Embedded Systems Coursework Specification

Coursework 2: Brushless Motor Controller

Functional specifications

1. The motor will spin for a defined number of rotations and stop without overshooting with a precision of 0.5 rotations for number of rotations.
2. The motor will spin at a defined maximum angular velocity of 5–100 rotations per second, with a precision of 0.5 rotations per second.
3. The system will perform a Bitcoin mining task and test 5000 nonces per second. Matching nonces will be sent back to the host.
4. The motor will play a melody while it is spinning by modulating the drive current. The melody is a repeating sequence of notes in the C_4 octave with durations of 0.125–1 seconds.

Command specifications

5. The system will be commanded by instructions sent from a host over a serial interface at 9600bps.
6. Each command will end with a carriage return character.
7. The syntax for rotation commands is the regular expression
   `R-?\d{1,4}(\.\d)?`
8. Rotation commands are relative to the current position.
9. The syntax for maximum speed commands is the regular expression
   `V\d{1,3}(\.\d)?`
10. On startup, the maximum speed should be set to 100 rotations per second and the initial rotation target should be zero, i.e. the motor should not move until commanded.
11. The syntax for setting the bitcoin key is the regular expression
    `K[0-9a-fA-F]{16}`
12. Matching bitcoin nonces should be sent to the host with a message matching the regular expression
    `N[0-9a-fA-F]{16}`
13. The syntax for melody commands is the regular expression
    `T([A-G][#^]?[1-8]){1,16}` (where `#` and `^` are characters)

Documentation specifications

The report should contain:

14. An itemisation of all the tasks that are performed by the system with, for each task,
    (a) the method of implementation (e.g. thread, interrupt, polling loop),
    (b) the theoretical minimum initiation interval,
    (c) the measured maximum execution time,
    (d) the maximum CPU utilisation.
15. A critical instant analysis of the rate monotonic scheduler, showing that all deadlines are met under worst-case conditions.

16. An itemisation of blocking dependencies between tasks with, for each dependency,
    (a) the type of dependency (e.g. semaphore, queue),
    (b) the task which is blocked by the dependency,
    (c) the task which releases the dependency.
17. A dependency graph that shows there is no possibility of deadlock.

Notes

- Examples of rotation commands are `R-1034.5` (spin backwards for 1034.5 rotations).
- An example velocity command is `V20` (execute rotation commands at a maximum of 20 rotations per second).
- An example melody command is `TA4C8G4F#8` (T followed by pairs of notes and durations).
- An example key command is `K0123456789ABCDEF`.
- The Bitcoin mining task is the computation of SHA-256 hashes of the 64-byte data sequence `{<data>,<key>,<nonce>}`, where `<data>` is 48 bytes of static data, `<key>` is an 8-byte number specified by a host over a serial interface and `<nonce>` is an 8-byte number that can be freely-chosen. A matching nonce is one that produces a hash that begins with 16 binary zeros.