Intelligent Bionic Hand

Date: 14/11/2017

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Revision History:

Revision History	*Date*	*Comments*
1.00	10 Nov,2017	Initial discussion
2.00	18 Nov,2017	2nd Draft
3.00	22 Nov,2017	Final document

Document Approval:
The following document has been accepted and approved by the following:

Signature	*Date*	*Name*
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Please note that there are many figures that you have to draw. I have only included two.

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1. INTRODUCTION

1.1. PURPOSE

This document serves to explain the design and architecture of the project "Intelligent Bionic hand". The ultimate goal of the project is to develop an anthropomorphic and dexterous hand which can be used for the betterment of amputees.

1.2. PRODUCT SCOPE

The primary objective of this work is to develop an anthropomorphic and dexterous hand which can be used for the treatment of amputees.
Firstly, we looked at the existing systems. These systems made use of image processing i.e. they used camera mounted on top of the hand , camera recognize and analyze the object and then the software devises the plan to deal with that object.
Other systems are invasive which means brain is connected to the bionic hand using electrodes. Most of the time amputee use just a dummy hand because above mention systems are expensive, heavy weight and noisy.
In an effort to provide low cost and light weight prosthetic hand we will use minimum servo-motors and lightweight 3-D printed hand and this artificial hand will be interface with forearm to perform three types of motion. They are:

- Grasp
- Victory sign
- Pinch

Table 2: Terms used in this document and their description

Name	Description
SBC	A single-board computer is a complete computer built on a single circuit board, with microprocessor, memory, input/output and other features required of a functional computer.
Deep learning	Deep learning is part of a broader family of machine learning methods based on learning data representations, as opposed to task-specific algorithms.
Servo Motors	A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.
CNN	In machine learning, a convolutional neural network (CNN, or ConvNet) is a class of deep, feed-forward artificial neural networks that has successfully been applied to analyzing visual imagery.

1.3. OVERVIEW

The system would comprise of four main components: a neural data measurement system, data classification system, Electric circuitry and 3D printed hand. The neural data measurement system record and transmit data to data classification system, where data is classified using deep learning algorithms. Electric circuitry to control the movement of 3D printed hand.
The diagram below shows how the data transfer would happen in the project:

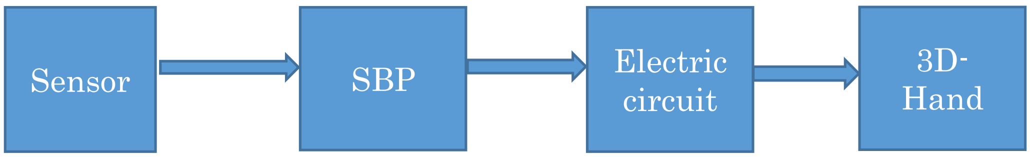


Figure 1

2. THE OVERALL DESCRIPTION

Our project consist of four parts. They are:

- 3D printed hand
- Single board Processor
- Electric Circuit
- Sensors

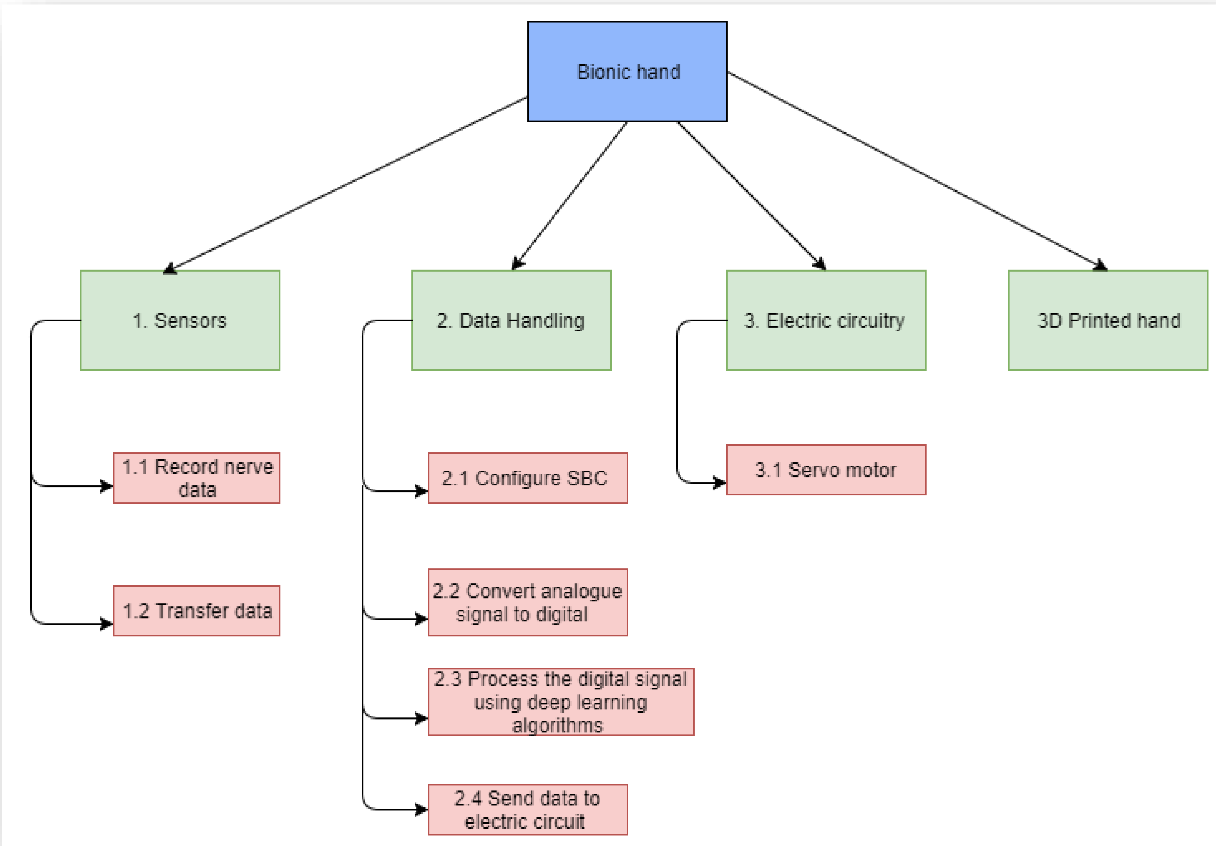
The sensors are attached to the forearm of amputee, which collects neural data. The data is passed to processor module.
In the processor module, the Sensory data is classified to appropriate motion (grasp, victory sign and pinch.) deep learning algorithms [2] using then electric circuit is triggered for corresponding motion.

2.1. PRODUCT PERSPECTIVE

The product is supposed to be an open source, under the GNU General Public License. This project is a standalone system that provides functionality describe in requirements section. The main purpose of this project is to provide a functional hand, to the amputee, at low cost. It will depend upon different kinds of hardware i.e. Sensors, SBC and Electric circuit.

3. WORK BREAKDOWN STRUCTURE

Figure 2 Work Breakdown Structure



4. Design

4.1 ARCHITECTURAL DESIGN

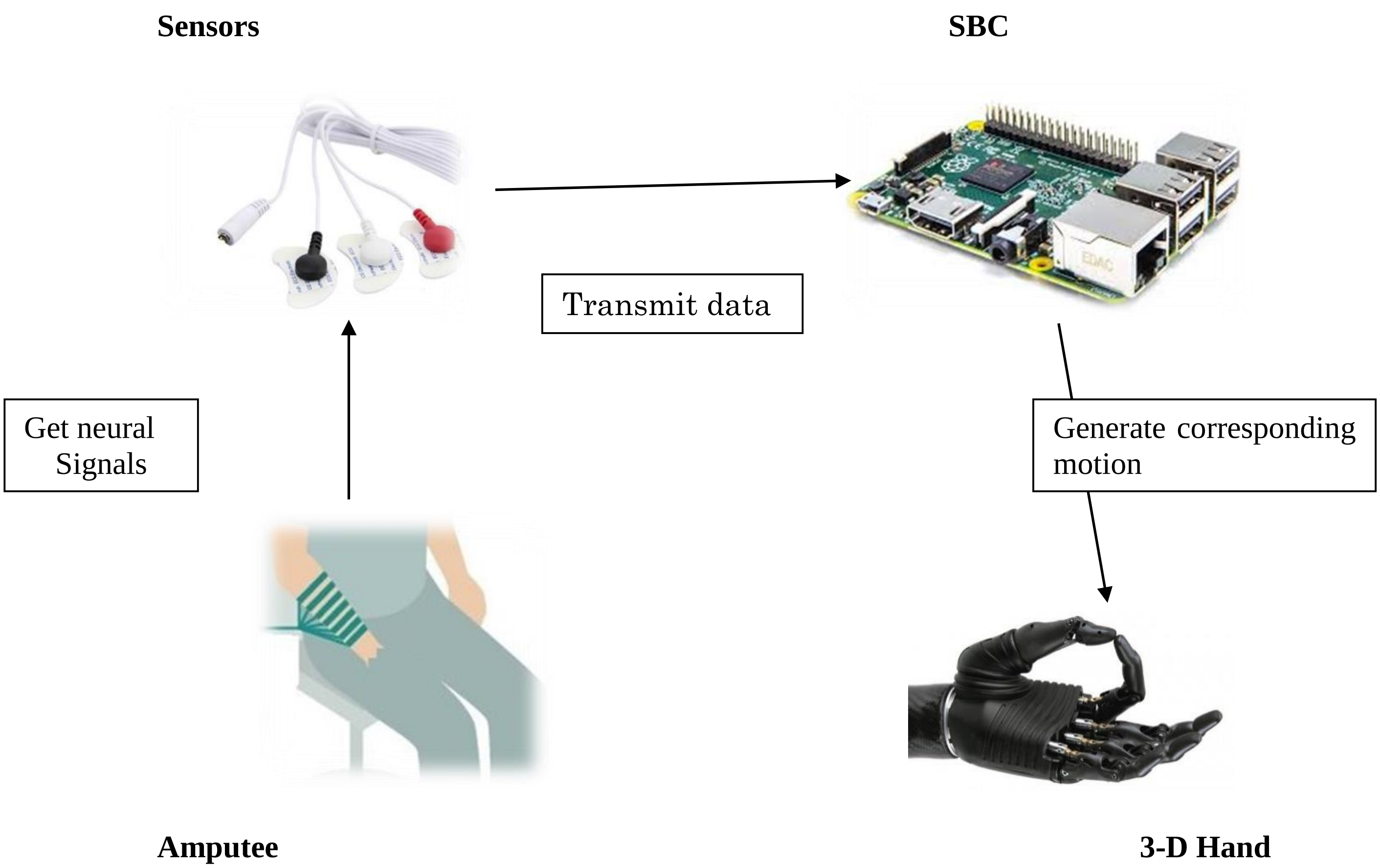


Figure 3

4.2. Why we choose **Pipes and Filters** Architecture Design?

The system primarily involves collecting the required neural data in raw form from forearm using sensors. This data is then sent to the SBC where it is classified using deep learning algorithms. The output data of SBC is then transmitted to electric circuit which use this data to generate corresponding motion. Therefore, Pipes and Filters Architecture Design is best choice for this project where Pump is Amputee forearm, SBC is Filter, Electric circuit is Sink and connecting wires are pipes. This figure shows general Pipes and Filters Architecture.

Figure 4

The **filter** transforms or filters the data it receives via the pipes.
The **pipe** is the connector that passes data from one filter to the next.
The **pump** or producer is the data source.
The **sink** or consumer is the data target.

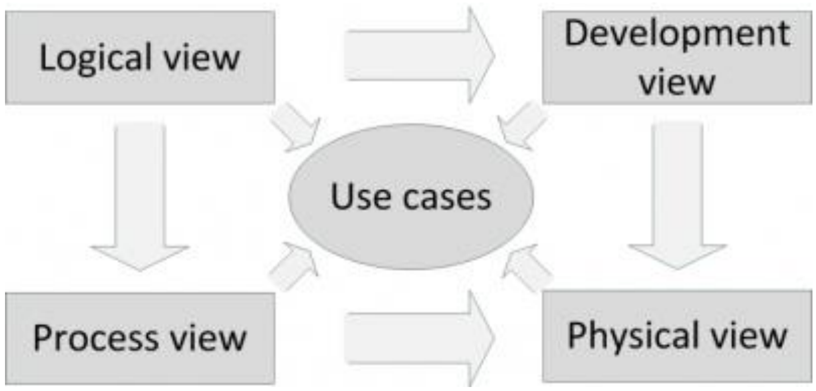
4.3. MODULE IDENTIFICATION

The project consists of several modules [1]:

- Collection of raw data at the forearm and converting analogue neural data to digital.
- Data transfer to the SBC.
- SBC to classify the data using deep learning algorithms.
- Electric circuitry to generate corresponding motion.
- 3-D Printed Hand.

5. 4+1 ARCHITECTURE VIEW MODEL

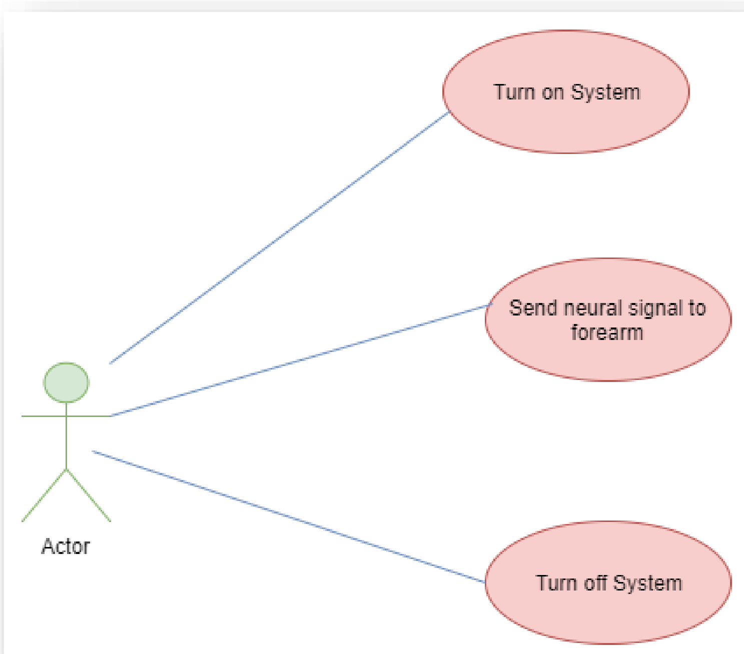
In this section, you draw the architecture using the views defined in the "4+1" model.



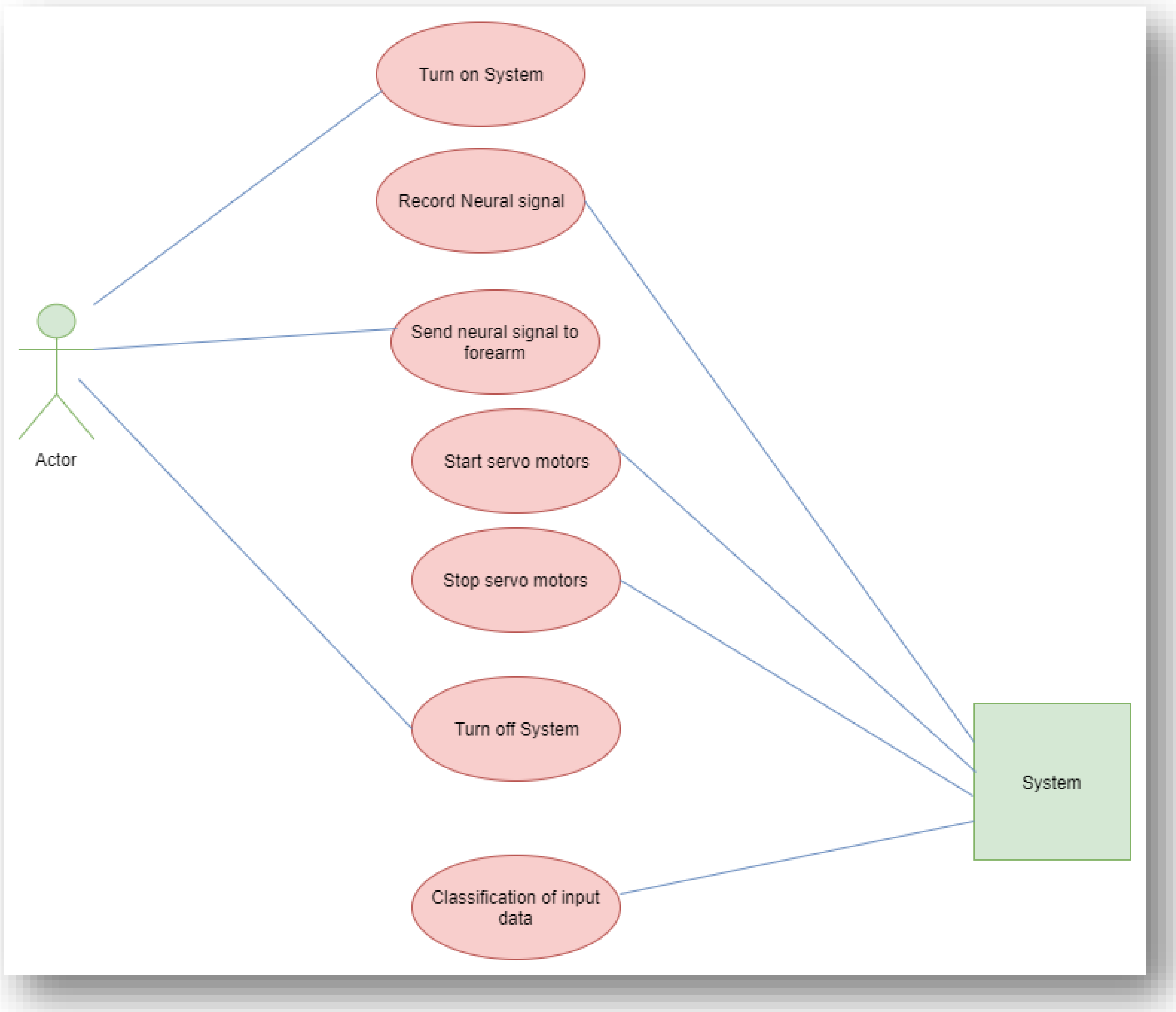
1 4+1 Architecture View

5.1. Use Case View

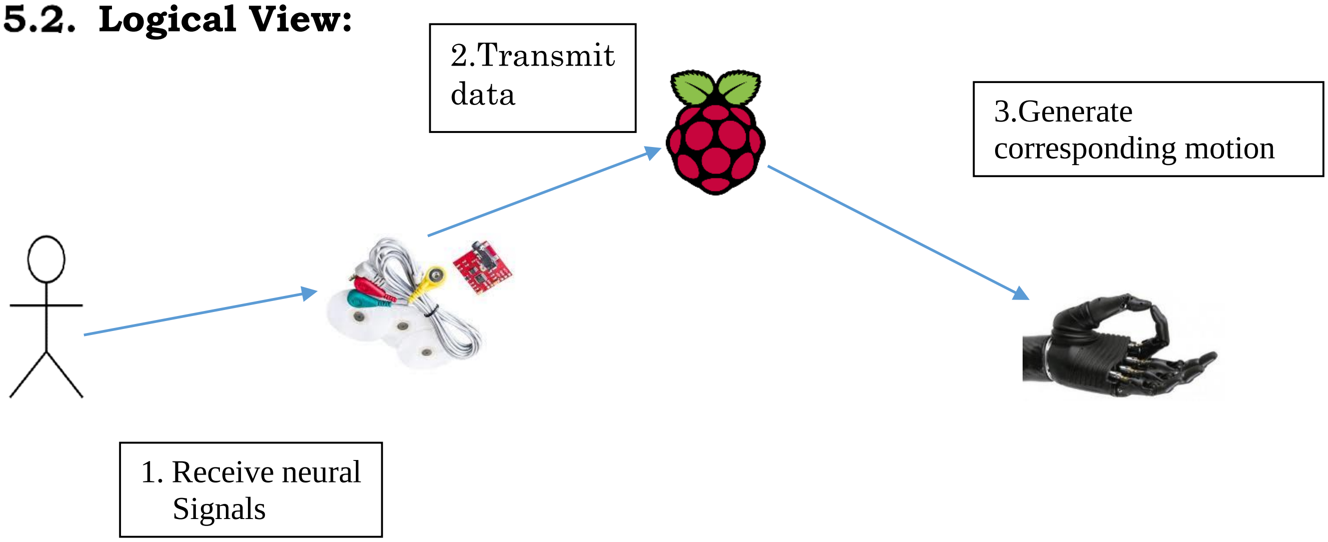
Use case for User:



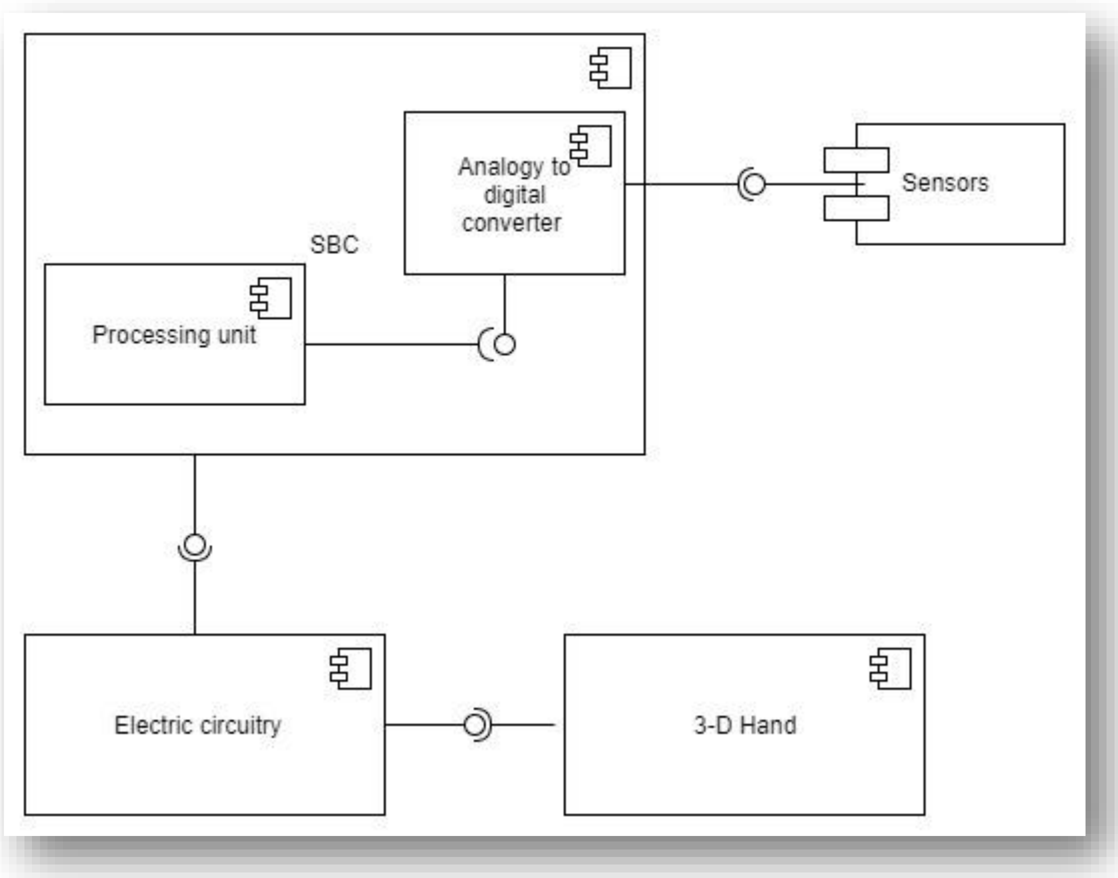
Use case for whole system:



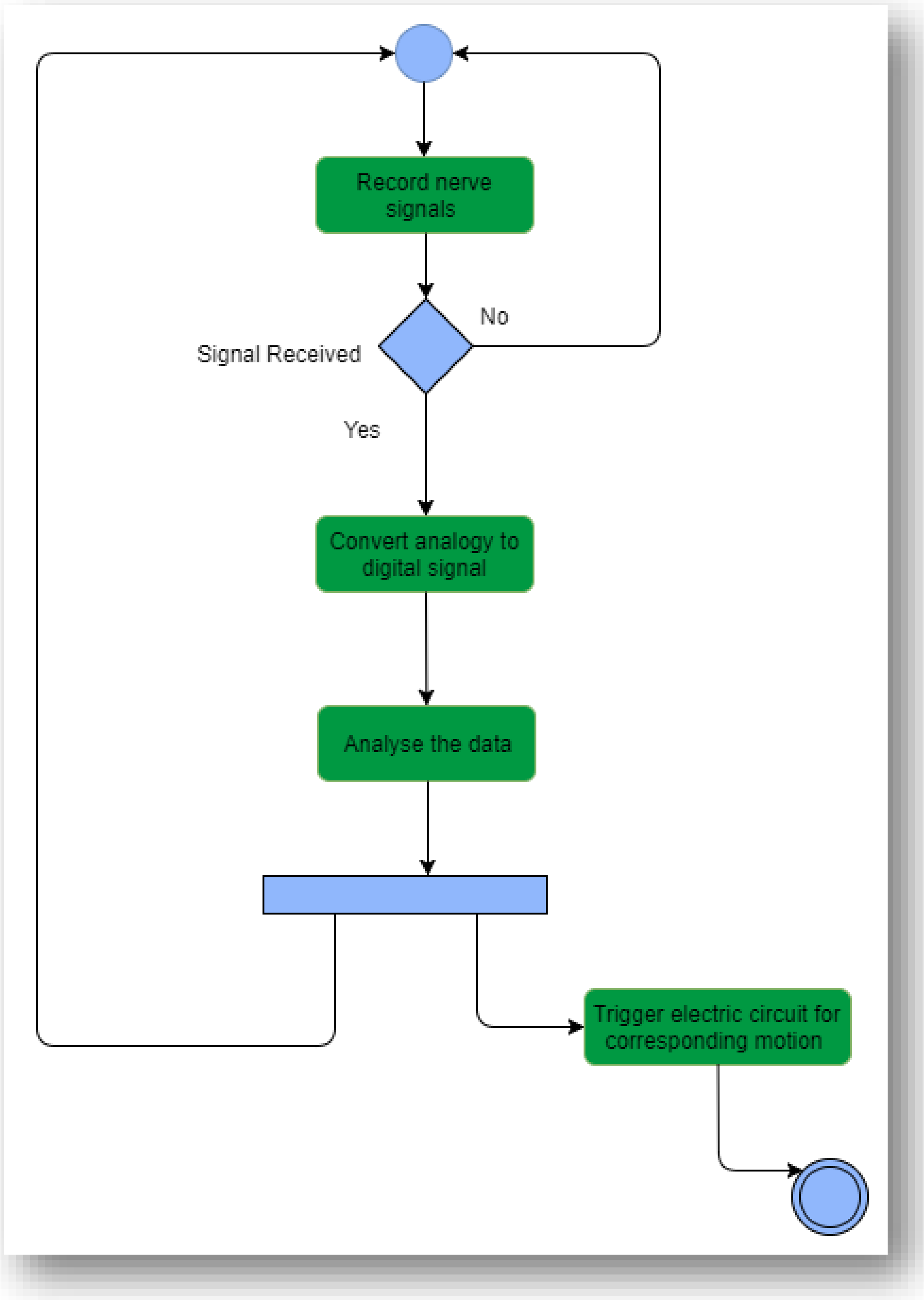
5.2. Logical View:



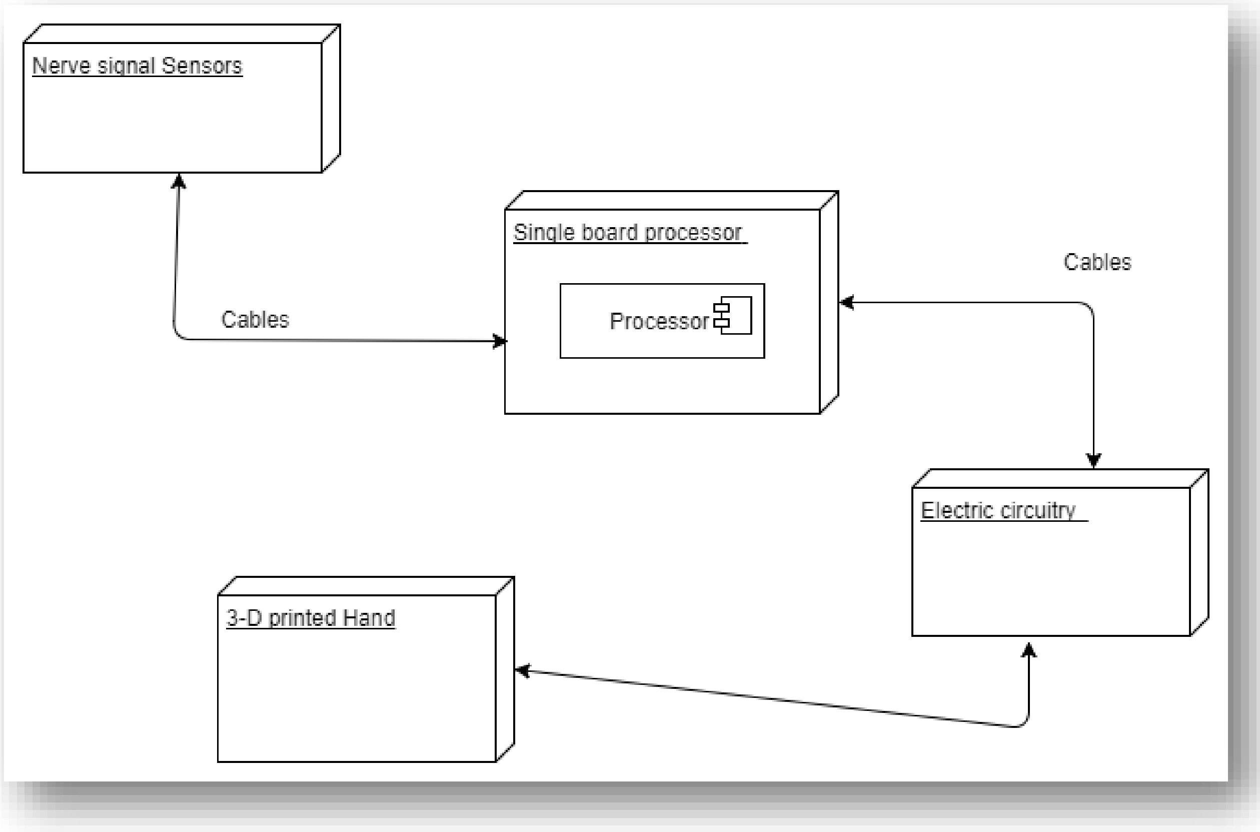
5.3. Development View



5.4. Process View



5.5. Physical View


Nerve signal Sensors
Single board processor
Processor
Cables
Cables
Electric circuitry
3-D printed Hand

6. References

[1] https://www.frontiersin.org/articles/10.3389/fnbot.2016.00009/full#h8
[2] https://www.nature.com/articles/nature17435