**ReadMe**

**1. Software Setup**

**Required Tools and Software**

* **STM32CubeIDE**: Version 1.10.1 or later.
* **Hercules Terminal**: For serial communication monitoring.
* **Python**: (Optional) for additional testing and debugging with pyserial.
* **FreeRTOS**: Pre-installed in STM32CubeIDE.

**Project Setup in STM32CubeIDE**

1. **Create a New Project**:
   * Open STM32CubeIDE.
   * Select the STM32F413ZH Discovery Board.
   * Configure the clock settings to use the internal 16 MHz clock source.
2. **Pin Configuration**:
   * Configure the following GPIO pins for PWM output to control the servos:
     + **PB5**: Base Servo (DS3235). – tim3 ch 2
     + **PA15**: Arm Servo 1 (SG90). – tim2 ch 1
     + **PB8**: Arm Servo 2 (MG996R). – tim4 ch3
     + **PB0**: Gripper Servo (MS24). - tim3 ch 3
   * Configure UART2 (TX/RX) for serial communication.
3. **Middleware Configuration**:
   * Enable **FreeRTOS** in the middleware section.
   * Create the following tasks in the FreeRTOS configuration:
     + **Listen Task**: Receives serial input.
     + **Parse Task**: Decodes received commands.
     + **Servo Control Task**: Controls the servo movements.
     + **Logging Task**: Logs data for debugging purposes.
4. **Code Integration**:
   * Add the servo control logic using HAL PWM functions.
   * Implement the command parsing logic to map commands like "MOVE 90" to corresponding servo movements.
   * Configure the USART2\_IRQHandler to enable serial data reception.
5. **Build and Flash**:
   * Build the project and ensure there are no errors.
   * Connect the STM32F413 to your computer using a micro-USB cable.
   * Flash the firmware to the board.

**2. Hardware Configuration**

**Components Required**

* **STM32F413 Discovery Board**.
* **Servos**:
  + DS3235 (Base).
  + SG90 (Arm Servo 1).
  + MG996R (Arm Servo 2).
  + MS24 (Gripper).
* **Power Supply**: 5V DC for the servos (external power source recommended).
* **Wires and Breadboard**: For connections.
* **Micro-USB Cable**: To connect the STM32 to your computer.

**Hardware Assembly**

1. **Servo Connections**:
   * Connect the signal pins of the servos to their respective GPIO pins configured for PWM with timers set to 2000-1 counter period with 50-1 prescaler.
   * Connect the power (Vcc) and ground (GND) pins of all servos to an external 5V power source.
2. **STM32 Connections**:
   * Connect the STM32 GND to the external power source GND to ensure a common ground.
   * Use jumpers to connect the signal wires of each servo to the corresponding GPIO pins.
3. **External Power Supply**:
   * Use a 5V 2A power source to ensure sufficient current for the servos.

**System Context Diagram**

[Voice Commands] --(Serial Communication)-- [STM32F413 Board] --(PWM)-- [Servos]