DAY 26-DAILY ASSIGNMENTS

ANSU MARIUM SHIBU

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1. SUMMARY OF HOW CPU WORKS:

CPU: The CPU is the brain of the computer, the CPU executes instructions and controls other components.

*CLOCK: Inside the CPU there is a particular wire that turns on or off at a steady rate to help everything in sync

*MOTHERBOARD: CPU fits into the motherboard. This motherboard allows components to connect to each other.

*RAM: On the right side of the motherboard. It will contain all the data being processed by the CPU.

*ALU: it will perform mathematical operations in the CPU

*CONTROL UNIT: It coordinates and controls the flow of data and instruction within the CPU.

*REGISTER: It will store a number temporarily.

*ENABLE WIRE: when we want to out the number stored in the register we want another wire.

*BUS: The output wires of registers will connect to the bus. Bus is a group of wires that can connect multiple components inside a computer

Advantage: It can easily move between the components

Disadvantage: It can only carry one data at a time

*INSTRUCTION REGISTER: The instruction itself with another register

*INSTRUCTION ADDRESS REGISTER: It mainly uses the CPU this register knows where the next instruction should come from in the RAM

*MEMORY ADDRESS REGISTER: It is an intermediary register. It is used to tell the RAM what memory address the CPU wants.

2. To develop an embedded product for an autonomous car that detects objects and takes corrective actions while driving, the requirements must cover the hardware, software, and environmental constraints. Below is a comprehensive list of requirements to guide the selection of a microcontroller for this project.

1. Functional Requirements

Object Detection

Support for interfacing sensors such as LIDAR, ultrasonic, RADAR, and cameras.

Real-time image processing capability for object recognition and classification.

Corrective Action

Ability to control actuators for steering, braking, and acceleration.

High-speed decision-making to avoid collisions or maintain safe distances.

Communication

Support for CAN, LIN, and Ethernet for communication with other car systems.

Ability to interface with GPS and IMU sensors for positioning and orientation.

Fail-Safe Mechanisms

Redundant systems to ensure reliability in case of hardware or software failure.

Automatic transition to manual driving in case of system failure.

2. Performance Requirements

Processing Power

High-performance ARM Cortex-M or Cortex-A cores capable of handling complex AI/ML algorithms.

Minimum clock speed: 200 MHz.

Support for hardware accelerators (e.g., DSP or AI inference engines).

Memory

Flash memory: ≥ 2 MB for program storage.

RAM: ≥ 512 KB for real-time processing.

Real-Time Operation

Must support real-time operating systems (RTOS) for deterministic behavior.

Low latency for sensor input to action output (≤ 50 ms).

Power Consumption

Optimized power consumption for automotive environments, with sleep modes and low-power states.

3. Hardware Requirements

Interfaces

Multiple UART, SPI, I2C, and GPIOs for connecting peripherals.

Support for high-speed data interfaces like USB or PCIe.

Robustness

Temperature range: -40°C to 125°C.

Vibration and shock resistance per automotive standards.

Safety Standards Compliance

Compliance with ISO 26262 for functional safety (ASIL-B or higher recommended).

Analog and Digital Input/Output

Support for ADCs and DACs for sensor inputs and control outputs.

4. Software Requirements

Development Tools

Support for standard toolchains like GCC, Keil, IAR, or vendor-specific IDEs.

Debugging capabilities with JTAG or SWD.

Connectivity

Support for wireless communication standards like Wi-Fi, Bluetooth, or 5G for over-the-air updates.

AI and Machine Learning

Compatibility with AI frameworks like TensorFlow Lite or ONNX for embedded systems.

Hardware or software-based ML acceleration.

Firmware Update

Secure bootloader for over-the-air firmware updates (OTA).

Encryption and authentication for updates.

5. Environmental Constraints

Automotive Standards

Must comply with AEC-Q100 for automotive-grade microcontrollers.

Electromagnetic compatibility (EMC) and susceptibility (EMS) compliance.

Power Supply

Operate within 12V DC automotive systems with tolerance for voltage spikes.

6. Cost and Scalability

Cost Constraints

Affordable while meeting all performance and safety requirements.

Scalability

Easily scalable for integration into different vehicle models.

Processor:The NXP S32G2 processor provides a balanced solution for all functional, performance, hardware, software, environmental, cost, and scalability requirements. Its automotive-grade certification, integrated safety features, high processing power, and support for AI and real-time operations make it ideal for autonomous car systems.