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ECE-40153- Introduction to Embedded Systems

Section 151126, Fall 2020

Lesson 2 assignment 1

1. I’ve always thought of a microcontroller as “a microprocessor and...”, meaning that an MCU is the core architecture of some MPU design plus peripherals (GPIO, communication circuitry, RAM, flash, etc). There are times when either could be a solution to a design, however, there are many criteria to consider on which would be the better option when either would be acceptable.
2. As an example of the above, I’d like to compare a lab/bench top style multimeter versus a pocket-style DMM meter. A pocket meter obviously needs to be small, battery powered, and doesn’t require much computational power beyond the ability to accurately perform simple ADC calculations and display results on a small LCD. This is an excellent application for a small MCU that meets the above requirements and not much else. Conversely, a lab meter only needs to fit within a reasonable definition of “bench top”, would typically be powered by mains voltage, and requires both speed and precision. It might also need to power a higher quality display, interface with a PC or network, as well as have the capacity for more complicated analysis. This would be a good application for an MPU, possibly in a backplane or motherboard style assembly to allow for different options or features based on HW and SW configurations, much like a PC.
3. Vehicle systems
   * TPMS
     + An MCU with capacity for an ADC (pressure/ temp) and communication (some low power radio spec) back to a centralized controller.
   * Instrument Clusters
     + An MCU that can drive a display (digital systems), actuate a stepper or servo tied to a physical arm (analog systems), and some communication interface back to a centralized controller.
   * GPS
     + Could go either way, I would guess most GPU modules are either ASICs (MCU-esque) or Systems On Chip (MPU-based). Regardless of the specific implementation, a GPS unit in an automotive context is still a subset of a larger system and needs to be able to communicate its processed data to rest of the appropriate system members (navigation interface, auto driving, or tracking logs).
   * Park/reverse assist
     + An MCU with some kind of sensor (light or sound based) and the ability to communicate back to a central controller.
   * Autonomous driving system
     + This could be an example of one of the controller systems mentioned above, that requires a large amount of processing capacity to both handle the amount of data from all of the above systems, as well as to prioritize one system’s feedback over another. For example, one tire being 1psi lower than the others should fall under a lower prioritization than an imminent collision being detected. Some MCUs on the market might have the capacity for this application but I would lean generally lean towards an MPU.
4. With no design criteria other than what is listed in the question, I would lean towards a system of distributed MCUs with HW and SW specifically applicable towards the task they are assigned to accomplish. Additionally, I would plan for the HW design to be modular, that is, in event of component failure within specific sections of the system, that task area’s constituent parts could be replaced without negatively affecting functionality to the rest of the system. For example, if I have an industrial control system monitoring inputs, controlling outputs, and communicating with a display, I would design so that my input capacity could be increased by swapping that section of the system for a different module while the rest of the system continues to function as-is.
5. Many of the STM32 series chips, including the L475 on our IOT board, incorporate a CAN interface. Safety issues aside, I have always thought it would be very cool to interface with a vehicle’s CAN bus to pull various date points such as engine temp, RPM, tire pressure, etc. and incorporate them into some kind of HUD projected on to the vehicle windshield. The STM32 IOT board has more than enough onboard horsepower for this while still being low powered enough that it could easily tap in to one of the unused spots on the vehicle fuse box.