn on when time is up
   b. LCD
      i. Displays time remaining
      ii. Displays Times Up
4. Are there any constraints or relationships between the inputs and outputs?
   a. When a value is entered, an LED must light up
   b. When the input time has passed, the LCD must display a message and have many LEDs turn on

Research/Imagine:
- How will I control keypad input and checking row/column?
  - Lecture 9
  - 9/29/21 lecture
  - Polling?
- Accounting for bounce?
  - Work this into the polling to find specific value as seen in class
- Possible Solution
  - Read key values off of keypad as seen in class
    - Use interrupts and have an isr for each row
    - Create conditions to read different keys
      - A, B, D, potentially C, have different behavior than 0-9
    - LED light-up each time a value is pressed

- ■ Maximum time of 3 values long
  - ● Keep track of logic for X min and 60 seconds
  - ● Reject 9 min 60 seconds
- ■ Build time as values are input
- ○ Begin clock -- we haven't really learned this time piece fully yet so I will add it to the plan when we do
  - ■ Time Remaining on LCD
    - ● Read the documentation for specifics on LCD commands
- ○ When time reaches 0:00
  - ■ Change LCD to display times up
  - ■ Turn on many LEDs
- ● Extra Credit?
  - ○ Add isr that will take input from key C and toggle into count-up mode?
  - ○ Begin clock
    - ■ Time Passed on LCD
  - ○ When time reaches the value input by user
    - ■ Change LCD to display time reached
    - ■ Turn on many LEDs

Plan:
- ● Variables: interrupts for each column, isr for each possible key value, accumulator (init to 0), row counter, something to track LCD, variables necessary for the clock
- ● We need the 1 Nucleo-L4R5ZI, ~10-15 jumpers, 1 breadboard, 4 LEDs, 1 LCD, 1 Keypad
- ● Test plan
  - ○ Do intended LEDs light up when a value from the corresponding column is pressed
  - ○ Print accumulator after each key press, is it reading the right value? Is the accumulator correctly building the total time?
  - ○ Does correct time display at start of clock cycle?
  - ○ Does it count down 1 second at a time until 0:00 is displayed?
  - ○ When 0:00 is reached, does the display change to times up? Do all 4 LEDs light up?
- ● Logic diagram for possible solution from imagine (excluding extra credit) is on the next page

```
                                    ┌──────────┐      ┌──────────┐
                                    │ Many LEDs│      │   LCD    │
        ┌─────────┐                 │ light up │      │ Display: │
        │  Start  │                 └──────────┘      │ Time's Up│
        └─────────┘                                   └──────────┘
             │                                             ▲
             ▼                                             │
   ┌───────────────────┐       ┌──────────┐         ┌──────────────┐        ┌──────────────────┐
   │ Variables: One    │       │  Reset   │         │ Clock has    │  ────▶  │ Reset and Prepare│
   │ interrupt for each│       │accumulator│        │ reached 0:00 │         │   for new input  │
   │ column            │       │  to 0    │         └──────────────┘         └──────────────────┘
   │ (PC5,6,8,9), row  │       └──────────┘                ▲
   │ value,            │        ▲        ▲                 │ Run
   │ accumulator for   │        │        │         ┌──────────────┐        ┌──────────────┐
   │ time, clock       │       Yes       │         │ Begin clock  │        │ LCD Display: │
   │ pieces, external  │        │      No │         │ process (add │  ────▶  │    Time      │
   │ LED for each      │        │        │         │ detail when  │        │  Remaining   │
   │ column            │    ┌───────┐  ┌───────┐    │ we learn it) │        │  __m:__s     │
   └───────────────────┘    │  Is   │  │  Is   │    └──────────────┘        └──────────────┘
             │              │accum- │  │accum- │           ▲ Yes
             ▼              │ulator │No│ulator │───Yes──────┘
   ┌───────────────────┐    │length │─▶│ =<    │
   │ Set .rise on all  │    │ > 3?  │  │ 959?  │
   │ interrupts to move│    └───────┘  └───────┘
   │ to ISR for column │        ▲
   │ to determine      │        │                                                        Yes
   │ specific key value│        │                                          ┌──────────────────────┐
   └───────────────────┘        │                                          │                      │
             │                  │                                          │                      │
             ▼                  │                                          │                      │
   ┌───────────────────┐        │                                          │                      │
   │ Prompt User       │◀───────┼──────────────────────────────┐          │                      │
   │ for input         │◀───┐   │                              │          │                      │
   └───────────────────┘    │   │                         ┌──────────┐     │                      │
             │              │   │                         │ If       │     │                      │
             ▼              │   │                    Yes   │currently │     │                      │
   ┌───────────────────┐    │   │                     │    │counting  │     │                      │
   │ User              │◀───┼───┼─────────────────┐   │    │down, stop│     │                      │
   │ Presses a key     │    │   │                 │   │    └──────────┘     │                      │
   └───────────────────┘    │   │                 │   │         ▲           │                      │
             │              │   │                 │   │        Yes          │                      │
             ▼              │   │                 │   │         │           ▼                      │
   ┌───────────────────┐  ┌──────────────┐        │ ┌───────┐ ┌───────┐ ┌───────┐
   │ Use row integer   │─▶│ LED connected│        │ │ Was it│ │ Was it│ │ Was it│
   │ to check row      │  │ to           │        └▶│  A?   │─No─▶│ B?  │─No─▶│ D?  │
   └───────────────────┘  │ corresponding│          └───────┘ └───────┘ └───────┘
             │            │ row flash    │
             ▼            └──────────────┘
   ┌───────────────────┐    ▲
   │ Was the button    │    │
   │ pressed a number? │─Yes─▶┌──────────────┐
   └───────────────────┘    │ If D was     │
             │              │ alredy       │
            No              │ pressed. add │
             │              │ to           │
             └──────────────│ accumulator  │
                            └──────────────┘
```