On the Future Use of BMI

Jovi Harrison[1]
joviharrison17@gmail.com[1]

Universitas Putra Bangsa Batam[1]

ABSTRACT

The brain-machine interface (BMI) could just be one of the most helpful technological breakthroughs of our time. This technology comes in the form of a micro-processor installed in the brain that can assist mental processes, just as the name suggests. Its current uses are in rehabilitating people who suffer from various nerve-related ailments where in the case of stroke victims, it would allow them to regain control over regions of their body previously lost [1], whether limbs, neck or facial muscles and in the case of aphasia victims, BMI would provide speech synthesis [2], where the damaged Brocha and/or Wernicke regions normally responsible for linguistic processing are bypassed. These applications present the already available uses of BMI thus far, but can BMI technology offer other forms of processing assistance to the brain, even contributing to enhanced brain performance? One mental capacity that would be ideal to have is the ability for cross-linguistic processing; and so, we wonder whether BMI can be used for linguistic augmentation and enhancement. In this paper I consider BMI in its potential application in providing real-time translation.

Keywords: BMI, AI, Machine Translation, Brain Implant, Real-Time Translation.

1. Introduction

Real-time translation has always been a challenge, even for experienced interpreters. There are always points which must be taken into consideration before one decides to hire an interpreter. Things such as; cost, availability, and reliability. This can be solved, to a certain extent through the use of BMI, where if the device were to be implanted in the brain, specifically in the domains which regulates and processes linguistic comprehension, auditory signals, and perhaps even optical signals, real-time translation can be achieved. The result would be rather similar to when a bilingual individual hears a language which their first language is not and understands it. This implementation of the device works by having the interface intercept the auditory signals sent into the brain and then translating it to a language which the wearer understands. This of course means that the signals sent by the device itself must be done in a speed matching that of the firings of electrical signals in the brain, and nothing short of that. The latency of the device needs to be considered if such a device were to be implanted in the brain. This implementation will also greatly streamline the process of translation through the use of Neural Machine Translation, similar to that of Google's. This would, in effect, be beneficial to individuals such as ambassadors, and other occupations which dictates the

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individual to travel to foreign lands and to speak a language they had not prepared for. The benefits of this however, would be much larger after the technology has been further developed. Since the most efficient and accurate machine translation currently available is Google's Neural Machine Translation, which lives in a mainframe somewhere in Silicon Valley, the technology required to turn this idea into reality needs to be able to compress all of that hardware in Google's warehouse to a single chip much smaller than the smallest processor currently available, which is Apple's A12 bionic mobile processor. This implementation, of course, does not come without its own fair share of challenges, be it linguistic, medical, computational, technological, or engineering challenges.

2. Methodology

The first thing, linguistically speaking, that must be considered when designing the algorithm for such a device is the syntactical difference between languages, even for languages which stems from the same language family tree, i.e. English and German coming from the same tree but possessing different syntactical structures. Knowing this, it is then important to also consider the pragmatic and semantic value of word arrangements, metaphors, etc. when considering the algorithm itself. This means that there needs to be a set of rules when determining the translation of a certain word. It is also imperative to consider the semantic primes when translating into another language. This platform needs to be able to deliver fast, reliable, and understandable translations if it were to be implemented in the brain. More and more technological breakthrough has shown promising progress in this field. Google, Microsoft, and Amazon, to name a few, have developed their translation technology, augmented with artificial intelligence which guarantees that the quality of translation itself will improve over time and become more and more accurate. If this was to be implemented into the BMI platform. It can take the Apple approach by storing all of the data collected locally instead of sending it back to the tech giants, and therefore solving the issue of privacy breach. This means that the AI-augmented translation technology will work well offline and will therefore not need a constant connection to the internet in order to work since it is not cloud-based. Which also means that this solution for the translation technology will not necessitate the construction of a machine that can "think" which rules out the problem of the AI being sentient and bypasses the Turing problem since the computing device itself does not have any need to "think" beyond any of the aforementioned parameters; language recognition, categorization, and translation. The AI aspect of the computing will merely serve to recognize, analyze and translate the signal to produce the most accurate output possible, and therefore looks over the need of building a machine that "thinks".

The medical aspects of this implementation must also be considered since the implementation of such a device would necessitate an invasive surgery into the brain. The device must also be made of a material which is resistant to degradation over time, unlike the materials currently in use in most corrective surgeries concerning the bones, for example. As spinal implants done to correct the misalignments in the spine are more often done with titanium. And since electrical components are more commonly made of things such as copper, plastic and other degradable materials, further developments in technologies must be made before such an attempt at such a device be tested on human subjects.

3. Result

The technological issues with this platform are as the previous paragraph had mentioned, is that the current technology does not allow for such a large memory to be contained in a processor so small that it will not occupy a space that inhibits any of the brain's tasks, and that would not disrupt any of the nerves. Some amount of time will be needed before such a breakthrough in technology be achievable. A processor significantly smaller than Apple's current chip must also be available. There is also the issue of overheating. As is the case with most electrical devices which, after operating for a prolonged amount of time under moderate to heavy workloads, the device will eventually heat up and this must not happen since the device itself is being implanted in the brain and would cause major damage if the device were to short-circuit or to heat up to any significant degree. The ideal conditions for this implementation would take the form of a micro-processor, merely microns in size to be implanted straight into the brain. This however, poses another problem. Namely; the patents involved. Companies are sure to patent their work and thus making it much harder to actually use the technology for any widespread use. Machine learning must also increase in speed in its cumulative learning curve if it is to provide a stable and accurate translation. The common theme in this issue is the size and power of the current available technology. It just isn't quite there yet in both terms, and this is not acceptable, especially when designing a device meant to augment the brain in any way, much so a device meant to be implanted in the human brain. Luckily, advancements in technology have given rise to what is known as "neural dust", as stated in a ScientificAmerican article, this technology is a sensor, mere microns in size, with researchers and engineers working to reduce the size to 50 microns. This would mean that with some minor modifications, it could possibly serve to be the ideal vessel for the implementation of this technology. In the past decade, tech giants such as Google, Microsoft, and Amazon have had major breakthroughs with their cloud-based machine translation, with Microsoft claiming that their AI-based model for machine translation has had significant progress over that of Google's Neural Machine Translation. Their research had resulted in a machine with the ability to translate Chinese to English as accurately as a person would, in other words, they claimed that their machine has reached human parity, which in itself is a giant leap in the right direction if this implementation of the technology was to be realized [3]. This however is yet to be tested. Google has also announced a new, more advanced AI-based machine translation system which they are calling Google Brain. They have claimed that this system has the inherent ability to be "self-aware", and in effect, the ability to teach itself to be better in translating. This has its advantages over the old Google Neural Machine Translation model, as the old NMT system is limited and is rather slow in its learning curve. This does not eliminate the problem of inaccurate translation, as the system does not perform well when copying a string of input. However, there is an alternative to this, by merging Google's NMT and Microsoft's AI based translation, the algorithm which is tasked with turning L1 into L2 would greatly improve and will cut the length of time needed for the algorithm to learn. This is due to the nature of AI which collects data and analyzes it in order to improve, no matter what task is assigned to it.

4. Discussion

My proposition is this, since translation between languages of differing language trees are much harder to do than the ones belonging to the same tree, i.e. English and German, therefore, through observing the current state of the underlying technology, it is much better to implement this platform in stages whilst waiting for the technology to catch up with the platform. Microsoft's system is a step in the right direction, though it is not quite at the point in which it is reliable enough. Google translate already works very well with translating languages within the same tree, therefore the AI algorithm needed to make this technology possible would need to be trained to be able to detect the language and its language tree respectively so as not to produce faulty translations. This system would work best in terms of being implemented in the first stage of the technology since it can also get better over time. Below is a rough schematic which demonstrates how data will be processed within the interface. The first step in this schematic is speech, or auditory input which is then received by the ear and then transformed into electrical signals to be sent to the brain for processing. This is where the interface will then intercept that data and decode it into the form of words, which is then processed to recognize the language and the language tree of the input respectively. When this is done, the results will be sent to the AI-based translation algorithm to be translated, after which it is then decoded back into the form of electrical signals, which is then sent back to the brain. All of these processes must not take more than a fraction of second to achieve a seamless experience which is imperative if the device is to have any significant benefit to the wearer.

The ideal situation could be reached only when the implementation of the interface itself is invasive, requiring the subject(s) to undergo brain surgery to have the device implanted into the brain itself. With this done, the focus can be shifted back into the interface itself. The first is the decoding-encoding process which ultimately makes up the majority of how the device will interact with the brain. The first point of discussion will be the encoding interface. Thanks to researches in the biomedical field in the past decade, the use of BMIs have been widespread enough that figuring out the various components which makes up the interface is no longer as complicated as it used to be. One of which is the decoding interface, specifically the intracortical microstimulations (ICMS) which communicates with the brain through ICMS using trains of electrical pulses, which will be delivered directly to the relevant and specified regions within the brain itself [4]. This, in effect will enhance the efficiency of the interface itself, as communicating the wrong data to the wrong region might cause disruptions within the brain.

With the decoding interface sorted out, it is then time to address the encoding interface. In the case of this paper then, the proposed interface is the population vector algorithm (PVA) which is already widely used on cursor-control experiments. This system can be implemented by tuning the receivers to detect auditory signals instead of motor signals, which this decoding interface was originally designed to detect.

Another point to keep in mind is that, for the highest level of translation accuracy, a closed-loop system is recommended, though it might be rather costly to manufacture due to the vast amount of training the software engineers need to apply to the AI algorithm to enhance the accuracy of the translation itself. there is also the issue of memory management that will naturally come up with the use of a bidirectional system that employs a closed-loop system such as that found in previous researches

5. Conclusion

To conclude, though the idea of implementing BMIs as a method of augmenting the brain's capabilities in terms of translation of foreign languages could prove itself to be greatly helpful to humankind and further minimizing the language barrier, the hurdles lying in the way of its realization are also numerous. Things such as linguistic issues between languages of differing language trees, medical challenges of finding a material which can resist degradation over time, computational challenges of composing an algorithm and machine learning efficient enough to provide a stable and reliable translation output, and not to mention that the translated product must also improve over time, and the technological challenge of compressing all the database, memory, and processing power into a chip small enough to be implanted into the human brain without causing any significance discomfort in the recipient of the device. If and when this implementation is globally adapted, then the language in which discourse takes form would no longer matter as each individual would know what the other person is saying even when both parties are speaking in different languages. This would, in effect, remove the language barrier altogether, and thus achieving global unity, a goal shared with the S2ST system [5]. All of these are things which can be achieved, given enough time. Therefore, more research must be done before any attempt at this idea can be execut

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