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# *Mind controlled hand or, Bionic Hand*

## Step 1 - Defining a Problem

Research revealed that every year, over 40,000 people in India lose their upper arms, and 85 per cent of them continue to live without any solution, the majority of whom come from economically underprivileged sections.

## Step 2 – Background Research

Most affordable Bionic Arm is made in India:

1. **Inali Arms** which is a startup by **Prashant Gade** who is a college dropout
   Durability: **>3 years**
   Price of 1 arm: **50k Rupees** only
   In the last two years, over 700 arms have been designed and given for free, while nearly 300 have been sold across the country.

2. **Robo Bionics** which is also a startup by IIT Patna's Alumni **Llewellyn Das** and **Jayant Vyas**
   **Grippy** is a patent-pending, 3D-printed prosthetic hand. It is NABL Lab Safety tested.
   Price of 1 arm: **2.5 - 3.25 Lac Rupees**

3. **Makers Hive** which is a Hyderabad based startup by **Pranav**
   **KalArm** is the bionic arm developed
   Battery: **2850mAh Lithium polymer battery**
   Battery life: almost **14 hours**
   Price of 1 arm: **3.5 – 4 Lac Rupees**

Bionic Arm from outside India:

1. **Aether Biomedicals**
   **Zeus Bionic Hand** – **8 Lac rupees** for 1 hand
2. **Super Motorica**
   **Myoelectric Bionic Hand** – **8 Lac rupees** for 1 hand

**Startups** Developing Bionic Hands:

1. **Sarcos Robotics**
2. **Ekso Bionics**

3. **ReWalk Robotics**
4. **Synchron**
5. **Xilloc Medical**
6. **Mobius Bionics**
7. **Marsi Bionics**
8. **Cyberdyne**
9. **SuitX**
10. **Open Bionics**

## Step 3 – Requirements

1. **EEG Headset** – to capture mind signals
2. **Raspberry Pi** or, **Arduino**
3. **3D Printer**
4. **Servo motors**, **Wires**, **LEDs**, **3D printed hand parts**
5. Basic toolkit including **solder** and other small things

## Step 4 – Brainstorm, Evaluate and choose Solutions

As solution to this problem is already present in the market.
So, we have to make a solution which is cheaper as compared to the Multinational companies and more efficient. (Make in India)

## Solution I (Cheaper Production):

Decrease the price by using lesser number of electrodes of EEG's and making a model which works with those number of Electrodes in EEG.

**Description of the Solution:**
We can make the model of Mind controlled Bionic hand cheaper by using lesser number of Electrodes in the EEG headset,
**Reducing some number of Electrodes decreases the price of EEG Headset significantly.**
As the price decreases, we can make it accessible to the poor community of India as well.

**Problems:**

1. We have to make a **working model** which can predict the signal efficiently and correctly.
2. Lesser number of electrodes means lesser data we have to take out the output implies **high chances of errors**.

## Solution II (Cheaper Working):

Remove the Electrical working and implement the Solar working with backup as Electrical Support.

**Description of the Solution:**

We can make the **hardware to work on solar energy instead of electrical energy** which makes it much more efficient as we are not supposed to charge it everyday.
Along with this we can make an **inside electrical power backup** for the machine if in some case the machine not able to get that much electricity which it requires.

**Problems:**

1. Requires **flexible solar panel** which can be implanted on hand as well as on head without causing severe damage to head.
2. It may get damaged earlier as compared to present solution.

## Solution III (Cheaper Repairing):

Using cheap and reuse-able hand by 3D printer.

**Description of the Solution:**

We can make the 3D printed hand with less amount of material or we can use some **cheaper material which can again be reused** (except Circuits and Electrodes).
This will make it easily available to people and whenever it gets deformed or gets a problem it gets replaced easily.

**Problems:**

1. Cheaper material **may get defected quickly** which leads to its unacceptability among the poor people.
2. Cheaper material leads to **company's bad image** among common people.

## Extra Step – Problems that may arise during choosing the best fit solution for this problem

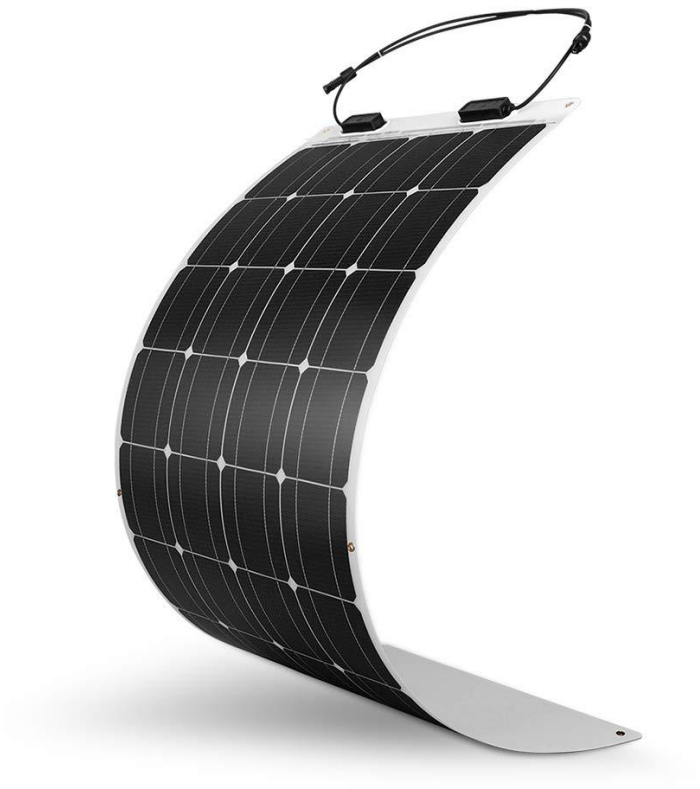
1. **Complexity** – Complexity of the circuit based on Number of EEG's
2. **Extended learning time** – Depend on Number of EEG's and Devise used for integration
3. **No bio-feedback** – No use of Brain Waves in Bionic Arms
4. **Affordability** – Price of the Bionic Arm
5. **Accessibility** – Access to poor community of the people

## Best Solution:

One of the best solutions is one which is **cheaper in Production, Working and Repairing (PWR)**. So, according to me the solution which is to be chosen is by

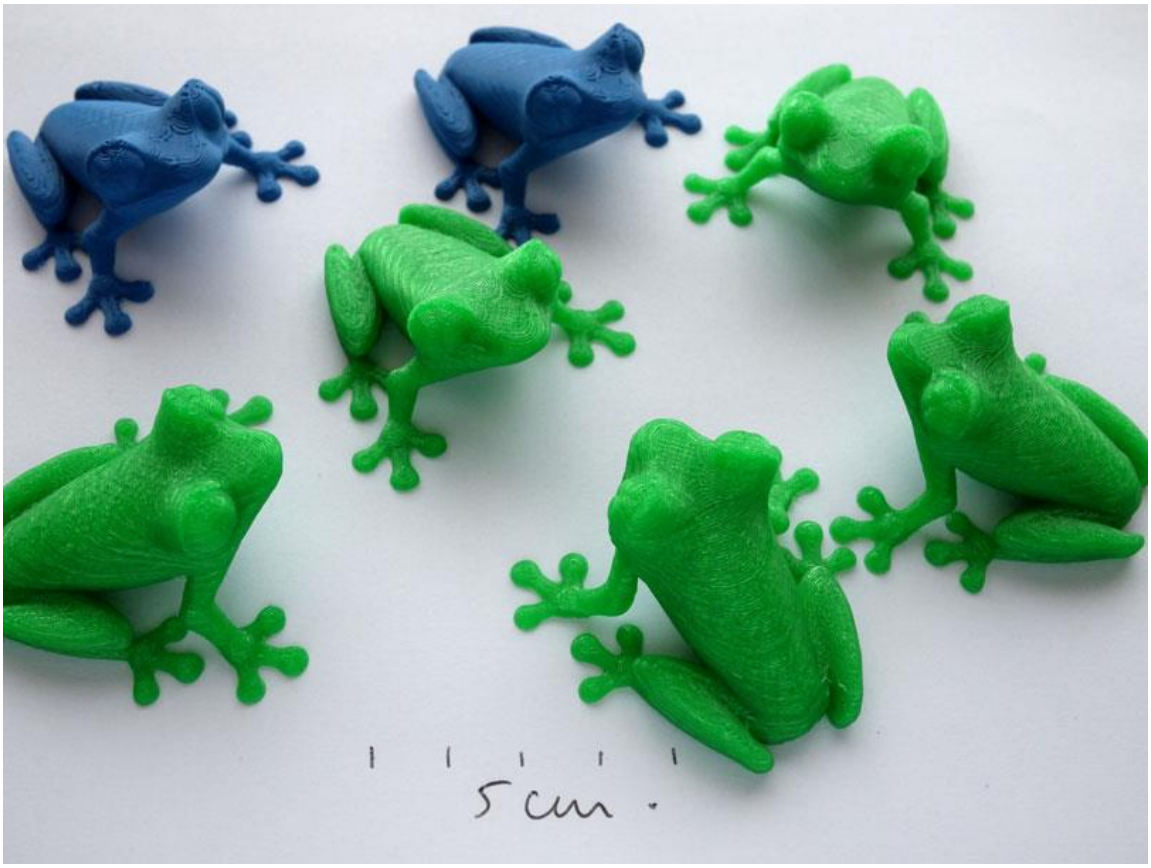
1. Decreasing some Electrodes in EEG headset not that much but some 1 or 2.
   Using **Emotiv EEG Headset** which has
   - **(i) 5+2 channels**
   - **(ii) 128 sampling rate per second per channel**
   - **(iii) Used Bluetooth 5**
   - **(iv) Upto 20 hrs battery life on single charge**
   - **(v) Price 500 US dollars** (which can become less in collaboration with any NGO and making it under Make in India)
     Otherwise it is equivalent to Rs 37,500 something which we can also use by reducing the profits initially.


2. Implement Solar Energy electricity for the power and a backup.
   Using Solar slips and any battery backup (Heavy Power bank also works)
   **Flexible solar panels** are widely used in many things and even are not that much costly.
   **One slip cost approxiamately Rs. 500**



3. Using Reuse-able material to create the hardware using 3D printer, so that it can be re-used leading to decrease in their price and cheaper Repairing.

   **PLA, a cornstarch-based 3D printing material** can be used as a Reuse-able material for 3D printing parts of the hand.



## Step 5 – Develop and Prototype Solution

We can develop the solution by,

1. **Integrating the EEG Headset with the microprocessor** we fit in the Bionic hand.
2. **Creating a Machine Learning model** which predicts what one wants to perform using his hands according to the inputs given by the EEG Headset.
3. Testing that Machine Learning model on different raw data and **get the maximum accuracy** that we can get with that model by using different algos.
4. **Inserting the ML model** in the **Arduino/ Raspberry pi** we have in our Bionic hand.
5. **Fitting the hardware parts** with each other so that they can work efficiently.

## Step 6 – Test and Re Design the solution

We have to test our prototype on different basis:

1. **Analyse the input Data:**
   whether the raw data we are getting is sufficient enough to make all direction actions we want to perform with the hand.

2. **Machine Learning Model Predictions:**
   whether the model we have deployed is giving the same output as we want from the machine because it may cause a severe problem in the future.

3. **Testing on Data that is not stored in our Training Data:**
   whether the machine is behaving unusual when data for which machine is not trained is given as input to the machine.

4. **Heat Generated:**
   whether our machine is heating too much when we are trying to get the output and whether the machine or human body parts are able to handle that much heat or not.

5. **Condition and Climate Test:**
   Check upto how much heat or cold the machine can work on and whether machine's screw and others hardware are tightly connected or not.

6. **Testing on Real Case:**
   Test this machine now on real subject such as a man who is willing to participate in testing phase whose hand is lost.
   This testing must be done on as many subjects as possible because this is the part where we get the reviews and we know the problem with our product.

## Step 7 - Re-Designing Phase:

1. If any of the **1, 2 or, 3 tests failed** then go to **step 1** in **"Develop and Prototype Solution"** part.
2. If **4 or, 5 tests failed** then go to **step 5** in **"Develop and Prototype Solution"** part.
3. If "**Testing on Real Case" failed** then **restart the process** from **"Develop and Prototype Solution"**.

## Step 8 - Communicate Results:

Finally, we have completed and created a Model (product) which can solve all the problems which we have in our Extra step (i.e. **Complexity, Extended Learning time, No Bio Feedback, Affordability and Accessibility**) and is able to compete with the market now.