Small or medium-scale focused research project (STREP) proposal

ICT Call 5

FP7-ICT-2009-05

Modified microphone bug with speakers for people with speech problems

AIMI

Small or medium scale focused research project (STREP)
Date of preparation: 13.01.2020.
Version number: 1.0

Name of the coordinating person: Goran Milenković, Katarina Živković
e-mail: goran.milenkovic95@gmail.com, katarinazivkovic95@gmail.com

Participant no. *	Participant organization name	Part. short name	Country
1 (Coordinator)	Faculty of Mathematics, University of Belgrade http://www.matf.bg.ac.rs	MATF	Serbia
2	Faculty of Electrical Engineering, University of Belgrade http://www.etf.bg.ac.rs	ETF	Serbia
3	Swiss Federal Institute of Technology Zurich http://www.ethz.ch	ETH	Switzerland
4	Braingineers https://braingineers.com/	BRA	Netherlands
5	German Autolabs https://germanautolabs.com/	GAL	Germany

Proposal abstract

There are many solutions for helping people with speech problems like tables or some kind of monitors for sign communication or some tools in experimental phase but none of them are really useful. Our main goal is to make something that will make this world a better place for people with speech problems.

We hope that AIMI will make giant leap forward in the area of artificial intelligence and to encourage others to follow our steps to do something better for this world. Also, we expect that AIMI will be massively used to test new medical results in this field.

Table of contents

Section 1: Scientific and/or technical quality, relevant to the topics addressed by the call

1.1   Concept and objectives

The major concept behind this proposal is developing hardware and software and insert into device such as microphone bug. AIMI will be capable of reading internal speech, process the data and send the results to the speaker. Also, AIMI could act as communication tool with computer, allowing people with speech problems to practice to make them feel more secure. One of the main goals of artificial intelligence is to integrate people and computers and this product just gives that. Also, researchers can use AIMI to better understand the dependencies between speech and the brain.

Our motivation for making this proposal is development of high-level artificial intelligence algorithm applied on microphone software, but, still reusable in others similar hardware. Idea is, above all, manipulation of large volumes of data from internal speech which are product of this kind of algorithm.

Objective 0: Project management

The goal of this objective is to make sure that absolutely each and every detail of this proposal, if it is awarded, be properly taken care of, which means: (a) All deliverables delivered in time, (b) All deliverables delivered at quality levels that satisfy the highest FP7 standards, (c) All deliverables delivered in a form which is consistent and helps convey the essence in a way which is easy to comprehend. For all this to happen, an effective set of system of reminders will be set.
Success criteria:
• Optimization of the reporting processes involved in the project (deadlines).
• Optimization of the control processes involved in the project.
• Optimizing finances of the project.

Objective 1: To generate use cases, which includes the following: a variety of applications, details of functionalities within each application, and definition of parameters of importance.

Use cases will be generated through a series of brainstorming meetings with the purpose of taking into account a variety of applications of interest (this includes both, the generation of new ideas and improvements of the existing ones). Workshops are also planned, with practical exercises. Crucial in this phase of the work is active exchange of information among system developers, users and concept designers at the universities.
Success criteria:

● Opinion of beneficiaries on the need for the generated applications, based on their knowledge about where the major unknowns are,
● Opinion of beneficiaries about the functionalities provided,
● Opinion of beneficiaries about optimal values of parameters involved.

Objective 2: To develop the system architecture, to determine the functionalities of all building blocks, and to develop hardware (HW), communications, and software (SW) requirement

The main objective is to develop autonomous system for processing internal speech. All details related to hardware, software, and communications have to be developed. Software details include issues like data mining, AI, decision trees, cloud computing services and other. Details imply algorithm, procedures, and the information system. Hardware includes using some kind of supercomputer and several workstations.

All measurements and testing will be performed in controlled laboratory conditions with people from appropriate institutions.

Success criteria:

● Potential speed of processing and decision making
● Software architecture which permits easy expandability and reusability
● Maximal resource usage

Objective 3: To establish concrete hardware (HW)

Basic requirements for this module include some kind of data flow supercomputer.

Success criteria:

● Successful usage of supercomputer and its capabilities

Objective 4: To establish concrete software (SW) details for the system

Implementing high-quality algorithm and following applications that will satisfy our demands. This will require expertise in fields of:
● data mining
● machine learning
● human behavior
● artificial intelligence

Success criteria:

● Very high stability and performance of the system
● Error free algorithm that will give the best possible results at the moment

Objective 5: To realize a simplified demo, with a reduced set of functionalities, but large enough for experimenting

The subset for implementation will be selected in cooperation with partner BRA active in related fields. This will enable EU industry to gain a more competitive position on the world market and consequently boost the local science community.

Success criteria:
• Smart reduction of functionalities so that all planned experiments can be successfully performed and the demo prototype implemented in time and without bugs
• Timely implementation
• Implementation without bugs

Objective 6: To test the demo system in a number of different scenarios, with different kind of speech problems, to compare results, to summarize the lessons learned, and to make recommendations for production prototype

Demo system developed in WP5 will be tested in real-production situations in two universities in Serbia. Tests will be selected and developed so that experience learned from the test can be compared in order to refine further results. Thus, recommendations for the production prototype can be obtained in the requirement specifications. This will enable new activities both in the region where the testing was performed, and in the EU, in general. As a result, the prototype will enable mass expansion of this new medium.
Success criteria:
• Test cases developed according to the needs gathered in WP1
• Specification of issues
• Details of the requirements for production prototypes to follow

Objective 7: To do constantly a public dissemination about this project (using media like newspapers, TV and Internet), to do periodically internal workshops (for consortium members and their students) and scientific symposia (to bring together researchers from outside of this consortium), to help raise public interest and generate companies interested in this system, and to prepare the adoption of this system to different purposes

The special sessions, seminars and workshops will be open events to spread knowledge among students towards better understanding of systems like this one. Suitable media events will be used to further spread information about the benefits of data flow computers in artificial intelligence. All seminars should be organized for collaborators and other suitable candidates.

Success criteria:
• Number of papers presented at internal workshops and the number of papers with potentials to get accepted for publication in SCI journals
• Number of participants at workshops, twice a year (min 15 participants per workshop)
• Number of participants at scientific symposia, twice a year (minimal 30 per symposium)
• Number of public presentations in media

1.2 Progress beyond the state-of-the-art

The idea of internal speech reading is tied, not closely, to the idea of mind reading. Mind-reading products and solutions that could be used for internal speech reading are in the experimental phase. An example is Facebook's mind reading machine or Oxford's fMRI machine.

There has not been too much progress in the field of internal speech reading or better said are not known to the general public. The primacy was taken over by private companies who realized that huge money could be taken and they do not share their research results. Research in this area is very expensive and without strong organization it is not possible to make some progress in this field.

Last year, 2018, Arnav Kapur, a postdoctoral student with the MIT Media Lab, has made a huge shift. He created AlterEgo, a non-invasive, wearable, peripheral neural interface that allows humans to converse in natural language with machines, artificial intelligence assistants, services, and other people without any voice—without opening their mouth, and without externally observable movements—simply by articulating words internally. The feedback to the user is given through audio, via bone conduction, without disrupting the user's usual auditory perception, and making the interface closed-loop. This enables a human-computer interaction that is subjectively experienced as completely internal to the human user—like speaking to one's self. The wearable system captures peripheral neural signals when internal speech articulators are volitionally and neurologically activated, during a user's internal articulation of words. This enables a user to transmit and receive streams of information to and from a computing device or any other person without any observable action, in discretion, without unplugging the user from her environment, without invading the user's privacy. A user's deliberate internal speech is characterized by neuromuscular signals in internal speech articulators that are captured by the AlterEgo system to reconstruct this speech. They use this to facilitate a novel user interface where a user can silently communicate in natural language and receive auditory output through bone conduction headphones, thereby enabling discreet, bi-directional interaction with a computing device, and providing a seamless form of intelligence augmentation.

This product has a lot of drawbacks which is why it is still research only. Its accuracy is about 90%, it has a fund of 100 words, can't help people with speech impairment and looks striking on the face.

References:
- https://www.media.mit.edu/projects/alterego
- https://www.digitaltrends.com/cool-tech/mit-alterego-technology-arnav-kapur/
- https://www.sciencealert.com/scientists-have-invented-a-mind-reading-machine-that-can-visualise-your-thoughts-kind-of
- https://www.telegraph.co.uk/news/science/science-news/7987821/Mind-reading-machine-can-convert-thoughts-into-speech.html
- https://www.technologyreview.com/s/614034/facebook-is-funding-brain-experiments-to-create-a-device-that-reads-your-mind/

1.3 S/T methodology and associated work plan

In order to achieve the overall project objectives, the following items are considered as crucial:

- Competent researchers well aware of the state of the art in the research field and able to take the research forward
- State of the art research infrastructure
- Ability to work, communicate and collaborate with researchers from various backgrounds, in various circumstances and environments
- Large network of contacts in the research community
- Public awareness of the benefits of the research in a chosen field and promotion of research results and achievements

The project is organized in 8 work packages as follows:
- WP0 Project management
- WP1 Development of Use Cases
- WP2 Development of System Architecture
- WP3 Software Details
- WP4 Hardware Details
- WP5 Proof of Concept Implementation
- WP6 Testing
- WP7 Dissemination

The main body of work is included in six work packages (WP1, 2, 3, 4, 5, and 6). The activities planned in these work packages correspond to the main strands of the project as described above. It is the responsibility of the project management team (WP0) to coordinate these activities to maximize the impact and benefits for everyone involved. Work package WP7 is considered a pillar that supports the main body of work.

Gantt Chart Diagram
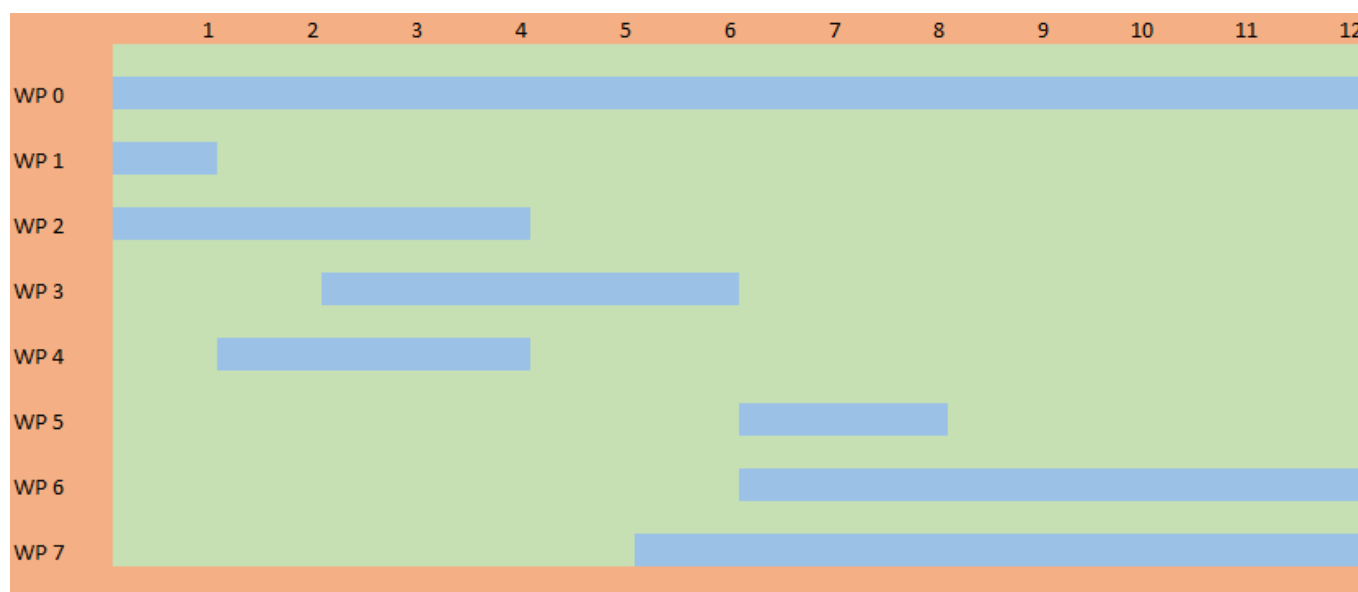
Work package list

Work package No[1]	Work package title	Type of activity[2]	Lead partic no.[3]	Lead partic. short name	Person-months [4]	Start month[5]	End month[5]
WP0	Project Management	MGT	1	MATF	70	M1	M12
WP1	Development of Use Cases	RTD	1	MATF, ETH	7	M1	M1
WP2	Development of System Architecture	RTD	2	ETF	19	M1	M4
WP3	Software Details	RTD	3	ETH	35	M3	M6
WP4	Hardware Details	RTD	5	GAL	12	M2	M4
WP5	Demo Implementation	RTD	1	MATF, ETF, BRA	8	M7	M8
WP6	Testing	RTD/DEM	1	MATF, ETF	110	M7	M12
WP7	Dissemination	DEM	4	BRA	50	M6	M12
	TOTAL				311		

---

[1]   Work package number: WP 1 – WP n.
[2]   Please indicate <u>one</u> activity per work package:
       RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium
[3]   Number of the participant leading the work in this work package.
[4]   The total number of person-months allocated to each work package.
[5]   Measured in months from the project start date (month 1).

List of Deliverables

Del. no. [6]	Deliverable name	WP no.	Nat-ure [7]	Dissemi-nation level [8]	Delivery date [9] (proj. month)
D0.0	Progress report for the 6 months of work	0	R	PU	M6
D0.1	Progress report for the 6 months of work	0	R	PU	M12
D0.2	Progress report for the whole project	0	R	PU	M12
D1.0	Use Case Diagrams	1	R	PP	M1
D2.0	System Architecture Specification	2	R	PP	M4
D2.1	Report on Software Details	2	R	PP	M4
D3.0	Report on GUI Specifications	3	R	PP	M4
D3.1	Documented code	3	R	PU	M6
D4.0	Report on Hardware Details	4	R	PP	M4
D5.0	Documented testing procedures and final code documented	5	P	PP	M8
D6.0	Report on testing results	6	R	PU	M12
D7.0	Dissemination plan	7	R	RE	M7
D7.1	Project promotional material	7	R	PU	M12
D7.2	2 Workshop report	7	R	PP	M8, M11
D7.3	2 Seminar report	7	R	PP	M9, M12

---

[6]   Deliverable numbers in order of delivery dates. Please use the numbering convention <WP number>.<number of deliverable within that WP>. For example, deliverable 4.2 would be the second deliverable from work package 4.

[7]   Please indicate the nature of the deliverable using one of the following codes:
R = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

[8]   Please indicate the dissemination level using one of the following codes:
PU = Public
PP = Restricted to other program participants (including the Commission Services).
RE = Restricted to a group specified by the consortium (including the Commission Services).
CO = Confidential, only for members of the consortium (including the Commission Services).

[9]   Measured in months from the project start date (month 1).

Milestones

Milestone number	Milestone name	Work package(s) involved	Expected date [10]	Means of verification[11]
M0.1	Kick-off meeting	WP0	M1	
M0.2	Consortium agreement signed	WP0	M1	Consortium Agreement with partner signatures
M0.3	Project shut- down – all deliverables achieved	WP0	M12	Final deliverables report
M1	Finished Use Cases	WP1	M1	Use Case documentation
M2	System architecture defined	WP2	M4	Architecture specification
M3	SW details defined and clarified	WP3	M6	SW report
M4	Hardware details defined and clarified	WP4	M4	HW report
M5	Prototype built and tested	WP5	M8	Prototype report
M6.1	System tested with complicated problems	WP6	M12	Testing report
M6.2	System performance test	WP6	M12	Performance report

---

[10] Measured in months from the project start date (month 1).

[11] Show how you will confirm that the milestone has been attained. Refer to indicators if appropriate. For example: a laboratory prototype completed and running flawlessly; software released and validated by a user group; field survey complete and data quality validated.

Work package description

Work package number	0		Start date or starting event:		Beginning of M1		
Work package title	Project management						
Activity type[12]	MGT						
Participant number	1						
Participant short name	MATF						
Person-months per participant	70						

Objectives

Project management - the goal of this objective is to make sure that absolutely each and every detail of this proposal, if it is awarded, be properly taken care of.

Description of work

The Project Manager (PM) will be the responsible person for all administrative, contractual and financial matters and he handle the overall management of the project. The duties, methodologies and management strategies that will be followed in the project are described in detail elsewhere in this proposal.

Deliverables

Progress report for the 6 months of work – M6, M12

Progress report for the whole project – M12

---

[12] Please indicate <u>one</u> activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Work package number	1		**Start date or starting event:**		M1		
Work package title	Development of Use Cases						
Activity type[13]	RTD						
Participant number	1	3					
Participant short name	MATF	ETH					
Person-months per participant	4	3					

Objectives

To generate use cases, which includes the following – a variety of algorithms, strategies, details of functionalities within each algorithm, and definition of parameters of importance.

Description of work

This work package will focus on knowledge transfer primarily among project participants with involvement of internal speech reading experts. Research workshops and seminars will be organized.

Deliverables

Use Case Diagrams – M1

---

[13] Please indicate <u>one</u> activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Work package number	2	**Start date or starting event:**			M1		
Work package title	Development of System Architecture						
Activity type[14]	RTD						
Participant number	3						
Participant short name	ETF						
Person-months per participant	19						

Objectives

The main objective of this WP is to create the system architecture

---

Description of work

To develop the system architecture, to determine the functionalities of all building blocks, and to develop software (SW) requirements.

Deliverables

System Architecture Specification – M4

---

[14]   Please indicate <u>one</u> activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Work package number	3	**Start date or starting event:**			M3			
Work package title	Software Details							
Activity type[15]	RTD							
Participant number	3							
Participant short name	ETH							
Person-months per participant	35							

Objectives

To establish concrete software which is using power of hardware mentioned in WP4

Description of work

The goal of this task is to ensure that appropriate software platform meets the requirements of the project requirements as specified in WP4.

Deliverables

Report on GUI Specifications – M4

Report on Software Details – M4

Documented code – M6

---

[15] Please indicate <u>one</u> activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Work package number	4	**Start date or starting event:**			M2		
Work package title	Hardware Details						
Activity type[16]	RTD						
Participant number	5						
Participant short name	GAL						
Person-months per participant	12						

Objectives

To acquire concrete supercomputer.

Description of work

The goal of this task is to ensure that appropriate hardware platform meets the requirements of the project requirements as specified in WP2.

Deliverables

Report on Hardware Details – M4

---

[16] Please indicate <u>one</u> activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Work package number	5		Start date or starting event:		M7		
Work package title	Demo Implementation						
Activity type[17]	RTD						
Participant number	1	3	4				
Participant short name	MATF	ETF	BRA				
Person-months per participant	1	4	3				

Objectives
To realize a simplified demo with a reduced set of functionalities large enough for experimenting in selected game scenario.

Description of work
The work in this work package is focused on providing system prototype with reduced functionality set when compared to the full system design. Furthermore, the work package will include the system testing and evaluation in order to produce next generation of the system.

Deliverables
Documented testing procedures and final code documented – M8

---

[17] Please indicate <u>one</u> activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Work package number	6		**Start date or starting event:**		M7		
Work package title	Testing						
Activity type[18]	RTD/DEM						
Participant number	1	2					
Participant short name	MATF	ETF					
Person-months per participant	80	30					

Objectives

To test the demo system in a number of specific scenarios, to compare experiences, to summarize the lessons learned.

Description of work

This WP includes tests definition and planning. This plan will define procedures and test cases for the technical assessment of the system in a real environment with people who have real speech problems.

Deliverables

Report on testing results – M12

---

[18] Please indicate <u>one</u> activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Work package number	7			Start date or starting event:			M6	
Work package title	Dissemination							
Activity type[19]	DEM							
Participant number	4							
Participant short name	BRA							
Person-months per participant	50							

Objectives

To constantly run a public dissemination about this project (using media like newspapers, TV and Internet). To help raise public interest and generate new companies interested in investing into the further development of this project.

Description of work

The findings in the report will be used to further improvement as an input for planning of new projects and new collaborations.

Deliverables

Dissemination plan – M7

Project promotional material – M12

2 Workshop report – M8, M11

2 Seminar report – M9, M12

---

[19]   Please indicate <u>one</u> activity per work package:
RTD = Research and technological development; DEM = Demonstration; MGT = Management of the consortium.

Summary of effort

A summary of the effort is useful for the evaluators. Please indicate in the table number of person months over the whole duration of the planned work, for each work package by each participant. Identify the work-package leader for each WP by showing the relevant person-month figure **in bold**.

Partic. no.	Partic. short name	WP0	WP1	WP2	WP3	WP4	WP5	WP6	WP7	Total person months
1	MATF	**70**	**4**				1	**80**		155
2	ETF			**19**			**4**	30		53
3	ETH		3		**35**					38
4	BRA						3		**50**	53
5	GAL					**12**				12
Total		70	7	19	35	12	8	110	50	311

Section 2: Implementation

2.1   Management structure and procedures

The project involves several partners from different countries and intends to provide support for multiple activities involving a number of researchers and students from different organizations. Therefore, coordination and management of the project are of enormous importance. The basic project management approach for the project is to have a scientific coordinator focus on the technology and to have an administrative coordinator handle the overall operational and day-to-day business. A clearly defined project management structure will be set up, including precise management processes and decision rules. This will ensure that the project meets its objectives and delivers the results in time and with high quality, using the following project management structure.

Precise milestones and delivery dates as well as the content of the deliverables are defined in a detailed project plan. Project control will be established, supported by communications tools and a central communications   platform.

A project management team including a senior project manager and a senior researcher as the scientific coordinator will lead the project, making use project management techniques of high-level. The objective of the day-to-day management is to keep the project always closely aligned with the project plan, reduce the risks associated with project activities and provide support to all partners. Individual effort for administration of the project should stay at a minimum, including the number of meetings necessary to control the project. The project operational steering board will be established to monitor the progress and direction of the project. Each partner will have one board member.

2.2   Individual participants

(1)   Faculty of Mathematics, University of Belgrade, Serbia
       Overall management, Development of Use Cases, Demo Implementation and Testing.

(2)   Faculty of Electrical Engineering, University of Belgrade
       Development of System Architecture, Demo Implementation and Testing.

(3)   Swiss Federal Institute of Technology Zurich
       Development of Use Cases and Software Details.

(4)   Braingineers
       Demo Implementation and Dissemination.

(5)   German Autolabs
       Hardware details.

2.3   Consortium as a whole

The whole consortium consists of well-known universities and companies who are well known for their work in their fields of research. The members of this consortium possess skills to find solution for every problem that is imposed by this project in their respective fields.

i) **Sub-contracting**: No external experts will be hired for work on this project.
ii) **Other countries**: No external experts will be hired for work on this project.

2.4   Resources to be committed

Mobilization of resources

The resources needed for the project activities are integrated from three academic organizations and two software development. All financial expenses are integrated into management expenses.

Travel related resources

The resources needed for travels and communication is hard to estimate precisely at this moment, but estimations are they will be worth at least 500.000€ (extra money returned, if not used).

Financial plan

The Consortium has pulled together total of 311 person-months of which 22% is allocated to management and the remaining effort to specific support activities. Budget for salaries and rewards is 2.000.000€, budget for other expenses is 700.000€. Together with traveling expenses, the total estimated budget for the project is 3.200.000€.

Section 3: Impact

3.1 Expected impacts listed in the work program

This project includes work on several fields of work: software development, AI, data management on large scales. The AIMI project will directly contribute to leadership and innovation of the industry in the area of Artificial intelligence. That will provide new areas to explore, especially among the different universities and other institutions interested in field of Artificial intelligence.

3.2   Dissemination and/or exploitation of project results, and management of intellectual property

A series of project workshops, lectures and exchanges of researchers are planned to address the need of internal dissemination. Plans for external dissemination are discussed in detail as work package 7. Additionally, a project website will be created, as well as series of publications.

Section 4: Ethical Issues

The proposed project does not directly involve any ethical, legal, social or safety issues.

Ethical Issues Table

	YES	PAGE
Informed Consent		
• Does the proposal involve children?	NO	
• Does the proposal involve patients or persons not able to give consent?	NO	
• Does the proposal involve adult healthy volunteers?	NO	
• Does the proposal involve Human Genetic Material?	NO	
• Does the proposal involve Human biological samples?	NO	
• Does the proposal involve Human data collection?	NO	
Research on Human embryo/fetus		
• Does the proposal involve Human Embryos?	NO	
• Does the proposal involve Human Fetal Tissue / Cells?	NO	
• Does the proposal involve Human Embryonic Stem Cells?	NO	
Privacy		
• Does the proposal involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	NO	
• Does the proposal involve tracking the location or observation of people?	NO	
Research on Animals		
• Does the proposal involve research on animals?	NO	
• Are those animals transgenic small laboratory animals?	NO	
• Are those animals transgenic farm animals?	NO	
• Are those animals cloned farm animals?	NO	
• Are those animals non-human primates?	NO	
Research Involving Developing Countries		
• Use of local resources (genetic, animal, plant etc.)	NO	
• Impact on local community	NO	
Dual Use		
• Research having direct military application	NO	
• Research having the potential for terrorist abuse	NO	
ICT Implants		
• Does the proposal involve clinical trials of ICT implants?	NO	
I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	