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User-friendly robots

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Human interaction with robots could be made safer and more productive with technology that varies the stiffness of robot arms.

Variable stiffness actuator technology, which is being developed under an EU-funded umbrella project called [Phriends](#) (Physical Human-Robot Interaction: Dependability and Safety), takes its inspiration from the opposing movement of mammalian muscles to create movement in limbs.

The technology achieves simultaneous control of a robot arm by forcing two motors to work antagonistically in a way that manipulates a non-linear spring. This acts as an elastic transmission between each of the motors of the moving part, allowing the arm to stiffen and soften.

Antonio Bicchi of the [University of Pisa's](#) Faculty of Engineering said that with the correct control, robots could replicate human behaviour.

'When we interact with something fragile or another person we tend to be very compliant and soft,' he said. 'When we do something requiring more force and accuracy we stiffen ourselves.'

Bicchi said his research group believes there are still many applications where robots are not economically exploited because, for safety reasons, it is necessary to keep them separate from humans. 'If a robot could work closely and interact with a human, then the human could touch it while it moves and be close without being in any danger,' he said.

Robots are most dangerous to humans when they are moving fast, said Bicchi, so the variable stiffness actuator softens the arm at high speeds. Similarly, when they are moving slowly, the actuator makes the arm stiffer.

'The technical trick,' he said, 'is decoupling the motors from the moving machine when at high speeds.'

Bicchi said any machine could be safe, even without variable compliance, if it were slow enough. 'However, a slow-moving machine would have poorer performance,' he said. 'And there shouldn't be a trade-off between performance and safety.'

There are currently robots equipped with special sensors to help them avoid collisions with humans. However, Bicchi said these systems rely on hardware and software that could at times fail. 'We want robots to be intrinsically safe,' he said.

The Phriends project has already received industry interest. project partner, Germany's Kuka Robotics, will release a new robot arm, which incorporates some features

developed by Phriends later this year.

Bicchi predicts that industrial robot arms that integrate full variable compliance are still four or five years away.

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