Work Assignment Proposals

Digital Embedded Systems

Master in Lifelong Learning in Cooperative, Connected and Automated

Academic Year 2024/25

Rules:

- Students will gather in groups of 3 or 4 people
- Each group will have to choose one work assignment. This will be done in a Query in Aula Global.
- Each work assignment will only be assigned to a maximum of 2 groups.
- Any group can also proposed its own work assignment. In that case, the proposal has to be firstly approved by the teacher, as to check that it fits with the course expectations.
- Once developed, the work assigned will have to be submitted through Aula Global, with the following content:
    - Short document showing:
        - Development platform used
        - Installation guide
        - Short presentation of the rest of the components used with the platform, with the interconnection information.
    - Source code and, if possible, executable files
    - Evidences showing the results obtained. A video may be a good evidence, considering that it not exceeds the maximum file size allowed by Aula Global.
    - Presentation to be used during the oral exam.
- Deadlines and further information will be provided in Aula Global
- The submission can be done at any moment, and can be updated before the deadline. Marking is not expected until the deadline has been reached.

Proposed work assignments:

1. **Analysis, development and verification of the low-power modes in the microcontroller**
    a. Description: The group will have to study the different low-power mechanisms available in the microcontroller. Once studied, a project will have to be developed, as to allow testing those modes. The project shall be simple in performance, as the importance is not so much the project functionality, but the analysis of the low-power modes. The idea is that such project will be executed with full power consumption, and after some time (enough to be able to measure trustfully the consumption, it will change to the following low-power mode, and so on, creating the mechanisms to wake up the microcontroller when needed. For example, the project can be blinking a LED every half a second and using the USER BUTTON to allow the control of the program flow (or wake up mechanisms).

b. Tools: Within the CubeMX perspective of STM32CubeID, there are some tools embedded (including a consumption calculator). Investigate how it works and if it is useful. Also, physical measurements of the current consumed, would be very interesting.

2. Domotic control of home window shutters

a. Description: The development shall emulate the control of the operation of window shutters in a home, considering, initially, 2 shutters. The operation should be opening, closing and stopping, being able to stop the movement in the middle of the whole course. The system will also have a light sensor that, depending on its value, it will change the status of the shutters. The system will be developed using FreeRTOS, and will have to consider, at least, the following specifications:
    i. If the light sensor provides an intensity between 35% and 90% of its maximum value, the shutters will open completely
    ii. If the light sensor provides an intensity higher than 90%, the shutters will be open only at its 50%
    iii. If the light sensor provides an intensity lower than 35%, the shutters will be closed completely
    iv. While the light sensor keeps its values between one of the 3 ranges described above, the shutters won't be changed, unless the change has been stable during the last 5 seconds (as to avoid oscillations in light values close to the thresholds)
    v. But at any time, the system may receive an instruction from the outer world indicating:
        1. Manual mode: Telling which shutter is affected, and the opening status (in percentage of the opening course). The automatic mode is disabled.
        2. Automatic mode: as described above.
        3. Holidays mode: where a certain cyclic sequence of opening and closing of the shutters will be defined (individually and different from one shutter than the other). Only 4 different levels of opening will be considered. The sequence shall be randomly chosen, each time this mode is started. This mode will also disable the automatic mode.
            a. In order to emulate this mode, the system will change the sequence step after 2 or 3 seconds.
b. The solution shall be well structured
c. The development can be done using, or not, RTOS.
d. The use of low-power consumption modes will be welcome.

3. Moving robot controlled by a smartphone

a. Description: A moving system will be developed, so that it can move autonomously but controlled by the commands received from a smartphone. The system shall conform to the following specifications:
    i. The system will be connected to a smartphone through a wireless connection (you can choose which one to use, e.g., Bluetooth, WiFi, etc.). The smartphone will be in charge of sending the setup and the movement orders.
    ii. The system shall be able to move at a minimum distance of 4 meters, without any external control. The system can receive a direction and distance to cover, or a set of points in the route that shall be reached in a sequential manner.

iii. The user will set the coordinates, and the system will have to reach them, whenever possible.
iv. The system will have an obstacle detection system, that will avoid any kind of accident. The obstacle detection system will be used to allow the system to overcome any obstacle in the route. If the system cannot avoid such an obstacle, it will have to tell the user that the target is not reachable.
v. When the target is reached, the user will received a message with the distance covered and the time spent for reaching the target.
vi. You can use an ultrasound system such as HC-SR05.
vii. You can also use the following device available in Amazon: *Gebildet 4pcs DC3V-12V DC Motorreductor para Coche de Juguete con Tracción en Las Cuatro Ruedas/Cuerpo Robótico/Juguetes de Aviones+4pcs Plástico Rueda Neumático*

4. Smart sneakers for sport persons

a. Description: The development will be a prototype of a device that will be able to recognize the physical activity of a person. The system shall comply with, at minimum, the following requirements:
    i. The system shall be able to measure the distance and the time taken for such a distance, as well as the energy consumed.
        1. Hint: use an accelerometer to detect the peaks that are produced while walking/running, obtain the frequency, and consider the size of the step being done to measure the distance. For the calculation of the energy consumed, you can simplify it by considering only the one depending on the rhythm (more rhythm, more energy spent). The calculations done do not have to be really based on any real algorithm for the energy spent calculation.
    ii. The system will have 2 working modes: a) monitoring, and b) physical exercise
    iii. In the monitoring mode, the device will perform periodic estimations (every 1 minute) of the energy spent, showing such information in a smartphone.
    iv. In the physical exercise mode, the system shall recognize, at least, the following intensity levels of physical activity: low intensity, medium intensity and high intensity, based on the energy spent and the rhythm detected.
    v. The system shall keep a historical record of the energy spent, covering, at least, the last 24 hours, indicating the working mode and the energy spent.
    vi. The system will be connected to a smartphone through a Bluetooth connection, in where you could show the physical activity detected, and where you can modify the intensity thresholds and the acquisition time in the physical exercise mode.
    vii. A target for the energy to be spent daily will be established, and when the user reaches that target, an alert will be sent to the smartphone. The user shall be able to modify the target to be reached.

5. Flower smart pot with WiFi connection

a. Description: The development will be a plant pot that can be controlled by WiFi. The minimal specifications are:
    i. The system shall control the status of the plant at all times (i.e., humidity level, light, temperature).

ii. When the plant needs attention, the pot will send a message to the smartphone.
iii. The user shall be able to set up a threshold for each of the parameters, so as to ask for attention.
iv. When the humidity is below the threshold, the plant will be watered automatically. Use a LED so as to turn on or off this functionality.
v. If the light is over the threshold, the shutters of the room will be closed as much as indicated by the excess of light.
vi. The sensing frequency of each of the magnitudes shall be edited by the user through the smartphone (30 seconds, 1 minute, 5 minutes or 30 minutes).
vii. At any time, the user can ask for a new measurement of the parameters through the smartphone.
viii. The smartphone will show the values of the last measurement available.