

## I. Core Electronics (The Brains & Muscle Control)

These are the essential components that make your animatronic move and communicate wirelessly.

1. **ESP32 WROOM Development Boards (x2):**
  - **Purpose:** One will be the "Animatronic Brain" (receiving commands and controlling servos), the other will be the "Controller" (reading joystick and sending commands).
  - **Why ESP32:** Powerful, built-in Wi-Fi and Bluetooth, excellent for MicroPython.
  - **Cost Estimate:** ₹500 - ₹800 per board.
2. **PCA9685 16-Channel 12-bit PWM Servo Driver (x1):**
  - **Purpose:** The ESP32 doesn't have enough hardware PWM pins for 8+ servos, nor can it provide enough current. This board handles all the servo control via I2C and can handle a separate power supply for the servos.
  - **Cost Estimate:** ₹300 - ₹600.
3. **SG90 Micro Servos (x6 and MG90S Servos ()):**
  - **Purpose:** These are your "muscles." You need one for each specific movement: 3x Eyes, 2x for Neck (up down, left - right), 1x Torso (Pant), 3x Hands (Wave).
  - **Cost Estimate:** ₹150 - ₹250 per servo.
4. **Analog Joystick Module x2 (e.g., PS2 Joystick Module) (x2):**
  - **Purpose:** Your input device for controlling the animatronic's movements. Provides X/Y axis readings and a push button.
  - **Cost Estimate:** ₹100 - ₹200.

## II. Power Supply (Crucial for Performance)

This is where many DIY projects fail if not adequately planned.

1. **Dedicated 5V Power Supply for Servos (x1):**
  - **Purpose:** Servos draw significant current, especially under load. Powering them directly from the ESP32's 5V pin (from USB) can cause brownouts, erratic behavior, or even damage the ESP32. You need a separate, strong 5V supply.
  - **Recommendation:** A 5V / 3A (or higher amperage) wall adapter or a power bank that can output at least 3A.
  - **Cost Estimate:** ₹500 - ₹1500 (depending on type and amperage).
2. **USB Power Source for ESP32s:**
  - **Purpose:** For powering the ESP32s themselves during development and initial testing. A phone charger, computer USB port, or small USB power bank works.
  - **Cost Estimate:** You likely already have this.

## III. Wiring & Connectivity

These are the "veins and nerves" of your system.

1. **Jumper Wires:**

- **Male-to-Male (M-M) Jumper Wires (1 pack of 40):** For breadboard connections and general wiring.
- **Female-to-Female (F-F) Jumper Wires (1 pack of 40): Highly Recommended** for clean connections to the pin headers of the ESP32 and PCA9685.
- **Cost Estimate:** ₹100 - ₹250 per pack.

2. **Small Breadboard (x1-2):**

- **Purpose:** Useful for organizing power and ground connections, especially for the joystick controller, and for prototyping.
- **Cost Estimate:** ₹50 - ₹150 per board.

3. **Micro-USB Cables (x2):**

- **Purpose:** For programming and powering your ESP32 boards from your computer or USB power supply.
- **Cost Estimate:** ₹50 - ₹100 per cable (if you don't have spares).

## IV. Mechanical & Structural Materials (The Endoskeleton Body)

These are for building the physical frame and articulated joints.

1. **Wooden Skewers (Various Diameters):**

- **Purpose:** Excellent for structural "bones," pivot pins for hinges, and pushrods to connect servos to moving parts.
- **Cost Estimate:** ₹50 - ₹150 (pack).

2. **Thick Cardboard / Foam Board / Thin Plastic Sheets:**

- **Purpose:** Your primary material for cutting out "bone" segments, frame pieces, servo mounts, and levers. Reuse old boxes, file folders, or plastic containers for cost-effectiveness.
- **Cost Estimate:** Free (recycled) to ₹100 - ₹300 (per sheet if bought new).

3. **Hot Glue Gun & Glue Sticks:**

- **Purpose:** Essential for fast, strong bonds, securing components, and reinforcing joints.
- **Cost Estimate:** ₹300 - ₹800 (gun + sticks).

4. **Paperclips:**

- **Purpose:** Unbend them to form rigid linkages, small levers, or simple fasteners.
- **Cost Estimate:** ₹20 - ₹50 (box).

5. **Small Screws & Nuts / Small Zip Ties:**

- **Purpose:** For more secure and permanent mounting of servos and other components, especially where hot glue alone might not be sufficient or you need adjustability.
- **Cost Estimate:** ₹50 - ₹150 (assorted pack).

6. **"Eyeballs" (e.g., Ping Pong Balls, Craft Foam Balls):**

- **Purpose:** The visual part of the animatronic's eyes.
- **Cost Estimate:** ₹50 - ₹150 (small pack).

## V. Tools (For Building & Troubleshooting)

These are general tools you'll likely use for many DIY projects.

1. **Pliers (Needle-nose and/or Combination):**
  - **Purpose:** For bending paperclips, holding small parts, general manipulation.
  - **Cost Estimate:** ₹150 - ₹400.
2. **Wire Cutters / Small Scissors:**
  - **Purpose:** For cutting wires, zip ties, cardboard, etc.
  - **Cost Estimate:** ₹100 - ₹300.
3. **Small Hand Drill / Awl / Pointy Skewer(optional):**
  - **Purpose:** For making clean holes for pivots and mounting points.
  - **Cost Estimate:** ₹100 - ₹400 (for a basic hand drill with bits or an awl set).
4. **Ruler & Pencil/Marker:**
  - **Purpose:** For accurate measurements and marking.
  - **Cost Estimate:** ₹20 - ₹50.
5. **Multimeter (Highly Recommended):**
  - **Purpose:** Invaluable for troubleshooting electrical connections, checking voltage, and continuity. Helps debug wiring issues quickly.
  - **Cost Estimate:** ₹400 - ₹1000 (basic digital multimeter).
6. **Soldering Iron & Solder (Recommended for Reliability):**
  - **Purpose:** While not strictly necessary if you use all jumper wires, soldering provides much more reliable and durable connections, especially for power lines or if you customize wires.
  - **Cost Estimate:** ₹300 - ₹800 (basic kit).
7. **Computer with Thonny IDE:**
  - **Purpose:** For writing, uploading, and monitoring code on your ESP32s. You'll need to install the ESP32 board definitions for Arduino IDE and the MicroPython firmware for Thonny.
  - **Cost Estimate:** Free (software).

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## Estimated Total Cost Summary:

This is a rough estimate for **additional materials** you might need, assuming you already have some basic tools and potentially some ESP32s/servos.

- **Core Electronics (Additional):** ₹400 - ₹1000 (for 2 extra servos + maybe a new ESP32 if you only have one).
- **Power Supply:** ₹500 - ₹1500
- **Wiring & Connectivity:** ₹250 - ₹600
- **Mechanical & Structural:** ₹300 - ₹1200
- **Tools (if you need them):** ₹1000 - ₹2500

## Overall Project Cost (Assuming you need to buy most things fresh):

- **Minimum (budget-conscious, reusing materials):** ₹2500 - ₹4000
- **Average (good quality, some new tools):** ₹4000 - ₹8000

- **Higher End (all new, better quality): ₹8000+**