

Controlling Moving and Shaking for Better Space Travel and Horse Training

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SUMMARY

Movement affects performance, whether it is a spacecraft, a robotic arm or even a horse. That is why Dr David McKeown at UCD School of Mechanical and Materials Engineering is developing new ways to monitor movement and, in some cases, make adjustments on the fly to improve performance.

Dr McKeown's research will help to improve the design of next generation rockets so they can carry payloads safely and more economically into space. His work is also supporting the first Irish satellite, robotic arm development for future Mars missions and even how to detect future lameness in high performance horses.

Analysing the Movers and Shakers

When rockets travel to space they are generally launched skywards into Earth's orbit or beyond, thrust and boosted by powerful engines. But there are more subtle movements in the rocket too that can affect the performance and even the cost of sending the craft to its destination.

“Rockets tend to be long and bendy, and when you launch a rocket, the force applied to the structure makes it shake, it pings much like a tuning fork,” explains Dr McKeown. “In addition, the fuel onboard sloshes around, which can throw the rocket off its course and make it harder to control.”

To help improve rocket design and operation, Dr McKeown is working with the European Space Agency's (ESA) Future Launcher Preparatory Programme, and his focus is rocket dynamics and control. He and colleagues at UCD are developing new technology to monitor the shaking and sloshing, and adjust the orientation of the engines to correct for unwanted movement and keep the rockets on course.

Dr McKeown is applying his expertise in control systems to Ireland's first satellite, EIRSAT-1, currently in development at UCD. At the same time to a developmental robot arm design for use in instrument deployment on Mars.

Closer to ground-level, Dr McKeown is studying the movement of horses, in particular the biomechanics of how they walk, in a bid to capture measurements about the future risk of lameness in high-performance animals.



Rockets on course

Through his work with ESA, Dr McKeown is developing a toolbox of **software that will make it easier for ESA engineers to test out control systems for various rockets.** “The software we are building automates the design of control systems for rockets,” he explains.

When rockets can be more easily controlled through intelligently re-orienting their engines to keep them from wobbling, **this will allow rockets to be made from lighter materials**, which will in turn bring down the cost of rocket manufacture. It will also **open up more potential for bringing larger payloads to space, or achieving higher orbits.** “Having better control of the rockets will give rocket designers more flexibility so that rockets can carry more supplies and experiments into space,” explains Dr McKeown. “It will also mean we can reduce the mass of the rocket structure, and that means you can go further using less fuel.”

To date the project with ESA’s Fly Your Satellite! initiative has resulted in several UCD researchers receiving valuable training and experience with the European space programme, and Dr McKeown believes this will help to build the capacity for more space-related research in Ireland.

He is also involved in one of the current space-related activities in Ireland: working with UCD School of Physics and industry on EIRSAT-1, which is due for launch into space in 2020. Dr McKeown’s lab is working on the de-tumbling and pointing algorithms that will allow the satellite to function effectively in orbit.

“The **EIRSAT-1 satellite will be released into space** from the International Space Station, and it needs to stop tumbling and spinning in orbit before we can communicate with the satellite from the ground,” he explains. “We are also enabling the satellite to point towards specific regions of space, so that a detector on board can capture information about events signalled by gamma-ray bursts from distant galaxies. Without that orientation of the satellite, the detector would not be as effective.”

Robot Arms and Horses’ Legs

While EIRSAT-1 will be keeping in Earth’s orbit, other spacecraft are destined for Mars, and technology enabled by Dr McKeown’s expertise in control and dynamics is **being used in the designs required for future Martian exploration.** He has been working with Italian aerospace company SELEX ES to help inform the working of the robotic arm design as part of ESA’s Mars Robotic Exploration Preparation (MREP) Programme. “The robot arm is light and long, and my research helps ensure that it moves smoothly, which will mean it can pick items up more accurately,” explains Dr McKeown.

His work on another type of limb could also **help in the management of high-performance horses**, such as racehorses and showjumpers. Along with UCD colleagues Dr Denise McGrath and Sonja Egan, Dr McKeown is using sensors to analyse the gait of horses and develop a system

to predict their risk of future lameness. “If you can predict early that a horse has an indication of lameness then you can factor in rest and not overtrain them,” he explains. “What we are developing is an objective measurement to feed into that prediction – this can be used by trainers in making the call about an individual horse, using hard data about the animal’s movement.”

Engaging Wide Audiences

As well as his research in control dynamics, Dr McKeown has created an impact through his work on events, outreach and communication. He is a co-founder of the successful annual Dublin Maker event, which attracts thousands of visitors each year to learn about maker culture, he is the co-ordinator of Science Hack Day, an annual event where people spend a weekend creating inventions and he has given several public talks, including Ignite, TEDx and Bright Club.

His research and outreach is **frequently featured in Irish media**, including several articles in The Irish Times, The Irish Independent and Silicon Republic, and he featured in the Science Apprentice book series for children. Dr McKeown is a commenter on a wide range of television programmes, including RTE Swipe TV for children and news broadcasts, and he is a frequent guest on live panel discussions.



References

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