

Milestone-Proposal:

First control of a robot using brain signals

To the proposer's knowledge, is this achievement subject to litigation? No

Is the achievement you are proposing more than 25 years old? Yes

Is the achievement you are proposing within IEEE's designated fields as defined by IEEE Bylaw I-104.11, namely: Engineering, Computer Sciences and Information Technology, Physical Sciences, Biological and Medical Sciences, Mathematics, Technical Communications, Education, Management, and Law and Policy. Yes

Did the achievement provide a meaningful benefit for humanity? Yes

Was it of at least regional importance? Yes

Has an IEEE Organizational Unit agreed to pay for the milestone plaque(s)? Yes

Has an IEEE Organizational Unit agreed to arrange the dedication ceremony? Yes

Has the IEEE Section in which the milestone is located agreed to take responsibility for the plaque after it is dedicated? Yes

Has the owner of the site agreed to have it designated as an IEEE Milestone? Yes

Year or range of years in which the achievement occurred: 1988

Title of the proposed milestone: First control of a physical object (a robot) using signals emanating from a human brain - 1988

Plaque citation summarizing the achievement and its significance:

In 1988 in this building, for the first time in the world, a physical object (a robot) was controlled using signals emanating from a human brain. After that research and applications of controlling physical objects such as home appliances, drones, wheelchairs, and prostheses is spread worldwide, for benefit of society ranging from educational to rehabilitation level.

In what IEEE section(s) does it reside?

Region 8 Republic of Macedonia Section

IEEE Organizational Unit(s) which have agreed to sponsor the Milestone:

IEEE Organizational Unit(s) paying for milestone plaque(s): Republic of Macedonia Section

IEEE Organizational Unit(s) arranging the dedication ceremony: Republic of Macedonia Section

IEEE section(s) monitoring the plaque(s): Republic of Macedonia Section

Milestone proposer(s):

Proposer name: Stevo Bozinovski

Proposer email: sbozinovski@scsu.edu

Please note: your email address and contact information will be masked on the website for privacy reasons. Only IEEE History Center Staff will be able to view the email address.

Street address(es) and GPS coordinates of the intended milestone plaque site(s):

18 Rudjer Boskovic street, Skopje, Macedonia,
Faculty of Electrotechnical and Information Technologies,
GPS Coordinates,

Describe briefly the intended site(s) of the milestone plaque(s). The intended site(s) must have a direct connection with the achievement (e.g. where developed, invented, tested, demonstrated, installed, or operated, etc.). A museum where a device or example of the technology is displayed, or the university where the inventor studied, are not, in themselves, sufficient connection for a milestone plaque. Please give the address(es) of the plaque site(s) (GPS coordinates if you have them). Also please give the details of the mounting, i.e. on the outside of the building, in the ground floor entrance hall, on a plinth on the grounds, etc. If visitors to the plaque site will need to go through security, or make an appointment, please give the contact information visitors will need.

The plaque will be placed in the building where there was the lab which carried out the first experiment of controlling a robot using human EEG. It is in the Annex of the FEIT building now. It will be mounted on the wall. .

Are the original buildings extant?

Yes.

Details of the plaque mounting:

On the wall at the entrance of the Institute of Computer Science and Engineering, where the lab resided at the time the achievement was made.

How is the site protected/secured, and in what ways is it accessible to the public?

The place is secured by the regular rules of entrance to the Annex of the FEIT building.

Who is the present owner of the site?

University Sts. Cyril and Methodius, Skopje, Macedonia

What is the historical significance of the work (its technological, scientific, or social importance)?

Before 1988 controlling a physical object using signals emanating from a human brain was named psychokinesis and was in the realm of the science fiction.

In 1988 in this building, for the first time in the world, it was shown how a physical object (a robot) can be controlled using signals emanating from a human brain. It was 11 years before such result was achieved for the second time, in 1999, in USA. Contemporary research and applications of controlling physical objects such as home appliances, drones, wheelchairs, and

prostheses is spread worldwide, for benefit of society ranging from educational to rehabilitation level.

What obstacles (technical, political, geographic) needed to be overcome?

The most important was the challenge of solving the problem of psychokinesis. The idea came of using EEG and a robot. Once the idea came, 11 years before second person in the world getting the same idea, the technical difficulties were to build an experimental setup where the idea will be tested and demonstrated. It included building a special robot polygon for moving mobile robots while connected to a power and signal cables. It was a unique setup, first in the world. Also technical obstacle was building a special software as well as biopotential amplifier interface and robot interface.

What features set this work apart from similar achievements?

It is its pioneering nature. It made a leap from science fiction to engineering. Many people taught of possibility of moving physical object with energy emanating from a human brain, but until 1988 nobody got an idea to record EEG signals and build interface needed to control movement of a physical object (a robot). The achievement was reported at a IEEE Conference in USA. In 1988 there was no world wide web, so it took 11 years till the next similar achievement, in 1999. (Chapin J., Moxon K., Markowitz R., Nicolelis M., Real-time control of a robot arm using simultaneously recorded neurons in the motor cortex. *Nature Neuroscience* 2, pp. 664–670, 1999). It was control of a physical object (a robotic arm) using signals generated inside the brain of an animal, a rat.

The difference between the first and the second achievement is not in the type of robot (mobile rover robot vs robotic arm), it is in a way EEG signals were recorded. The first achievement in 1988 recorded EEG non-invasively, from a human scalp, while the second achievement in 1999, recorded invasively, inside the brain with implanted electrodes.

Other efforts in the world were to control objects on a computer screen but not physical objects to solve the long lasting psychokinesis problem. The challenge was setup by Vidal (1973) and is now known as brain-computer interface challenge. In 1977 Vidal controlled a cursor-like object on a computer screen. In 1988 Farwell and Donchin controlled writing text on a computer screen, at the same year the psychokinesis challenge was overcome.

So the control of a physical object using EEG was an unique effort of solving the psychokinesis problem.

References to establish the dates, location, and importance of the achievement:

Minimum of five (5), but as many as needed to support the milestone, such as patents, contemporary newspaper articles, journal articles, or citations to pages in scholarly books. **You must supply the texts or excerpts themselves, not just the references.** At least one of the references must be from a scholarly book or journal article.

The five references which establish dates, locations, and importance of achievement are:

1. Bozinovski, S., Sestakov, M., Bozinovska, L. (1988) Using EEG alpha rhythm to control a mobile robot. In: G. Harris, C. Walker (eds.) Proceedings of 10th Annual Conference of the IEEE Engineering in Medicine and Biology Society, , track 17, Biorobotics, New Orleans, LA, vol. 10, pp. 1515–1516 (first short report of the achievement)
2. Bozinovski S. (1990) Mobile robot trajectory control: From fixed rails to direct bioelectric control. In O. Kaynak (Ed.) Proc IEEE International Workshop on Intelligent Motion Control, Istanbul, vol 2: 463-467 (describing the algorithm)

3. S. Bozinovski, "Controlling robots using EEG signals, since 1988," In S. Markovski, M. Gusev (eds.) ICT Innovations 2012, Springer Verlag, p. 1-11, 2013 (detailed description)
4. Bozinovski S., Bozinovski A..(2015) Mental States, EEG Manifestations, and Mentally Emulated Digital Circuits for Brain-Robot Interaction, IEEE Transactions on Autonomous Mental Development 7(1): 39-51 (publication in a IEEE Transactions)
5. Lebedev M., Nicolelis M. (2017) Brain-machine interfaces: from basic science to neuroprostheses and neurorehabilitation, Physiological Review 97:737-867 (a review from the person achieving second control of a robot using EEG signals in 1999, on page 779 pointing out explicitly that " It is worth noting that the first publication on a human controlling a robot with EEG activity dates back to 1988 (85)" where reference (85) is the reference 1 above.) .

Supporting materials (supported formats: GIF, JPEG, PNG, PDF, DOC):

All supporting materials must be in English, or if not in English, accompanied by an English translation. **You must supply the texts or excerpts themselves, not just the references.** For documents that are copyright-encumbered, or which you do not have rights to post, email the documents themselves to ieee-history@ieee.org (mailto:ieee-history@ieee.org). Please see the Milestone Program Guidelines (/Proposing_a_Milestone) for more information.

The following supporting materials are provided

All the papers mentioned in the references in PDF format

All the Figures paper 3 of the references. in JPG format

Copy of page 779 of the review paper, reference 5 above, in PDF format

Please email a jpeg or PDF a letter in English, or with English translation, from the site owner(s) giving permission to place IEEE milestone plaque on the property (/Sample_Site_Owner_Permission_Letter),

Site Owner Permission Letter

Letter of permission from site owner hosting IEEE Milestone Plaque

IEEE Milestone Program Administrator
IEEE History Center
ieee-history@ieee.org

Re: Site Owner permission to place IEEE Milestone plaque commemorating
First control of a physical object (a robot) using signals emanating from a human brain

[Site owner] agrees to host the proposed IEEE Milestone plaque commemorating
First control of a physical object (a robot) using signals emanating from a human brain
and to permit the plaque to be installed at 18 Rudjer Boskovic street in place where plaque will
be viewable by the public. [Provide details of plaque installation and placement here]

The plaque, which will be bronze, will be 12 inches x 18 inches, and carry a citation describing
the technical achievement being recognized as a milestone.

The cost of installation will be borne by the IEEE organizational unit sponsoring the milestone,
and the plaque will remain the property of IEEE. Should the plaque need to be removed for
reasons such as building renovation [the site owner] will notify the IEEE History Center so that
IEEE can make arrangements for the care of the plaque.

Sincerely

[Site Owner Signature]

and

a letter (or forwarded email) from the appropriate Section Chair (http://ethw.org/Sample_Section_Support_Letter) supporting the Milestone application to ieeehistory@ieee.org with the subject line "Attention: Milestone Administrator." Note that there are multiple texts of the letter depending on whether an IEEE organizational unit other than the section will be paying for the plaque(s).

Letter/email when the Section will be paying for the plaque and the ceremony

Section letterhead

Date:

Subject: IEEE Milestone proposal docket number XXX.XX [if known, if not known leave blank

Title of Milestone:

First control of a physical object (a robot) using signals emanating from a human head

Dear _____

The IEEE Republic of Macedonia Section agrees to sponsor the Milestone proposal above. Sponsorship has three aspects: 1) Payment for the cost of the plaque. (2) Arranging the dedication ceremony, and 3) agreeing to monitor the plaque and to let IEEE History Center staff know in case the plaque needs to be moved, is no longer secure, etc. Number 3 must be done by the IEEE Section in which the plaque is located, however any IEEE Organizational unit can pay for the plaque and the dedication ceremony may be planned either by any IEEE entity, or by the site owner (e.g. a corporate, academic, or government organization) or combination of the IEEE entity and site owner.

The IEEE Republic of Macedonia Section accepts the responsibility of monitoring the plaque, and of letting IEEE History Center staff know in case the plaque needs to be moved, is no longer secure, or some other reason. The Plaque will remain the property of IEEE Section.

The IEEE Republic of Macedonia Section accepts the financial responsibility of paying for the plaque: Yes

The IEEE Republic of Macedonia Section accepts the responsibility for arranging the Milestone dedication ceremony: Yes

Sincerely

[Name of the Section Chair]