**Team Members:**

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**Project Proposal:**

Digit Pattern Recognition System using Neural Network on ATmega32

**Idea:**

The goal of this project is to design and implement a small embedded system that recognizes keypad-entered binary digit patterns using an Artificial Neural Network (ANN) running entirely on an ATmega32 microcontroller. The system will take a binary pixel input of a digit (for example, a 3x3 grid entered via a keypad), process it using a trained neural network model, and display the recognized digit on an LCD screen. This project aims to demonstrate the feasibility of running basic neural network inference on low-resource hardware.

**Purpose:**

* To explore practical implementation of Artificial Neural Networks in resource constrained embedded systems.
* To learn hardware interfacing with keypads and LCDs, as well as the challenges of fixed-point math and optimization in microcontroller programming.
* To gain hands-on experience in converting machine learning models trained offline into embedded C code suitable for microcontrollers.
* To build an educational project showcasing how AI concepts can be embedded into simple devices.
* To strengthen skills in microcontroller programming, matrix math, and embedded system design.

**Methodology:**

1. **Hardware Layer:**
   * Use an ATmega32 microcontroller as the core processing unit.
   * Interface a 4x4 matrix keypad to input a binary pixel pattern of a digit.
   * Use a 16x2 LCD or LED matrix display to show the recognized digit.
   * (Optional) Use EEPROM to store pre-trained neural network weights persistently.
2. **Software Layer:**
   * Train a small feed-forward neural network offline on a PC using Python (e.g., with TensorFlow or NumPy) for digit classification based on binary pixel inputs.
   * Export trained weights and biases, convert them into fixed-point arrays for microcontroller usage.
   * Implement neural network forward propagation in C, including matrix multiplication and activation functions.
   * Develop firmware to scan keypad inputs, run inference, and update the LCD display with the recognized digit.
   * Optimize code to fit within ATmega32 memory and processing constraints.

**Components Needed:**

| **Component** | **Purpose** |
| --- | --- |
| ATmega32 | Core microcontroller running the neural network inference and input/output control |
| 4x4 Keypad | Input device for entering the binary digit pattern |
| 16x2 LCD | Output device to display the recognized digit |
| EEPROM (optional) | Store neural network weights for persistent use |
| Power Supply | To power the embedded system |

**Expected Results:**

* A working embedded system capable of receiving binary digit patterns via keypad input.
* Accurate recognition of digits (0-9) based on a pre-trained neural network model running entirely on ATmega32.
* Real-time display of recognized digits on an LCD.
* Demonstration of AI inference on a low-resource microcontroller platform.
* Hands-on experience with embedded C programming, neural networks, and hardware interfacing