European Clearing House
for Open Robotics Development
www.echord.info

# Information for Prospective Experiment Proposers

– Distributed at the Opening Event in Munich, Sept. 4, 2009 –



SEVENTH FRAMEWORK
PROGRAMME

# 1 Background information

This document is related to the EU-funded FP7 project ECHORD (European Clearing House for Open Robotics Development, Grant Agreement Number 231143).

In the context of ECHORD, small-scale projects, the so-called experiments, will be conducted. An experiment is a small to medium sized technical project carried out by a consortium of one or more research institution or organisation and one manufacturer. For the experiment, a manufacturer will provide state-of-the-art equipment (robots, components, software, …) and will have the option to participate – but it is not compulsory. A list of suitable equipment offered by manufacturers to the research institutions and organisations, along with terms and conditions of providing this equipment, will be available on the ECHORD web site.

Approximately 50 experiments will be funded in 3 distinct *Calls for Experiments*. The first call will be issued on September 28, 2009. All calls will be posted on the ECHORD web site and be announced via the EURON mailing list. Each call will be open for 2 months. Evaluation and selection of proposals will last 2 months from the time of call closing. The proposals will be evaluated by independent experts from science and industry, ranked by an expert panel and then approved by the European Commission.

Experiments can be of three different types:

**Joint enabling technology development**. Experiment partners work together to develop new robots, components, and networks, etc. based on the bi-directional exchange of knowledge and on the industry quality equipment provided by robot manufacturers. ***Expected results***: a workable technological solution to a given problem that can be directly applied to the areas of operations of the robot manufacturers. ***Learning effects***: knowledge about the theory and practice of a certain problem solution, knowledge about the internals of the robot manufacturers' components (on the part of the academic partner). ***Competences needed***: robot specialists on both sides who share a common vocabulary and have complementary skills.

**Application development**. Robot equipment from the robot manufacturers (which may need to be modified), together with components from third parties, are combined to perform tasks in new applications. This can include standard tasks in new areas or new tasks in known areas. ***Expected results***: robust prototypical implementation of the new task/scenario with associated publications. ***Learning effects***: a basic understanding of the potential of robotics technologies, limitations and constraints of the equipment, as well as the identification of further technological challenges. ***Competences needed***: good working

knowledge of the conditions of the target area (new or classical), and roboticists who are able to work together with specialists from other domains (e.g., cognitive sciences, systems science, materials science, …).

**Feasibility demonstration**. Unlike application development, this is for demonstrating in principle that robots can be used in complex industrial settings where they have not been used before. As an example, this could be (small) SMEs that do not have enough capital (and lot sizes) to justify the use of a fixed robot for just one specific task. If, however, the robot could be easily adapted to a number of similar tasks and could easily change its location, completely new uses for such a robot may become possible. Another example would be hospital laboratory automation with mobile manipulators, where only some of the crucial tasks would be demonstrated to be performable. ***Expected results***: if crucial parts of the automation of a new domain can be shown to be realizable, this will encourage other industries to see a new market niche. ***Learning effects***: potential for improvement of the chosen approaches for the crucial tasks, needs for further developments to handle the entire complex process. ***Competences needed***: this should only be done by people who have experience in robotics technologies (on both sides). Here, it will be optimal to have industry, academic researchers, and system integrators work together.

## 1.1 Scenarios and research foci

**Three scenarios** for likely future robot use have been defined to outline the scope of research work to be performed in the experiments. These scenarios make it possible for all stakeholders to get a clear picture if and how their proposed work and envisaged results can be embedded into a coherent vision of robotic applications. Thus, they describe the application context from an exterior view. The individual scenarios are described in Section 1.2.

For breaking down the application-driven scenarios **four research foci** have been identified. The research foci guide the research work. They were chosen as to provide a complete coverage of the relevant aspects of all the scenarios. The research foci are described in section 1.3.

## 1.2 Scenarios

The set of research topics and subjects in the field of robotics is virtually unlimited. Thus, ECHORD uses a clear thematic research orientation which is reflected in **scenarios**.

Three **scenarios** have been identified which are both scientifically challenging and commercially relevant. They represent comprehensive sets of challenges in an illustrative way, so that robotics experts can easily relate their own research to them. The scenarios build on each other.

The **first scenario** of ECHORD is the **human-robot co-worker**. In this scenario, the

traditional idea of a robot performing pre-programmed action will change drastically, in that a robot co-worker interacts with a human towards achieving a common goal.

The **second scenario** is the **hyper-flexible cells scenario**. This scenario envisages not only one or more highly dexterous and cooperative robots, but also the hardware and software integration of the robots with an automatic warehouse system and the other devices present in the cell.

The **third scenario** is the **cognitive factory**. This future scenario will embrace both the first and the second scenario and take the classical concept of the flexible manufacturing systems to a new level. Cognitive factories will, to a large extent, configure themselves and be fault-tolerant. They will contain autonomous robots jointly participating in the production process with their human counterparts.

## 1.3 Research foci

Within the scenarios, different **research foci** have been identified. The research foci are reference points for the expected scientific progress of experiment proposals. They bring together mechanical design and controller technology from manufacturers with the knowledge and experience in sensing, cognition and behaviour control of the research community.

The **first research focus** is on **human-robot interfacing and safety**. Here, the main goal of the experiments is to show that safe human-robot cooperation is possible, taking all kinds of sensor failures and inconsistencies into account.

The **second research focus** is on **robot hands and complex manipulation**. Here, the experiments will have to show the improvement of laboratory setups towards practical usability as well as promising breakthroughs in the areas of sensors and sensor-guided manipulation.

The **third research focus** is on **mobile manipulators and cooperation**. Here, mobile manipulators will have to solve concrete problems in dynamically changing environments with moving obstacles and interaction with humans.

The **fourth research focus** is on **networked robots**. Here, two areas are possible: One is networked industrial robots, where the expectation is to use demonstrators that can only be built in collaboration between industry and academia, with industry providing controller architecture and academia contributing knowledge in advanced real-time networking technologies as well as service-oriented architectures. The second area concerns more loosely coupled systems, where experiments with mobile robots are expected that establish new showcases, e.g. in the area of search and rescue with robots, new applications of robots in urban areas, and robot systems for monitoring tasks.

The intended relation between scenarios and research foci is given in the following non-exhaustive table:

| Scenario / Research focus | Scenario 1: Human-robot co-worker | Scenario 2: Hyper-flexible cells | Scenario 3: Cognitive factory |
|---|---|---|---|
| Human-robot interfacing and safety | X | | |
| Robot hands and complex manipulation | X | X | |
| Mobile manipulators and cooperation | X | X | X |
| Networked robots | | X | X |

The research foci are listed in the table below, along with **examples** for possible experiments.

| Research foci | Experiments topics (examples) |
|---|---|
| *Human-robot interfacing and safety* | • Practical multi-modal (HMI) interfaces<br>• Human detection devices<br>• Speed/position supervision<br>• High-speed force control<br>• Algorithms for adaptive vision<br>• Off-line high-level programming environments with physical simulators |
| *Robot hands and complex manipulation* | • Improving hand performance through (new) lightweight materials and actuators<br>• Miniaturized mechatronics for hand designs<br>• Object recognition for grasping scenarios<br>• Theory and practice of bimanual and trimanual manipulation<br>• Simulation package integrating sensor models with soft/hard con-tact/slippage control<br>• Real-time motion planning and collision avoidance for kinematics with many DOFs |
| *Mobile manipulators and cooperation* | • Hardware/software integration of arm controllers and platform control<br>• Precise synchronised control of locomotion and manipulation<br>• Safe navigation and mapping with walking humans in the way<br>• Real-time trajectory-planning and re-planning<br>• Cooperation with humans and with fixed robots<br>• Intuitive programmability of complex interwoven tasks integrating arm and platform<br>• Robot team cooperation |

| | |
|---|---|
| *Networked Robots* | • New concepts for open controllers giving safe low-level access to actuators<br>• High-speed inter-robot communication<br>• Shared knowledge building<br>• Wireless sensors, universal-plug-and-play networks<br>• Flexible workflow simulation package allowing the integration of user-specific devices and components<br>• Tightly synchronised control of great numbers of cooperating robots and motion axes<br>• Coordination of a multi-robot system with a cell storage system and other devices<br>• Specific showcases |

# 2 Experiment proposals

## 2.1 Characteristics of an experiment

### 2.1.1 Size, resources and indicative average duration

The size, scope and internal organisation of experiments should be compatible with overall objective and manageability of the whole endeavour and can vary from research focus to research focus and from scenario to scenario.

The **expected** number of participants for each experiment is 1 to 3, with an average funding of around 300 K€.

Experiments are expected to last between 12 to 18 months.

### 2.1.2 Funding scheme

Costs for equipment from the equipment list will be funded up to 100%. The activities to be carried out in the context of an experiment are only of the type Research and Technological Development (RTD), aimed at a significant advance beyond the established state-of-the-art, including scientific coordination.

## 2.2 How to apply

### 2.2.1 Proposal focus

The work set out in the proposal must correspond to one of the ECHORD scenarios and associated research foci. Proposals that fail to do so will be regarded as ineligible. A “pre-proposal check” service is available by the ECHORD Service Centre (see ECHORD web site). Pre-Proposals can be submitted until four weeks before the call is closed. They

should not be longer than two pages and only describe the experiment idea and its context. A member of the staff of the ECHORD Service Centre will respond to pre-proposers within one week. The response will be limited to clarifying whether they fit into the ECHORD call's scope (innovation, compatibility with call).

### 2.2.2 Participation

Proposers must be established in one of the member states of the EU or in an associated country. For a list of associated countries, see ftp://ftp.cordis.europa.eu/pub/fp7/docs/third_country_agreements_en.pdf.

### 2.2.3 Proposal Model and Language

Proposals must comply with a standardised template available on the ECHORD website upon opening of the call to allow their easy conversion into a Description of Work in the event of proposal selection. Proposals can be submitted in any of the official languages of the European Union. An English translation of at least the abstract and the objectives of the proposal will facilitate the evaluation operations.

### 2.2.4 Submission

Proposals have to be submitted using the electronic proposal submission service provided by ECHORD. Full instructions will be found on the ECHORD web site on the opening of the call.

Proposals must be submitted on or before the deadline specified in the call text. It is the proposer's responsibility to ensure the timely submission of the proposal. Call deadlines are absolutely firm and will be strictly enforced.

## 2.3 Evaluation

### 2.3.1 General

On receipt by ECHORD, proposals are registered and acknowledged and their contents entered into a database to support the evaluation process. Eligibility criteria for each proposal are also checked by ECHORD before the evaluation begins. Proposals which do not fulfil these criteria will not be included in the evaluation.

A proposal will only be considered eligible if it meets all of the following conditions:

- It is received before the deadline given in the call text.
- It is complete (i.e., the proposal description has been provided in all its parts).
- The content of the proposal relates to the ECHORD Scenarios, Research Foci and Experiment Types provided in the call text.

### 2.3.2 Evaluation by independent experts

The evaluation of proposals is carried out by independent evaluators. Each proposal will be evaluated by two independent experts (evaluators). They will maintain strict confidentiality with respect to the whole evaluation process.

ECHORD ensures that the process is fair, and in line with the principles contained in the Commission's rules (for evaluation criteria, see 2.3.3 below). Experts perform evaluations on a personal basis, not as representatives of their employer, their country or any other entity.

The list of evaluators will be made public but disclosed only after the evaluation and selection of experiments.

### 2.3.3 Evaluation criteria

Similarly to what is done in the evaluation of FP7 proposals, the evaluation of experiments will be based on marks given according to three basic criteria:

a) Scientific and/or technological excellence, intended to measure the degree of innovation and the quality of the participants.

b) Efficiency of the implementation, intended to measure the appropriate allocation of budget and resources.

c) Expected impact, intended to measure the effectiveness of the technological transfer. As for this criterion, the following qualities serve as indicators:

- bi-directional know-how and technology exchange between robot manufacturers and research institutes/organizations (e.g., software at source-code level, critical component data, …),
- documented degree of synchronicity between robot manufacturers' research plans and experiment goals,
- commitment on the part of robot manufacturers for using the work in their future product program,
- potential of proposed work to contribute to new products/services/tools in a reasonable time frame,
- European dimension of the experiment, intended as potential impact of the experiment activities and results on European research, society and economy.

For each criterion, a 0-to-5 mark will be given; the experiment will be eligible for final selection if the marks are above specified thresholds. Details will be given together with the publication of the call.

## 2.4 Selection

Selection, to be conducted by an evaluation panel, will rank the experiments which are above the thresholds. The ranking will be based on the individual evaluation reports from the evaluation. The chair of the evaluation panel will be appointed by the EC. The role of the chair will be to moderate the discussion in a neutral manner. An annotated ranking of the proposals will be compiled at the end of the evaluation panel, together with evaluation summary reports. The reports and evaluation panel minutes will then be forwarded to the Commission by the Coordinator with budgetary information. The Commission will approve the final list of selected experiments.

## 2.5 Experiments implementation

The experimenters of selected proposals are proposed for accession to the ECHORD Grant Agreement by means of a request for amendment submitted by the ECHORD Coordinator to the Commission for approval. Strict deadlines will be set for compliance with the obligations related to the accession procedure (signing of B forms, legal validation, etc.). Contract amendments can only be handled by the EC after all new beneficiaries have been legally validated.

The experimenters will receive a payment from ECHORD at the beginning of the experiment to cover their equipment costs. Labour and other costs will be paid after the end of the experiment's reporting period in accordance with the provisions of the Grant Agreement.

## 2.6 Experiments monitoring

Experiments will have a specific (small) set of deliverables including regular (short) reports (typically one page), which will be evaluated against the terms of the experiment's description of work. In return for being lightweight in terms of preparatory paperwork, it is expected that every experiment produces a final demonstrator presenting the promised features. During the duration of the experiment, the experimenters are encouraged to produce multimedia material (video and pictures) showing their progress.

The mid-term and final review of experiments will be managed by the ECHORD consortium, which appoints at least two experts for reviews. The reports about these reviews will include a recommendation (continue, continue with modifications, discontinue), the EC will then make a final decision after consulting the ECHORD consortium.