"Is It Really Dead?" - Digging into Dead Brains through Analyzing Its Behavior in Response to Inducing External Impulses

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Even though live brains are widely studied in the literature, dead brains remain little explored as perhaps it is generally believed to have a dead brain not workable anymore. In contrary to such general perception, in this work, we explore the possibility of making a dead brain work again. To be more precise, we explore outputs from a dead brain in response to applying external stimuli (in form of electrical signals) to it. We perform several experiments following different approaches and analyze the outputs of a dead brain for various sets of inputs applied to it. We found a couple of novel behaviors from these observations and analyses. Later, based on our obtained outputs, we explore transfer characteristics of a dead brain and interpret the corresponding function via representative circuits. Further, being inspired by our observed outcomes, we attempt to employ a dead brain in classifying black and white color pixels in simple checkerboard images. We also inspect the possibility of manipulating the dead brain to work as a memory unit. To the best of our knowledge, these studies are the first of its kind in the literature. Finally, we explain our observations that inspire more future experiments and explorations in this field.

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1 AIM AND INTRODUCTION

There exist several studies on Brain Computer Interface (BCI) and integrated brains [S. Kotler 2002]. However, studies on detached brains, despite having a lot of potentials, have been relatively scarce [Warwick et al. 2010]. Mass experiments on living brains raise ethical questions, which is perhaps not the case for a dead brain. Therefore, it would be much more pragmatic and effective if we could use a dead, detached brain for complex tasks such as pattern recognition and identification instead of computers. We work with dead brains collected from goats, and have real experimentation on them through inducing external signals and then collecting responses from the dead brains accordingly. Here, we primarily focus on a detached brain and its I/O pathways. Upon analyzing responses from cranial nerves and also from random positions in the gyrus in response to the induced external signals, we analyze and demonstrate deterministic transfer characteristics from Vagus and Oculomotor nerves subsequently, however, non-deterministic behaviors from other different brain lobes.

Upon observing the pattern from Vagus and Oculomotor nerves , we define 1V and 0V as an encoding of two class labels: high and low, or white and black pixels, respectively. We use this encoding to detect black and white images from the output readings of the brain.

From the 2-bit input study, we observe that most of the nerves retain their previous state, meaning that these nerves store the value they were given. From this observation, we can conclude that a detached brain may be used for storing and retrieving data.

2 METHOD

In this study, direct wire connections are provided throughout the raw brain to perform an invasive experiment. We start our investigation with a raw goat brain without any chemical preservatives. We take readings from random positions in the gyrus and log the data with the help of oscilloscopes. Then we target four lobes of the brain and do not find any deterministic results. After that, we start working with the cranial nerves, and this time we find some deterministic results. At this stage, we change our measuring device

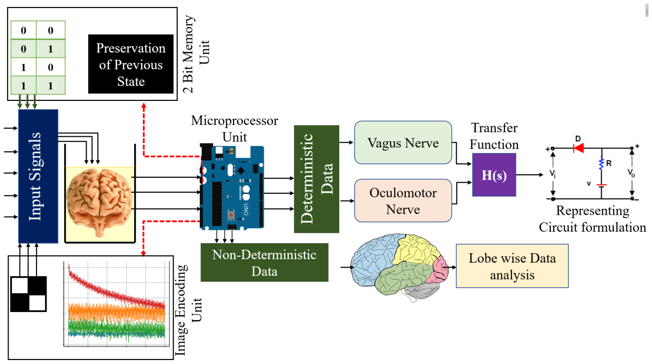

Fig. 1. Basic layout of our experimental setup

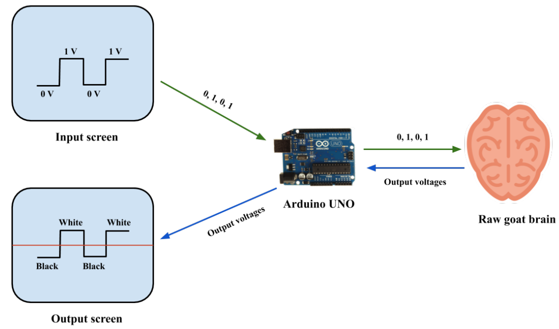

Fig. 2. Black and White Color Detection System

from an oscilloscope to a micro-processing unit as due to the low amplitude of brain signals, it is challenging to interpret oscilloscope readings even after amplifying the output. Also, we start using an artificial CerebroSpinal Fluid to preserve the brain for a more extended period during the experiment. After finding some promising result from the analyses of output from the cranial nerves, we further our study to use the brain to differentiate between colors. Till now, we have worked with a checkerboard to distinguish the colors black and white with input signals as 0 and 1. Finally, we explore the field of using the brain as a memory element by conducting a 2-bit input study. In Figure 1, the basic layout of our final experimental setup is shown.

3 RESULTS AND DISCUSSION

3.1 Determinism in result

Our first try with the brain lobes was not successful as we could not find any deterministic output from these parts of the brain. Later on, while working with the cranial nerves we found deterministic outputs from the Oculomotor and the vagus nerves when the input was given in the optic nerve.

3.2 Input Prediction and Image Encoding

The brain is fed with two different colors as two different voltage states. So far the experiments prove that the brain can detect these two colors with two different responses (voltage states) as shown in Figure 2. Since we have fed only black and white colors to the brain, discrete output is achieved. Further experiments may prove a band of outputs for individual colors in the spectrum.

3.3 2-Bit Input Study: Scope of Working as a Memory Element

At the beginning of our experiment, one of our prime goals was to know whether a dead brain could act as a memory like an alive brain if cultured and given external signals. From the 2-bit input study, we observe that most of the nerves retain their previous state, meaning that these nerves store the value they were given. From this observation, we can conclude that a detached brain may be used for storing and retrieving data. This experiment has also opened up a new scope of study of the memory management of a disconnected brain of a dead animal.

3.4 Interpreting the Functionalities as a Processing unit:Transfer characteristics

We explore two possible circuit interpretations for our obtained transfer characteristics. Firstly, if we inspect the input-output graph characteristics for vagus and Oculomotor nerves, we can model them quite accurately using a positive clipper circuit. Secondly, we perform polynomial regression for both the Vagus nerve and Oculomotor nerve to derive a representative transfer equation from the experimental data. Derived transfer characteristics for Vagus and Oculomotos nerves are given below:

For Vagus Nerve:

$$V_{out} = -2.95 + 4.52 \times 10^{-2} V_{in} + 7.44 \times 10^{-6} V_{in}^2 - 1.82 \times 10^{-8} V_{in}^3$$

For Oculomotor Nerve:

$$V_{out} = -11.06 + 6.79 \times 10^{-2} V_{in} - 2.80 \times 10^{-5} V_{in}^2 + 1.54 \times 10^{-9} V_{in}^3$$

4 CONCLUSION

The prime goal of this study is to make a detached brain of a dead mammal work like an electrical processor, which is yet to be explored in the literature to the best of our knowledge. Here, we aim to study whether a detached brain, if kept in appropriate conditions, exhibits any deterministic behavior. To do so, we adopt an experimental setup, which is reasonably cheap as we avoid the use of costly device, surgery, or system. Some notable outcomes of our study include analyzing outputs from four lobes of a brain in response to inducing external signals, synthesizing input-output relationships to find transfer characteristic of the dead brain, investigating outcomes of inducing a simple encoded image to the brain, and distinguishing outcomes obtained from dead brains while experimenting with or without aCSF.

We find from our experiments that the dead brain exhibits a unique transfer characteristics unlike the ones we generally obtain in the cases of conventional circuits such as RC, RL, or LRC circuits. In addition, we find novel properties of the dead brain from our experimental data. Using the properties, we attempt to classify black and white colors with the dead brain. Nonetheless, we explore the possibility of making a dead brain work like a memory.

REFERENCES

Vision Quest S. Kotler. 2002. First HCI. https://www.wired.com/2002/09/vision/.

Kevin Warwick, Dimitris Xydas, Slawomir J Nasuto, Victor M Becerra, Mark W Hammond, Julia Downes, Simon Marshall, and Benjamin J Whalley. 2010. Controlling a mobile robot with a biological brain. *Defence Science Journal* 60, 1 (2010), 5–14.