Whether at hospitals, at factories or on the roads, the points of contact between humans and machines are ever more frequent. Effective communication is vital to avoid misunderstandings with serious consequences.

Understanding Each Other

Technical systems are performing more and more tasks autonomously. But cooperation with humans will always be necessary. Computer scientist Susanne Boll and sociologist Gesa Lindemann are therefore researching how people and machines can communicate with each other

Humans talking to machines is nothing really new. When we call the hotline of a phone company we generally end up talking to an automated answering system first. For many, the question-and-answer game with robots like the iPhone's virtual assistant Siri has become routine. But the discussion about autonomous cars has given the topic of communication between man and machine new impetus. Technical systems in general are becoming more intelligent and even making their own decisions: warehouse systems, for instance, can now automatically place orders for spare parts when supplies are running short. But no matter how independent the technology becomes – humans will remain an integral part of the equation. The future interaction of humans and machines is the subject of interdisciplinary research at Oldenburg in which computer science, psychology, philosophy, jurisprudence and social science all intersect. Computer scientist Prof. Dr. Susanne Boll and sociologist

Prof. Dr. Gesa Lindemann of the University of Oldenburg are focusing on how to harmonize communication between humans and machines.

Not human error

Computer scientist Susanne Boll is studying how to make this interaction as smooth as possible; how humans and machines can learn to work together as a team. This is by no means always the case, and misunderstandings can cause damage and even lead to disasters. “People often talk of human failure when this happens,” says Boll. “Humans are seen as the error in the system. I see it differently: basically it’s the system that has failed because it didn’t cooperate properly with humans.” When there is an emergency in an intensive care unit and all kinds of devices and warning lights start blinking and beeping, it can be extremely difficult for the doctor to correctly assess the situation. This can lead to mistakes. “It’s therefore particularly crucial in communication between humans and machines that the transfer of control goes smoothly,” Boll explains. “This can succeed if the technical system explains what it is doing in a way that is immediately comprehensible to the human in a given situation.” A sliding door doesn’t need to announce that it is about to open. An autonomous vehicle, on the other hand, should inform the driver well in advance that there are road works 500 metres ahead where the person will need to take back control of the vehicle.

A human model

Whether such a message gets across will depend among other things on what state the person is in at that moment. Susanne Boll and her colleagues are therefore trying to develop a form of human model that can help autonomous systems to determine what frame of mind a person is in and how to respond accordingly. If a person is extremely irritated by the voice commands of the on-board computer, it doesn’t make sense for it to keep trying to communicate in that way. The system could switch to clear optical signals instead. Boll is investigating which sensory channels are best suited for conveying information in different situations. The scientists also hope that the human model will teach vehicles and other autonomous systems to assess the chances of a human understanding a message in a given situation – in order to avoid misunderstandings. Boll is working closely with psychologists to develop this model.

Once an autonomous system has determined a person’s mental state, it needs to find the right way to communicate with them. With cars in particular, two aspects need to be taken into account: task engagement, in other words how engaged a person is in an activity, and task duration, i.e. how long the driver has been engaged in a side-line activity. “Both have a strong influence on the driver’s state,” Boll explains. “A scientific rule of thumb is emerging that it takes around seven seconds before a person is ready to switch from autopilot to taking the wheel. In our view that interval varies considerably depending on state of mind and situation.” Consequently, she wants to study the length of these intervals more closely – and which sensory channels the computer should use to communicate with the driver, depending on the situation.

Correctly packaging the information

Another interesting question concerns the information that the system should pass on to the human when handing over control. Should it simply instruct the person to take the wheel? Or would it be better to announce that there are road works 500 metres ahead at the same time? Or would it perhaps make even more sense to tell the person what direction to drive in once he or she has taken the wheel – to make it easier to merge with the traffic ahead of the road works, for example. To this end Boll’s co-workers have developed a steering wheel with an arrow that lights up and points left or right. Task engagement and task duration also determine whether a person will respond better to acoustic or optical signals, or other types of signal like vibrations.

Orientation for emergency medics

Cars and the correct transfer of control from autopilot to human is just one of many aspects Susanne Boll’s working group is researching. Another field of research is the hospital environment, where the requirements for communication can be very different. Here the researchers are working on a system that provides doctors with swift guidance when an emergency occurs and the medical technical equipment starts blinking and beeping. The idea is for the system to analyse the current data and extract the relevant information so that the doctor is informed about the patient’s condition. The information can then for example be fed into a pair of Augmented Reality Glasses (AR Glasses). “In this way the doctor is shown the relevant information while he is on his way to the patient’s room,” says Boll. It would also be conceivable that a symbol appears on the AR glasses showing which body part is affected. “This sort of aggregated picture of the overall situation that points the doctor to the relevant part of the body could be a great help when things get stressful,” she adds.

Discussions with machines?

At the heart of automated technology are cyber-physical systems , the control systems that are built into the devices. The term refers to the merging of artificial intelligence and the real world. At the University of Oldenburg and among experts in the field everywhere, there is a discussion about the extent to which humans will be able to conduct genuine dialogue with such systems in the future. It is conceivable that at some point we will be able to debate with intelligent navigation systems about why they selected a certain route. The question is when and whether such a dialogue is desirable. Sociologist Gesa Lindemann wants to find out how dialogue between humans and increasingly intelligent cyber-physical systems could influence the way we communicate, and is working with IT experts at the University to do this. “The interesting thing about communication between two people is that the meaning of the communication develops during the dialogue,” says the scientist. “A question like: ‚Do you know what time it is?‘ could elicit the response: ‚Yes, I’m nearly ready!‘ for example. So the conversation moves to a new level. The meaning of the dialogue develops in a particular direction.”

Social researchers call this “indexical communication”, where the meaning of a dialogue depends on the context in which it takes place. The opposite of this today is technical communication, which follows clear rules and predefined patterns. “We call this mathematized communication,” says Gesa Lindemann. “For us social scientists the question is how communication as a whole will change as people start communicating more and more with intelligent technical systems, even though indexical communication is inherent to humans.” Lindemann considers it important that such aspects are taken into account in the development of communicative technical systems.

While humans are generally good at interpreting the intention of their dialogue partners, it is not possible to know why a technical system gives a certain response to a certain question. “When I ask Google a question, I don’t know where the answer comes from or what data it is based on,” says Lindemann. “The system might give a particular answer because it knows my preferences or has gathered other information about me,” she explains. “This can be an advantage, but it also touches on key human aspects like dignity or my right not to have a machine or an algorithm know everything about me.”

Machines that “read the air“

From their research Lindemann and her colleagues know that communication with machines is handled or experienced very differently from one culture to another – for example in the way people deal with service robots. “In Japan people expect machines to be smoothly integrated into daily life, to be invisible, as it were – they don’t want to communicate with the device,” says Lindemann. She notes that the Japanese have a saying that a person can “read the air”, which means that they can perceive a mood and adapt to it to create a harmonious work environment. The Japanese expect the same of an intelligent machine like a service robot. “A machine that requires a dialogue is therefore basically an affront,” says Lindemann. In Germany the situation is completely different. There, she explains, people consider conducting a dialogue with a machine – or even a discussion in times to come – to be useful. “I see it as crucial that the developers of intelligent and communication-enabled technical systems are aware that their culture defines them – and develop the technology accordingly.” Gesa Lindemann talks here of a “reflexive loop” that needs to be taken into account in the design process. Developers need to be aware of which ideas about communication they are using as a basis to design a system – and critically review those ideas, she says. And Susanne Boll adds: “In this process we are pursuing the common goal of designing technology that enables humans and machines to really understand each other better in future.” (ts)

Computer scientist Susanne Boll is researching ways to improve communication between humans and machines. To this end she also works with experts from other disciplines, including social scientist Gesa Lindemann.