Digital Systems Laboratory

Final Project Nº9 School Year 2023/24

Reaction time tests**:** minimum competition

1. Introduction

The central theme of this project, to be carried out with the *Altera DE2-115* development *kit*, is the evaluation of how quickly (usually measured in milliseconds) a user physically reacts (by pressing a key) to visual stimuli. You can try out tests of this kind at https://cps- check.com/en/reaction-test, for example.

A typical **elementary test cycle** comprises the following steps:

1 - Start-up:

By pressing a button, the user causes a delay-on timer to be set to a random value ($_{don}$) in ms in a suitable range and to start at that same instant.

2 - Stimulus activation:

Once the $_{don}$ delay has elapsed, the visual stimulus is activated, at which point the stopwatch starts measuring the reaction time ($_{treac}$) in ms.

3 - Reaction to stimulus:

The user must press a button (it can be the start button again) as soon as they see the stimulus activate. At this point, $_{treac}$ is recorded, the stopwatch is restarted and the stimulus is deactivated.

Note 1: It is essential that the $_{don}$ delay has a random duration, to avoid predictability of the stimulus and consequent bias (albeit unintentional) of the results. However, a minimum limit is required to guarantee the user's readiness for consecutive tests. Once these requirements have been met, $_{don}$ must be short, to avoid biasing the results due to user fatigue and wasted time.

Tip: it is possible to satisfy these conditions with a simple free-run counting block: if the reading time is determined by manual action, the value read will be random in the counting range, with a more uniform distribution the higher the clock frequency.

Note 2: In consecutive test cycles, step 3 of each cycle may constitute step 1 of the next.

2. Specifications

The aim is to run a competition between two players who alternately carry out elementary test cycles (see the structure described in the Introduction) in which the visual stimulus is the LEDG lighting[7..0]. The winner will be the one who achieves the best minimum reaction time record over a set number of cycles.

In an **initial configuration stage**, in which the HEX3-HEX0 *displays* must show '`ConF`', the number of test cycles assigned to each player (6 by default) can be adjusted between 2 and 9 using a single push button (unit increment with each touch). The number will be displayed simultaneously on the HEX7 and HEX6 displays which, at this stage, should flash at 1Hz. Completion of this step will be indicated by pressing another push button.

This will be followed by the **competition stage**, in which the HEX3-HEX0 *displays* should start by indicating '`tESt`'. The progress of the sequence will be shown on HEX7 and HEX6, which will constantly update the number of cycles still to be completed by players 1 and 2 respectively. The HEX5 display should

show which player (1 or 2) gets a turn (starting with 1, of course). After player 1's first test, the HEX3-HEX0 *displays* will show the minimum reaction time recorded so far (in ms), with HEX4 showing the number of the player (1 or 2) who obtained it.
In the test cycles, both players use the KEY0 key. Note that, in this alternating competition format, step 3 of one cycle should not constitute step 1 of the next; a new press of the KEY0 key is required.
If a player reacts prematurely to the stimulus, LEDR[7..0] must light up briefly (e.g. for 1s) to signal this. The penalty applied to the offending player will be the loss of the right to the remaining attempts: the respective *display* (HEX7 or HEX6) must therefore show the number
0. Note that the system must correctly manage the opponent's remaining attempts.

The competition ends when both players have completed their attempts. This is followed by the **completion stage**, in which the minimum reaction time displayed on HEX[3..0] will flash at 2Hz for 6s. At the same time, HEX4 will display the winner's number flashing at the same frequency or, in the event of a tie, the numbers 1 and 2 alternating at 1Hz. Since a tie is highly unlikely, use a simulation to demonstrate that the system is taking this into account. At the end of this stage, the system should return to its initial configuration.

3. Work phasing

A phased development approach is recommended, successively planning, building and testing the various blocks/assemblies and gradually integrating the operating requirements, starting with the simplest. Below is a suggestion, with quotations given as a guide:
1 **- [2]** Single cycle with 1 user and reaction time display.
2 **- 4]** Two successive cycles (one for each player), updating the minimum reaction time and the player who obtained it, ignoring premature reactions - FEM control must be applied (it is crucial to start by carefully designing the state diagram).
3 **- 3]** Competition with a fixed number of cycles (e.g. 6), indication of the progress of the competition and updating of the minimum reaction time, ignoring disqualifications.
4 **- [2]** Cycle number setting (initial configuration step).
5 **- [2+1+1]** MEF for general system control (configuration, competition and completion stages): integration of the functionalities for initial adjustment of the number of cycles and final lighting effect.
6 - 3**]** Review of phases 2 and 3 to detect premature reactions (phase 2) and apply the criteria for disqualifying a player (phase 3).
7 **- 2]** Addition of other relevant functionalities and/or options to improve the system.

4. General recommendations

- A single clock signal (50MHz) must be applied to all sequential components.
- A general 'reset' input must be provided (protected against accidental actuation) that will return the system to the initial configuration stage.