## Impact Objectives

- Train a new generation of researchers on safe cognitive robot concepts for human spaces
- Use an innovative concept of project-based learning and constructivist learning in supervised peer networks

# The next generation of robots

***Dr Sven Magg** and **Professor Stefan Wermte**r discuss their work training the next generation of researchers on safe cognitive robot concepts*

*Dr Sven Magg*

*Professor Stefan Wermter*

**Can you begin by describing the main challenges the Safety Enables Cooperation in Uncertain Robotic Environments (SECURE) project is seeking to address?**

**SW:** While robots in industrial environments have been specifically designed for such spaces, robots in human spaces present a series of unique challenges. Two of the problems faced by robotic assistants in these human environments are the dynamic nature and the safe collaboration with humans in a shared space. A robotic assistant's behaviour in a domestic environment has to be robust to changes and the assistant has to be able to cooperate with humans in a shared space efficiently. However, the most important requirement is that the robot's behaviour has to be safe. This means that the robot not only has to react to situations when they happen, such as a collision with a human collaborator but should act in a way that prevents such situations to occur in the first place.

**The project is a training network (ITN) about robotics. One of the key focal points is training Early Stage Researchers (ESRs) on the most advanced humanoid robot platforms available in Europe. Why do you think this is an important objective?**

**SW:** Creating safe robot companions of the future needs expertise in a large number of fields, ranging from mechatronics and computer science to build the robot itself, up to cognitive science and psychology to address the challenges in human-robot interaction. A successful researcher has to understand the problems that have to be solved based on these fields, and the researcher needs the expertise to solve occurring problems and efficiently exploit synergies between solutions. By training researchers on the most advanced platforms, they can get insights about state-of-the-art solutions for different types of robotic assistants and also learn about the latest challenges. This will enable them to push the boundaries on the basis of the most advanced robotic solutions.

**How are you sharing the knowledge gathered in the project?**

**SM:** SECURE has a strong commitment to making the results visible to as large an audience as possible. This includes continuous publication at scientific conferences to get feedback and disseminate findings quickly within the scientific community. Publications are also made publicly available through Green Open Access to reach a wide audience. Collected data has or will also be made accessible, where appropriate. This is especially important for the projects working with neural networks where large amounts of data are needed to train the networks to improve the results. By publishing the data, the community can benefit from a larger variety of data for training and thus more robust models.

**Do you have upcoming dissemination activities where you will be sharing knowledge with researchers in the same field?**

**SM:** Currently, many papers are under review or have been accepted and will be presented soon. In 2018, there will be a joint PhD conference between the two ITNs SECURE and SOCRATES, especially targeting young researchers, to bring together people from different disciplines early in their careers to facilitate interdisciplinary discussions and collaborations. Both projects are highly interdisciplinary and share the focus on human-robot interaction and the same goal of creating better social robot companions.

"Care-O-bot 4" (c) by Fraunhofer IPA

# Securing the future of robotic humanoids

***The Safety Enables Cooperation in Uncertain Robotic Environments (SECURE)** project's success will usher in a new generation of researchers overcoming the challenges associated with robotic assistants integrated into human environments*

According to the London Science Museum, the history of robots stretches back some 500 years. Since then, technological breakthroughs have meant that rather than belonging to the realms of science fiction, robotic assistants now are beginning to become an integral part of our lives. For years, industries have incorporated robots into their manufacturing lines, more often than not to perform repetitive tasks. Over time, such robots have been refined further and further until the environments in which these robots operate are perfectly suited to their safe operation.

Innovative movements, such as Machine Learning, Neural Networks and the 'Internet of Things', have given rise to the first adaptive robotic assistants. Toys, kitchen appliances, lawn mowers and vacuum cleaners make use of robotics, and it is now likely that soon - for some tasks - robotic assistants could become companions in our home. The challenge is that the domestic environments which are designed for humans are still often unsuitable for robotic assistants.

## ENABLING HOLISTIC COOPERATION IN THREE MAIN WAYS

To address these challenges, the Safety Enables Cooperation in Uncertain Robotic Environments (SECURE) project has been established. This highly interdisciplinary four-year project is a training network that focuses its attention on educating the next generation of researchers in a way that ensures the safety of humans and robots in the home. In the future, novel cognitive robot companions will be developed, from service robots to humanoid robots, which are able to learn from their human counterparts and adapt to the conditions in which they find themselves and dynamic contexts.

Dr Sven Magg and Professor Stefan Wermter manage and coordinate the project SECURE which addresses the safety challenges and considerations associated with humanoid robot platforms. These platforms can be thought of as robots that mimic the human form, in that they have a head, two arms and two legs. As home environments are specifically designed for human habitation, making robot platforms for human spaces instantly lends a quality of suitability to them, in terms of dimensions and space. In addition, there is a familiarity between humans and humanoid robot platforms precisely because behaviour patterns can be related. This, in turn, facilitates social cues to enable a more natural interaction.

SECURE has been established in such a way that the challenges of uncertain robotic environments can be addressed holistically. This will be achieved at three specific levels. Firstly, on the level of safe hardware and its movement control; second, on the level of efficient knowledge extraction in the current situation; and third, on the level of human-robot interaction, which takes social cues into account to shape the behaviour of the robotic assistants and enables natural communication with humans. By combining these three levels, robots will be able to act safely, and interact more naturally with humans to avoid misunderstandings and thus undesired situations.

## CONCEPTS TO MATCH TECHNOLOGY

Given that the focus of the project is on future innovations in robotic technology, it is fitting that the team involved in SECURE have approached the project with innovative concepts in mind. One is the structured approach to the highly interdisciplinary fields involved in the project. 'The SECURE project brings together partners from a variety of relevant research fields and industry, which creates the optimal training ground for the Early Stage Researchers (ESRs), but also brings leading academic and industrial players in Europe closer together, fostering interdisciplinary collaboration,' explains Wermter. 'The high involvement of industrial partners, ranging from global players like KUKA Robotics, Honda Research Labs Europe and Softbank Robotics, to small enterprises like Cyberbotics, helps to focus the research on current problems that need to be solved to introduce robot companions into the market.'

> *"One of the most interesting aspects so far has been to learn about the different approaches to address the overall common goal of improving safety"*

By pooling resources and ideas from different disciplines, both the academic fellows and the SECURE team members can find a variety of synergistic approaches that will lead to more efficient solutions, in addition to informing future research in Europe. In combining the three holistic approaches, it is hoped that the algorithms developed will address a wider range of problems and integrate methods that have been developed independently before.

Another innovative concept is that the SECURE team will use the project's peer network to teach processes of the scientific community by replicating them within exercises utilising this smaller community. This will then enable the researchers to practically experience the concepts before using them beyond the SECURE network.

## NEXT RESEARCH GENERATION

However, perhaps the most important aspect of the project is its focus on training ESRs who, even though the project is only in its second year, have already learned a significant amount. 'One of the most interesting aspects so far has been to learn about the different approaches to address the overall common goal of improving safety,' observes Magg. 'Learning about the challenges from, for example, control theory and motor control, helped to understand the complexity of the problem from the view of a fellow from psychological neuroscience.'

In addition, giving ESRs the opportunity to see how certain robot design decisions affect the behaviour of the humans working with it, such as the trust a human might develop towards a robotic assistant, enables them to think more carefully about their solutions. They are able to consider the problems on a different scale than they might in other circumstances. Ultimately, this will shape the way the ESRs evaluate the challenges they face in the future and approach them from different viewpoints. In this way, collaboration is shown to be an intrinsic aspect of the project's success.

## THE NEXT ERA

While developing robotic assistants that are safe is important to the wide variety of industries involved in creating them; there are wider societal benefits that will be brought about by the completion of the project. 'Users cannot always easily understand what led to certain behaviour of the robot companion in a given situation and the interaction, which would resolve such issues between humans, is still challenging for robots,' says Wermter. 'By creating robot companions that are safe and can interact in a way we are used to, we are making it easier to predict and understand their behaviour.

The importance of this last point cannot be emphasised enough. It is one thing to develop robotic companions for human spaces in the future, but it is entirely another to secure an acceptance of this concept. If the SECURE project proves to be a success, the progress towards accepting robot companions in human spaces and establishing what is necessary for safe interaction will be advanced, preparing the grounds for the introduction of safe robot companions into an accepting market.

## Project Insights


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SECURE
Safety Enables Cooperation in Uncertain Robotic Environments

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