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Talking Things

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Abstract. Have you ever wished to know and actually feel what your friends feel so you could help them better? Or maybe you have wondered how it is to be one of those celebrities you admire? And how about to become an apple for example? To experience lazy days of hanging on a tree enjoying sunshine and being washed by rains? Or maybe it feels the opposite – a hard life of fighting against worms, decay, and poor weather conditions? What is that thing that makes us feel ourselves and being aware of the boundaries of our body? Can an iPhone we hold in our hands become a part of our body image? Can its processor unit become part of our brain, while various sensors embedded into it become part of our nervous system? So what if so you wonder? An answer follows.

Keywords. Human-machine interfaces, neuroengineering, implants, sensors, multisensory integration, 'rubber hand illusion', provenance, security.

Introduction

Every manufactured product could be equipped with an embedded processing unit and memory to routinely record and store contextual information of the products use. Similarly to humans, physical objects that surround us and services we receive would then be able to speak for themselves, socialize, create communities, exchange knowledge and pass it to their descendants by way of upgrades, and thus develop and evolve. Based on the many discussions of the 'Internet of Things' and how robots could go beyond our control [1], this paper further explores the relationship and boundaries between artificial and natural intelligence and how current scientific discoveries about human nature (from studies in neuroscience, medicine and psychology) could inform future technological innovation.

More specifically, this paper looks at the possibility of our connection to external (beyond our biological brain) processing units, extending this way our personal self beyond our physical body and consciousness. Furthermore, the paper questions what happens to the 'here and now', when we connect and bring personal memories and memories of the Things from the past into the present moment?

Why would we need this? One quick practical example – wouldn't it be nice if the common knowledge becomes part of our conscious instead of us spending many boring hours finding relevant information and then maybe having some tough times studying it? But read the story to find out more. Spinning out of the recent scientific research, this science fiction prototype blurs the boundaries between internal and external, natural and artificial, present and past.

1. Research underpinning the story

Smaller processing units, electronic memories of larger capacity, and a wider range of available sensors make it possible for humans to sense, store, and process more signals. This is our way to understand (or control?) the physical world. Using various instruments, we can see and hear things with different physical qualities inside our body, deep under water and the land, high in the sky. Such instruments may come in the form of standalone external devices (microphones, telescopes, microscopes, etc.), or wearable gadgets (smart clothes, Google glasses, etc.), or they can be attached directly to our nervous system or tissues, thus extending our natural sensory system and allowing us to connect to other biological systems or control electronic devices remotely. Examples of the later technology include the 'bionic ear' developed by Princeton scientists [2], neuronal and magnetic implants developed by Professor Kevin Warwick and his student at the University of Reading [3 - 6], and a number of recent neuroengineering tools for brain-computer interfaces and neuroprosthetic implants [7 - 10].

Extension of our conscious experiences may be soon achieved not only in the spacial dimension, but also in time. Technologies such as Evernote [11] may allow us to experience past events in the present moment as if they were real.

The above examples raise the question of what and where our conscious will be in the future as we experiment with our mind and the nervous system by injecting the artificial into biological and designing devices to enhance our mental and physical abilities. What will happen to our perception of the self and boundaries of our body?

A number of recent studies suggest that multisensory integration plays an important role when the brain needs to distinguish "between parts of one's own body and objects in the external world" [12]. The 'rubber hand illusion' reported first by Botvinick and Cohen in 1998 [13] is now the subject of many different experiments and studies carried out by psychologists and cognitive neuroscientists alike [14 - 16] in an attempt to answer the philosophical questions of "How do we come to feel that we own our body? What is the relationship between our body and our sense of self?" [12]. The 'rubber hand illusion' is "a perceptual phenomenon whereby tactile sensations are referred to an alien limb as a result of the interaction between vision, touch, and proprioception" [15]. While the original experiments were carried out with an artificial (rubber) hand, some later studies have demonstrated that external real objects (that look not like a hand) could also be perceived by us as part of our body image [16], as could phantom limbs [17].

Many applications of these findings have already been tested, ranging from advanced hand prostheses [18], through manipulation of pain perception [19], to virtual reality and simulated environments [20, 21]. Such studies not only blur the boundaries between natural and artificial, virtual and real, the body and its environment, but also open doors for possibilities to explain various types of transformations that are currently considered to be mysterious. For example, we already know that a guitar can be made to sound like a piano and any voice can be made to sound like someone else's [22]. But we don't yet consider it is possible to turn into another person and actually consciously become that person.

Regardless of how far we stretch our imagination, extend boundaries of the body or advance transformations, the eternal question remains the same: What is the original? Would a provenance infrastructure [23] allow us to know for sure that a source is genuine and what its origin is? Even if we assume that 'the free will' (which

from the neuroscience perspective may be considered as our ability to intentionally inhibit our voluntary actions [24]) is the feature that distinguishes us from robots [25], are we still in control, can we still maintain the balance? How emotional relates to physical? How natural relates to artificial? The more interfaces we develop, the more opportunities for flaws we create [26].

In my research, I have explored capabilities of brain-computer interfaces to find and justify complex connection between our physical and mental states [27], proposed a model for maintaining homeostasis (balance) in biological organisms [28], and contributed to the development of the ICmetrics technology [28 - 31] – the technology of generating unique identifiers that may serve as encryption keys directly from characteristics of electronic systems' behaviour (to ensure security and safety of human-machine interfaces for example). These are some of the important aspects involved in devising technology that may advance human performance and capabilities. There are however many other issues to consider if we want to extend our consciousness beyond our physical self. The following science fiction story is designed to highlight some of these problems and suggest possible solutions to them.

2. The fictional story

2.1. Preface: Cabbage

Once upon a time, there were four Kingdoms, all lying around a big Cabbage, but nevertheless not being aware of each other. The habitants from the first Kingdom were routinely attaching new leaves to the Cabbage due to observed shrinkage which they believed was a natural process beyond their control. The habitants from the second kingdom were routinely removing leaves from the Cabbage as they saw it expanded which they believed was a natural process beyond their control. The habitants from the third kingdom were routinely both adding and removing Cabbage's leaves depending on its size which they believed changed naturally and had no control over. The habitants from the fourth kingdom were routinely adding what they believed were good leaves and removed what they believed were bad leaves. They thought they were in control of the process. They were all wrong. The Cabbage didn't care. It believed all the changes occurring to it happened naturally.

2.2. A bump on a road

"Meditate, eat a red apple and one egg, put on the orange tie with penguins" – Paul read on the screen of his iPhone. "OK, let's see how far we go with this today" – he thought, scrambling himself from the bed and heading to the bathroom. He removed the usual morning routine from the program not to clutter the screen. Apparently he could do the same for his morning meditations which also seemed to be set as a constant for his profile. Where things started to deviate slightly from the script was the recommended breakfast and by the time the day was nearly done and bed was in reach again, his actual path seemed to have nothing in common with the original plan set out for him. All attempts to figure out why, when and where deviations were happening hadn't led him any further forward only to use "the fortune" excuse.

After reading somewhere about scientific research suggesting that a key for well-being is to keep balance (which in this case meant to load all brain regions evenly throughout the day), Paul bought an app suggesting alternative activities for each brain region and making recommendations for his life based on his profile and actual everyday activities. Consequently Paul would perform a brain scan at the end of each day and map it to the daily log of completed activities and those scheduled for tomorrow. The app would then suggest him what to eat and wear the following day along with a list of recommended alternative activities.

It never worked for him.

But he guessed there were people out there who benefited from the tool, otherwise it wouldn't be so popular. Maybe the app was designed by or for 'tanks'. Paul liked to think of life as driving with different vehicles on the road (bicycles, motorbikes, cars, buses, lorries, trams, etc.). Drivers start from somewhere, they might have a destination point in mind (or not), a map, and a navigator to guide them through. They might even be aware of road closures, diversions, road works, and trace accidents in real time. But Paul was convinced only the power of a higher divine could determine the minds of other road users, what happens in their little 'car' world, and how they react to unexpected events (created by the very same road users). Some (whom he called 'tanks') would go forward no matter what, 'removing' anything obstructing their path. Others would get angry and stressed creating even more mess. Yet others would relax and enjoy the opportunity to deviate and discover new routes. Paul preferred not to rush. He noticed many times that those in a hurry would have to wait for those behind anyway.

He wondered though, what would happen if 'traffic lights' enforced by authorities were removed; how big would the gap between people become? At the same time, the strongest force that keeps people from flying are their own habits. The longer a man lives, the deeper his roots go into the ground. Paul had lived long enough not to be able to keep up with all the innovation, most of which he thought was unnecessary. He still did multiplication on paper, when his children used calculators. He still made notes by hand, when his grand children typed on a computer. He still read paperback books, when nowadays any mobile device could read out loud an electronic version of it.

Old skills die, new emerge. Paul loved the analogy of adding and removing leaves from a cabbage. They call it neuroplasticity. He wondered what man's brain would be in future times when there is no need for people to read, write, calculate or even reason. Now his new app was suggesting him what to do today. It is a navigator. "No way will I take the back seat!" – Paul encouraged himself for the day.

He scanned the apple. Another gadget he considered to be a waste of money – real time food scanner which tells you the actual nutritional content of the item along with the (long) history of its origin and actual path (he loved the sound of the word 'provenance' though). Some fruit even had a video camera, shock and heat sensors so the fruits life from birth to consumption could be shared. The paradigm "from the farmer directly to your table" seemed to be from the genre of fantasy. He wished he hadn't used the scanner this morning either, since now he had to swallow a tasteless multivitamin tablet as the poor red thing appeared to be virtually free from anything except the various nasty chemicals it was washed in.

"OK, the orange tie with penguins… ha-ha" – Paul knew where that instruction came from. Of course, it was Tuesday, meaning the dreaded meeting with the bore of a boss was today. Normally, Paul would follow any such 'Tuesday' advice as it always proved to be fun; but not today. It was one of those mysterious indescribable feelings,

as if someone was adding something to his glass while he was not watching. He 'knew' something would 'happen' today.

Failing on two things today so far (the apple and the tie), Paul set himself off to work to witness once again how his personal nature and those of other road users would ruin another perfectly designed day intended to keep him fit and healthy. Well, he did make an attempt to correct himself by playing a tune from the collection "Cheer me up" on leaving the house. That was the trick he usually used and sometimes it actually worked. He sorted various artifacts according to the effect they seem to make on him. He always had quick fixes for any situation. Whatever was the task in front and whatever was his mood and physical state right now, there was always a treat in his collection bridging the two. From boring to funny, from tired to energized, from depressed to enthusiastic – not a problem for him.

It was a problem for him however to manage his physical health. Sudden headaches started to bother him recently. Neither he nor doctors could think of a particular reason. The attack happened again; the pain was unbearable strong this time.

No one, except one guy, paid attention to a man falling unconscious on a street bench; drunken people were the norm in this area.

2.3. A day of a courier

Paul worked as a courier. Not like a courier in those old days when you collected a box from the delivery depot and transport it to the address printed on the label. No. Today all things could speak for themselves and have attitude. He loved it in a way; at least someone to talk to. So, the thing would tell him how to be treated and where to be delivered. Those from his higher management also had access to the thing's memory telling its history (to prevent crime so they say).

Recently however, some new suspicious parcels (actually boxes constructed from an unknown material) started to appear at the depot. No one knew where they were coming from and what was inside. They had no delivery address labels and they were packed in such a way that no one could open them. The rumour was that even higher managers didn't know the provenance of the boxes; the boxes had no memories.

First, the boxes were kept in a storage room, while investigation into their origin was going on. They kept coming however, and managers started to worry where to find a space for them (they were afraid to destroy the boxes for political reasons). The worry was unnecessary though. Something strange was going on; despite adding the boxes to the storage room, it never became full. So far.

The most worrying thing for Paul however was the feeling that he had seen those boxes somewhere previously.

2.4. Knowledge essence in a probe

- Who are you? – Paul stared at the guy. – Where am I? – Paul couldn't recognise the room.
- Hi, I'm Roger, you are in my house; you fell unconscious on the street, so I brought you here.

- Me? Unconscious? – Paul couldn't believe it. – Ah, that must be the headache attack had finally got me. Thank you very much for rescuing me, what I can do for you in return? Do you want money? What time is it now? I need to get to work!
- It is half past nine; you have only been here for an hour.
- Oh my god! I'm already late for the meeting with my boss at ten. Where exactly is this place, I might take a taxi?
- I'm sure your boss can wait; you are still too weak to travel.
- You don't know him, he will kill me!
- Your illness will kill you sooner. Where do you work?
- In a bank. How do you know about my illness? Do you know what it is?
- Not quite yet, but I believe we could figure that out.
- What do you mean not quite as if you know something about it? And how can we identify the disease? – Paul was lost somewhere between the urge to leave for the meeting and his curiosity about the man and the situation. He wanted to know what was going on with him recently, where those headaches were coming from.
- You told me some facts about your illness, and I believe we can get more details if you follow me.
- Have we met before? You said I had been unconscious, how could I tell you anything?
- Well, not you explicitly, but your experience of being a cell that delivers nutrients.
- What? – Paul was confused. "What should I do, this man seemed quite mad" – he thought.
- Let me explain. I am a scientist; I designed an interface which allows you to become or 'tap' into an external thing. I call it the Tap Machine. With it, you could consciously become aware of someone else's (or personal but from a different perspective) experiences, knowledge, and memories. I could have called an emergency when I saw you on the bench unconscious, but I thought that was a great opportunity to test my machine outside the laboratory and for a good cause. I brought you here in a car, and as you were not aware of your body at that time, the transition of your consciousness to the level of a cell was smooth. I didn't know where to start and had already considered the possibilities of self diagnosis by means of blood cell becoming. From my previous travels I had an understanding that we may lose consciousness if supply of oxygen or nutrients is restricted to the brain... – Roger stopped for a moment. – You can call the police now, but I don't think they will believe you, I don't hold you, and you are rescued at the end of the day.
- I don't think I quite understand you. Do you mean I can become this fly and feel like it? – Paul's eyes followed an insect flying in the room. – Or become you for example? – he looked into Roger's eyes.
- Yes, exactly. I know a bit about your health problem because I set you to become your own blood cell and recorded your memory and experience as a cell within your body.
- A cell? I am my cell?
- Please don't worry, and don't shout. No, you are not your cell now, now you are you. This is still only a prototype, but it looks promising. I need to do a couple more experiments to make sure everything is working. Could you help me please? I could test the Machine on you, we may then find the cause of your headaches and hopefully fix it.
- I am not a laboratory mice, sorry. What if this thing kills me?

- I will repeat; your illness may kill you soon anyway. I am not claiming anything of course, and choice is yours, but I personally wouldn't ignore those headaches.
- I haven't, I have consulted with doctors!
- And what? Have they got an answer what it is and found you a treatment? Apparently not, otherwise you wouldn't have fallen unconscious in the street. Why do you think they will help you in the future?
- Just hoping. – Paul really didn't know what to do. It all happened so unexpectedly. He needed to think about it, and this man, whoever he was, was putting pressure on him.
- Paul, what are you living for? To satisfy your boss? Or to ride yet another road because your main one has been closed? I, for example, want to make a thing that will help others, so less people suffer from headaches and other diseases. We all come and go, what remains is our product. Please help me to leave a useful product. I know you want to feel secure, but always staying in the middle of the see-saw won't make you any different tomorrow, or after tomorrow, or until you die. Let's move to the edges and fly higher to see further. You know the game, you'll be back to earth, nothing to worry about. I promise I will be here for you to get you safely to the ground.
- Your see-saw analogy reminded me my childhood. You are right in a way; I haven't progressed much since then. Still write by hand... Maybe it's time to get my hands on the 'new technology'; oh, I hate it!
- Do you remember much about your childhood? As this is exactly what I have in mind for our next experiment. I was wondering about those boxes you seem to remember as a cell. Boxes and the delivery depot were just my graphical interface to represent the actual data. As far as I could see from the log, there is a suspicious substance circulating and accumulating in your body. Neither your body nor medics could recognise it. But some of your cells seem to remember it from the past. I tapped into the aggregated knowledge of recognised physiologists and psychologists alike and many seem to agree that some diseases we develop as adults are caused by problems we had as children, despite whether it is mental, emotional or physical problems. It makes sense in a way as we are basically a collection of everything that we and others have been putting into us since our birth: the environment, people, media, adverts... who knows which transformations and reactions may happen between them as we add more and more.
- Are you saying you consciously experienced what doctors of all times knew?
- And yes and no. Of course I wouldn't have time to live each one of their lives (although I could if I wished), but I have designed an algorithm which extracts a summary of only distinct, significant events and discoveries, so I tapped into their aggregated knowledge and experiences. In a way, I was a fusion of the essences of the knowledge of all recognised experts in the field.
- Incredible, you could rule the world if you knew everything!
- I wouldn't be me if I was them and would become insane if I knew everything. I have discovered that lots of information is repetitive, despite it can be presented in different forms to hide similarities. There is also lots of rubbish out there. As I said earlier, similar to plants we are like sponges that absorb anything we come across, even if not recognising this. You might have tasted different tomatoes for example. Some tomatoes grow surrounded by farmers' love, under the sun, in a fertile soil, others accumulate tones of pesticides. Some are juicy and sweet. Others are more sour, bitter or watery. Yet others are tasteless.

- But you can get only the best, can't you?
- Well, the problem is how to identify the best and unique. We all have different preferences and certain knowledge and experiences might be not good for us. If you get used to sour tomatoes, you won't necessarily like the sweet ones, and high sugar content might be not a good idea if you have diabetes.
- Your invention would seem to be very dangerous: I could likely kill myself if tapping into a wrong source, equally I wouldn't be happy to know that someone is tapping into me, in other words becomes me.
- I totally agree, there is a lot to consider and many years will pass until regulatory institutions are established and the public warms up to the new possibilities. So far, this is just a laboratory prototype. I use it only to tap into the knowledge and archives that are publically available. Tapping should be only permitted with the owner's permission, whether it's their material or intellectual property, or indeed their biological (or not fully so) body. Would you give me such permission? We could of course arrange things formally, if you wish, but it will delay the experiment which you may not afford providing your situation. I will leave it up to you to consider all risks and decide.
- OK, I think I am impressed with your imagination enough to continue the journey. I am late for the meeting with my boss anyway, so doesn't matter much who or what will kill me first, him, my illness, or your machine.

2.5. The past saves future

Paul received the same vaccine as all other children in the nursery he attended. It was designed to protect him from a disease going around at the time. The vaccine did it job; Paul didn't get sick at the time. However, a microorganism included in a vaccine became a food for other bad bacteria in Paul's body. No one reported the side effect, and no one recognised the problem with Paul. His immune system was strong enough to kill the bad bacteria. Unfortunately, an emotional distress occurred later in his childhood, causing a hormonal imbalance which weakened the immune system. The mass of bad bacteria started to grow whenever Paul had hard times as an adult. The bacteria didn't show up in a few laboratories tests Paul took; the immune system was still fighting. But every stress promoted reproduction of the bacteria and their mass became critical. The bacteria could win the battle against the immune system at any moment.

With the help of the Tap Machine, Paul was able to recognise the dangerous situation within his body. By becoming aware of the experiences of his own blood cell, he learned about the bacteria (the suspicious boxes as designed by Roger in the graphical interface of the Tap Machine) and their origin. Paul of course didn't remember all the details from his childhood and couldn't make connections between the events. Only with the help of the Tap Machine could he live his childhood again and relate past events to the present moment.

Paul requested one more laboratory test despite the last saying he was in the clear. The doctors were shocked to find this new condition. But fortunately it wasn't too late and Paul received the treatment he needed in time. The Tap Machine saved his life. Will it saves other lives? Will we be able to use the technology wisely?

3. Summary

The science fiction story presented in this paper explored the possibility and consequences of our ability connecting to external things and memories extending in that way our physical body, mind, and consciousness beyond our biological system. As opposed to the idea of extending and expanding our sensory system through inclusion of external sensors to continuously sense more, this paper suggests to tap into additional modalities and sources only when and is required. This could be a need for artificial limbs (a technology that already exists) or for conscious awareness of the human common knowledge and personal history; not as we remember it, but how it actually happened.

We have developed ways to preserve records electronically. Can means be found to include it into our conscious perception of self? The story demonstrated it could be a useful technology to the extent that it can save lives. But would it always be safe and how much information are we ready or can digest?

Evolution can be seen as a process of shifting boundaries. It is down to the human's perception of where the boundaries are. Our picture of the world is changing all the time, with the focus ruled by current trends in science. The problem is that scientists can only glimpse a portion of data that can be extrapolated from world we live in. As our data-rich environment supplies more at an ever increasing rate, the task of selection to solve a problem in a meaningful way becomes far more difficult. It doesn't really matter what is available or exists, but rather what we are tuning for. The information retrieval community may need to develop revolutionary new search algorithms as more (unusual) sources become available to us.

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