University of British Columbia
Electrical and Computer Engineering
ELEC291/292

Project 1: Reaction Game with Capacitive Sensors

Dr. Jesús Calviño-Fraga P.Eng.
Department of Electrical and Computer Engineering, UBC
Office: KAIS 3024
E-mail: jesusc@ece.ubc.ca
Phone: (604)-827-5387

February 4, 2022

Objectives

- Project 1 Requirements.
- Teams.
- Suggested game rules.
- Random number generator.
- Capacitor sensors for project 1.

Project 1 Requirements

- **8051 based Microcontroller System:** For this project use the AT89LP51RC2 microcontroller. If you wan to use a different processor, you'll need the instructor approval first.
- **Sensor Capacitors:** You'll need to build at least a couple of sensing capacitors. The simplest way of building the sensors is by using aluminum foil between two sheets of transparency plastic. Try to make your sensor capacitors as robust as possible.
- **A-stable Oscillators or similar:** These oscillators will change their frequency with the capacitance variations of the sensor capacitors. You could use the 555 timer on an a-stable oscillator configuration for this purpose. Similar to lab #3.
- **Speaker and LCD:** The game must use both the CEM-1028 mini speaker (or similar) and the LCD.
- **Assembly programming:** All programming for this project must be completed in assembly language.
- **Sensititivity:** The capacitive sensors should be able to reliably and quickly detect a hand on top of them.

Suggested Game Rules (or make your own):

- The game will produce either a 2100 Hz tone or a 2000 Hz tone randomly using a timer and the CEM-1023 speaker.
- If the tone is 2100Hz, the first player to press its capacitor sensor wins a point.
- If the tone is 2000Hz, the first player that presses its capacitor sensor looses a point.
- Use the LCD to display the points for each player.
- The first player to reach 5 points wins the game!

Teams

- Teams of 3 students.
- For this project, students can be in any section.
- Share ideas, work, source code, test etc.
- One submission per team.
- You should be in a team ASAP!
- Support each other! A happy team gets good marks.

Random Number Generator

- Look for 'Linear Congruent Generator'.
- Could ask players to push a button at the beginning of the game to generate a first 'Seed' with the help of one of the timers.
- A popular one (I tested this one in asm):
  - Seed=214013*Seed+2531011
- Another one:
  - Seed=8121*Seed+28411
- https://en.wikipedia.org/wiki/Linear_congruential_generator

Pseudo Random Number Generator

```
179 ;--------------------------------;
180 ; Pseudo random number generator ;
181 ;--------------------------------;
182 Random:
183     ; Seed=214013*Seed+2531011
184     mov x+0, Seed+0
185     mov x+1, Seed+1
186     mov x+2, Seed+2
187     mov x+3, Seed+3
188     Load_y(214013)
189     lcall mul32
190     Load_y(2531011)
191     lcall add32
192     mov Seed+0, x+0
193     mov Seed+1, x+1
194     mov Seed+2, x+2
195     mov Seed+3, x+3
196     ret
```

Initial Seed

```
394     ; Wait for a push of the BOOT button
395     ; to initialize random seed:
396     setb TR2
397     jb P4.5, $
398     mov Seed+0, TH2|
399     mov Seed+1, #0x01
400     mov Seed+2, #0x87
401     mov Seed+3, TL2
402     clr TR2
```

4

Using Random and Seed

To choose the tone to play:

```
424    lcall Random
425    mov a, Seed+1
426    mov c, acc.3 ; Use an arbitrary bit of 32-bit seed
427    mov HLbit, c
428    jc tone2
```

To wait a random time between 0 ms and 1024 ms:

```
357    Wait_Random:
358        Wait_Milli_Seconds(Seed+0)
359        Wait_Milli_Seconds(Seed+1)
360        Wait_Milli_Seconds(Seed+2)
361        Wait_Milli_Seconds(Seed+3)
362        ret
```

Making a Sensing Capacitors

- You can make your capacitors any way you want!
- I made my sensor with stuff from the dollar store:
  - Cutting mat ($1.5).
  - Double side sticky tape ($1).
  - Masking tape.
  - Aluminum foil.
  - Transparency (paper works also, but not durable).
- There are many different ways of making the sensor capacitors.

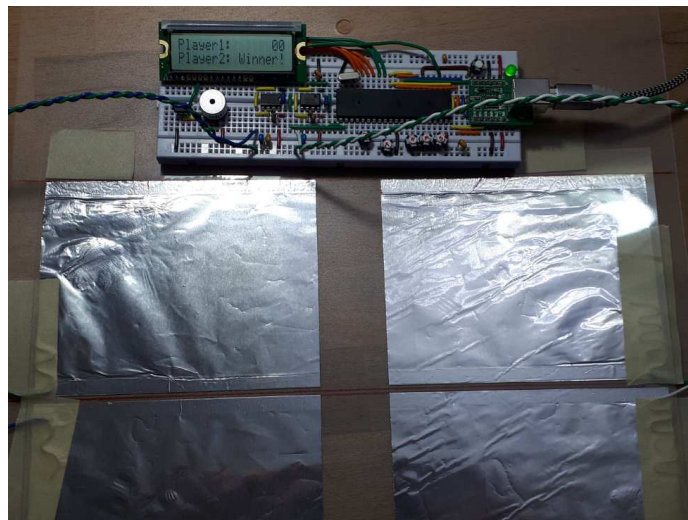# Sensor Capacitors (some options)

- Option 1: aluminum foil. Easy to make but not very solid; rips easily.
- Option 2: pop can aluminum. Harder to work with but solid and durable! BE VERY CAREFUL WHILE CUTTING THE POP CAN!
- Option 3: aluminum tape. Used it in the past.

11

Sensor Capacitors

12

6

Potential Problems

- The speaker sound could interfere with 555 timer frequency.
- Wire contacts with the sensor capacitors may get loose.
- The capacitance of the sensor capacitors is very small.