

## My “Digitized” Venice

by Oleg Senkov

It so happened that in one broiling June day I appeared in the most mysterious place over the globe – Venice – an aging town wrapped in hundreds of myths, floating on the greeny turquoise Adriatic water. The first conceptual thought which came to my mind was that it can’t be reality, rather an abandoned theater that has all its stage decorations left around undisturbed; or some lavish Hollywood’s open-air pavilion... Everything was like in some fairy tale – half befogged, hazy, unreal, and half apparently very touristy. The second thought of mine was abruptly cut off by almost a scream coming out of my leg muscles. “*We* have no longer a simple life over here with all these steps up and down of endless “vertical”<sup>1</sup> bridges to get to the final destination of *his* moody Italian journey – a small church lost someplace in the *sestiere*<sup>2</sup> of San Marco!!!”.

At last, having fully experienced the sweating complexity of a spider’s web-like maze of Venetian tangled cobbly streets, I eventually dived into a hyper-maze of a brain labyrinth while listening to notorious Gurus at [3<sup>rd</sup> European Neuro-IT and Neuroengineering School “Neuroengineering of Cognitive Functions”](#). Bishop S. Magnus, who has first been inspired to build the Church of San Salvador, placing it almost in the heart of Venice, at the foot of the legendary Rialto Bridge, would have never believed that in one of its convents, nearly a millennium after, they will talk about most cutting-edge modern technologies ever existed – encoding/decoding human thoughts, brain-computer interfacing, modeling of different states of cognition, and natural neuro-circuits embedded into robots.

It was hard to swallow: 6 lectures daily, one week of hellish soaking heat above 35 (degrees) and no air conditioning within the Venetian perimeter. The only time that was left – evenings, when I could feel myself a bit more of a human being, loafing around with my digital camera and trying to digest what I perceived on lectures during the day.

But that wasn’t easy, too- pictures from different talks, Venetian historical epochs, electronic circuits, populating everywhere tourists, statues, churches, unsupervised learning paradigm, gondoliers, yelling under bridges, mad pigeons, intriguing *Carnevale*<sup>3</sup> masks... they were continuously overlaying and intermingling with each other. My MT/V5 area in the visual cortex failed to discriminate past from present. Dr. Orban from Catholic University of Leuven, Belgium, was right, this area is incapable to process temporal information, only spatial contingencies - motions of 3D objects caught on fly, but not 2D shapes. It is therefore very useful in any robotic simulations, bank surveillance systems etc. Hardware, software and brains from different species were messed in one big Italian Pizza, served with a name “Viva Brain-Computer Interfacing”, flavored with lots of salty math, always unsure spicy statistics and bearded philosophy as a not-secondary meal.

I was taught by Barbara Webb from the University of Edinburgh, UK, how to build a robot in three days - an insect, a small cricket with brains almost equal to its progenitor in sense of navigating in space by using only one source of information – audible. Probably, soon, it might

help t domestic robots to get slippers to their masters even in a very noisy room with a dozen guests, pets and the TV on, just by one whistle.

Looking at a long black gondola, ornamented with tiny golden sea-horses on both its sides – two hippocampi, which was passing by , I recalled a fine speech of Matthew Wilson from MIT<sup>4</sup>, USA, who highlighted his new discovery regarding how a brain structure of the same name, responsible in mammals for abilities to learn and memorize, encode and decode information about location of a subject in space throughout of so-called “place cells” activity governed precisely by theta waves generated locally in the hippocampus, special oscillations with a frequency between 4-10 Hz, drawing a “cognitive map” of any experienced environment within the brain for further usage. Such hippocampal place cells always start to fire whenever an animal appears at a particular place of environment. This is a fresh idea in the field. Before, people were quite puzzled about putative mechanisms behind this phenomenon. In humans, there’re also place cells which behave the same way as in rodents whenever a subject’s looking for an exit in VR<sup>5</sup> mazes or simulated towns.

Once I was sitting very close to Piazza San Marco, gazing at the local highest 100 m skyscraper – the campanile – a red bell tower from which Galileo used to explore the sky with his famous telescope. However, nowadays the building is just a detailed replica of the one that collapsed in 14 July 1902. A replica!? How well actually does it reproduce its original? I summoned up Henry Markram from The Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland, who announced to us that the most ambitious project, after “Human Genome Project”, has just launched this July with a code name “[The Blue Brain Project](#)”. They want to make a close 3D replica “*in silico*” of a brain area responsible for cognitive functions, learning, memory and - in humans - speech: neocortex. They’ll try first to simulate on the molecular level an elemental block of the cortex, a single column, a cylindrical 0.5x2 mm brain volume stuffed with nearly a hundred thousands of neurons, and then they’ll try simply to multiply several simulated columns to give birth to something more like a human brain. All this 5 km length circuitry of a given single column will be accurately replicated and run on the most powerful supercomputer over the world - the IBM’s Gene/L<sup>6</sup> with a speed up to 22.8 teraflops<sup>7</sup>. “*Eppur si muove*”<sup>8</sup> – a Galileo’s popular phrase would now have a second life! We’ve moved finally into the Era, Dr. Markram said, where a ponderous volume of knowledge about the brain, its architecture and functions has been accumulated for centuries, but still we only poorly understand how the brain really works. The brain isn’t yet catalogued, not even a simplest database of it exists<sup>9</sup>. But the power of computers now is enough to quite precisely simulate<sup>10</sup> if not the whole brain - probably it wouldn’t never possible - but at least several distinct micro regions of it. The only remaining question is: will it be still a human, ok, *in silico* brain, or something else, with new capabilities, yet unknown?

Continuing to explore Venice next nights, not once was I hopelessly stuck somewhere in crane’s neck-like, tightly packed Venetian streets, over the Castello *sestiere*. Dozen times already I realized the uselessness of any maps in Venice. One should have something totally “handheld-free” in this place to be able to navigate through here, while simultaneously perceiving all these beauties around. And at that very moment in my memory suddenly appeared a miracle device designed by Dr. Peter König et al., from the University of Osnabrück, Germany, which has been devoted exactly to liberate our eyes, attention from whatever guidebook, map but yet to be a guider in space. At the first glance, it is an ordinary wide belt for climbing, but at a short, it has some kind of unrelated-to-components: a ring of vibrators, an electronic compass and a small

box of control unit and batteries. This funny tool nicknamed “[feelSpace](#)” was developed to introduce a new sensory modality, a sensation of the north direction through a tactile stimulation of our skin around the belt with tiny vibrations. A user, after little time for training, would become one of the “fantastic four”, a creature like those migrating thrushes reading the earth’s magnetic fields like a man reads newspapers. Only I was wondering how it can more entertainingly help us to get to whatever target in an unknown megapolis? I’d better like to have something resembling a GPS<sup>11</sup> system of Mercedes-Benz C-Class; a female pleasant voice saying “next crossroad, please, turn left, here’s the biggest supermarket in this area...”

[The Berlin Brain Computer Interfaces](#) – another top enterprise of several research groups focusing only to design a self-adopting interface between brain and machine. Klaus (isn’t he Klaus? - Alena)-Robert Müller from Fraunhofer FIRST<sup>12</sup> and Gabriel Curio from Charite University Medicine, Berlin, could use up to 128 channels EEG<sup>13</sup> to record brain signals from user’s scalp and then to decode on-line meaningful information from them, which represents user’s mental intention to do something, e.g. to press a left or right button on a keyboard, to move a cursor in a special area on the computer screen and so on... Only simple tasks... Just imagine, a gamer who’d control Lara Croft’s weapon shooting, or the hardest Resident Devil’s labyrinth navigating, all done without touching a single key, only thoughts speedily run whatsoever on the screen... Imagine, a completely paralyzed patient with ALS<sup>14</sup> or spinal cord injury lying helplessly down in a bed, not even able to speak, lost, cut off the whole world, one day would be able to freely communicate throughout such computer interface, sending emails, making phone calls with artificially synthesized voice, and even control some everyday-use smart devices around remotely, using only – thoughts...

This time of AI<sup>15</sup> is already very close! What else artificial will it bring to us?! I hope at least the Venetian sunset won’t be ever simulated, substituted and then digitally worshiped...

1 Nearly 400 bridges in Venice have an arc-like construction with many steps up and down;

2 *Sestiere* – ancient administrative areas in Venice;

3 Carnival;

4 MIT – Massachusetts Institute of Technology;

5 VR – Virtual Reality;

6 [www.top500.org](http://www.top500.org)

7 22.8 teraflops - 22.8 trillion calculations every second;

8 “*Eppur si muove*” - Galileo’s popular statement that the earth moves around the sun, spoken in 1632, literally means “But it moves”;

9 There are some brain fMRI databases available in the net, but they are just descriptive and not predictive;

10 To a certain degree – one artificial neuron can contain of a dozen of ion channels with given properties, but a real one has at least in 1000 folds more of them;

11 GPS – Global Positioning System;

12 FIRST – Fraunhofer Institut Rechnerarchitektur und Softwaretechnik, Institute Computer Architecture and Software technology, Berlin, Germany;

13 EEG – Electroencephalography;

14 ALS – Amyotrophic Lateral Sclerosis;

15 AI – Artificial Intelligence.