

# EE 249 Project Proposal

## 1 Team

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## 2 Overview

This project aims to build a very cute anime figure robot head, capable of expressing emotions through eye and head movements and responses to user hand gestures. When the user makes a pointing gesture, the figure will track and stares at the user's fingertip. A digital twin will also be created to provide a visualization on the real robot's state.

### 2.1 Key Ideas

- Interfacing with servo motors and LCD screens
- Running neural networks on RISC-V embedded platforms
- The Ethernet communication stack
- Making Custom PCBs (?)

## 3 Approach

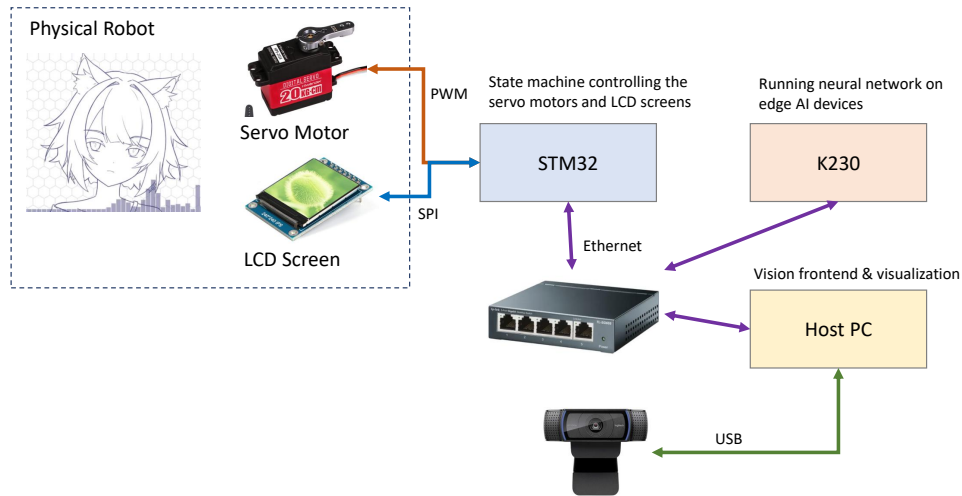


Figure 1: Overview of the system.

The system will be composed of three compute platforms. An overview of the system is provided in Figure 1. The servo and LCD screens will be driven by the STM32 processor. The host computer will perform the front-end detection of the user gesture, which takes RGB image frames from the USB camera and detects the hand keypoint landmarks. The visualization software will also run on the host computer. The K230 RISC-V SoC will then takes the landmark and passes through a CNN-based network to detect user gesture. The system will be connected together with Ethernet interface, and the data packets will be transmitted with UDP frames.

If time allows, we will port more neural network workloads onto the K230 SoC to enhance the capability of the robot.

The mechanical structure of the robot will be designed with OnShape CAD software, and be manufactured with 3D printing. Since this is not the primary focus of the project, we will leverage some prior works.

## 4 Resources

### Hardware Components

- STM32 NUCLEO-F429ZI development board
- Kendryte K230 RISC-V development board with RVV 1.0 instruction set support
- Desktop PC with Ethernet port
- Bambu Lab 3D printer and filaments

### Software

- Cursor the AI code editor
- STM32CubeIDE
- OnShape
- Altium Designer
- VTube Studio
- Github Repository: `git@github.com:T-K-233/NAI-Head.git`

## 5 Schedule

**2024-10-30** Finish project proposal (this document).

**2024-11-05** Finish most of the mechanical integration; Finish STM32 code; Have a training environment of the hand-detection neural network.

**2024-11-11** Finish network training; Port the network onto K230 device; Finish UDP communication between system components.

**2024-11-18** No work. Review for Midterm.

**2024-11-25** System integration and testing.

**2024-12-02** Draft of demo videos and presentation slides.

**2024-12-09** Buffer week. Bug fixes.

**2024-12-16** Final version of demo, video, and posters.

**2024-12-23** Project summary video uploaded to YouTube and Bilibili.

## 6 Risk Mitigation

There are many unknowns. The system integration might take longer than expected. The neural network might be difficult to train. We decide to follow the lean design methodology and focus on getting a minimum-viable product ready at each stage to have a better control over the timeline.