

# Forging the Future of Total Motion Control

HarmonicDrive® comes in many variations that is used in such applications as multi-axis articulated robots and other industrial robots; medical equipment; optical measuring equipment; communications equipment; and printing equipment—as well as in such scientifically and technologically advanced fields as deep-sea robotics and outer space development.

Technological innovation contributes to the progress and development of industry and modern civilization, and it is our technical expertise that helps make such innovation possible. In addition to the uniquely constructed HarmonicDrive® itself, we also manufacture such peripheral equipment as AC and DC servo motors and drivers; intelligent hollow-shaft actuators; optical scanners and drivers; and linear actuators.

Indeed, the key that will unlock the future potential of 21st-century technology is total motion control, the very goal that Harmonic Drive Systems Inc. is working to achieve.



Our HarmonicDrive® technology has continued to evolve since its inception. Compared with the R-series HarmonicDrive® of 1981, today's CSF, CSG series is only three-fifths as tall, but capable of twice the power transmission. The latest of CSD series is only one-third as tall as the R series, but still maintain a high level of torque and positioning accuracy.

## ● Humanoid Robot (ASIMO)

HarmonicDrive® products are used in robotic arms and legs. Next-generation robots seem destined to achieve functionality that is nearly human.



Photo courtesy of Honda Motor Co., Ltd



## ● Solar Air-Conditioning Systems

Incorporating HarmonicDrive® products, this system aligns its mirrored panels with the movement of the sun to maximize the collection of solar energy.



## ● Subaru: A large Optical-Infrared Telescope installed on Mt. Mauna Kea in Hawaii

A total of 264 actuators which use HarmonicDrive® and AccuDrive® in combination are built into the structure of the telescope's mirror section so that the surface imperfections of the main mirror (which is 8.2 meters in effective diameter) can be kept within a tolerance of 0.1 μm. Subaru is probing deep space 15 billion light years from earth in an effort to unlock the secrets of the origin of the universe.

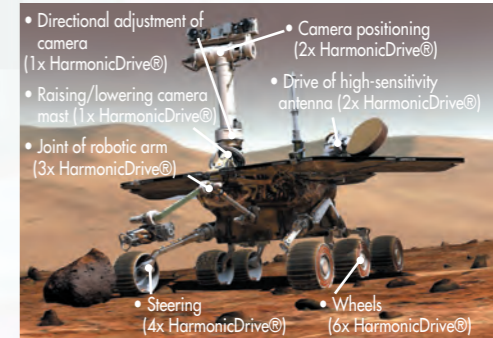
Photo courtesy of the National Astronomical Observatory of Japan, National Institutes of Natural Sciences



## ● Navigation System

Airbus (a merger of French, German and Spanish interests in the EADS Group and BAE Systems of Great Britain) uses HarmonicDrive® products in the navigation systems of its aircraft to help ensure flight safety (inertial navigation systems).

Photo courtesy of Airbus S.A.S.



## ● Mars Rover

Each of humanity's first Mars exploration vehicles, Opportunity and Spirit, contains 19 HarmonicDrive® actuators. They play a crucial role in the vanguard of space science, which has captured the imagination of the entire world.

Rover image created by Dan Maas, copyrighted to Cornell and provided courtesy of NASA/JPL-Caltech.



## ● Neurosurgical Operation System

Various HarmonicDrive® products are used for surgical instruments to ensure an outstanding movement tolerance.

Photo courtesy of Carl Zeiss



## ● Semiconductor Wafer Transport Robot

AccuDrive® speed reducers are employed to operate semiconductor wafer transport robots in clean rooms because of the many advantages they offer, including compact configuration, high precision, high rigidity, smooth movement, and long service life.

Photo courtesy of Daihen Corporation



## ● Satellites

HarmonicDrive® products are also in great demand for use in solar array drives on satellites to ensure accurate positioning and attitude control. A great deal of effort has been put into developing the materials and construction of HarmonicDrive® products used in spacecraft so that they provide a long service life under extremely harsh conditions.

Photo courtesy of the Japan Aerospace Exploration Agency (JAXA)



## ● Directed Excavation System for the Oil and Gas Industry

HarmonicDrive® products are used in steering systems of underground drilling equipment to help ensure accurate hole placement and drilling speed. These systems make it possible to accurately thread through boulders and other obstacles found in oil and gas fields, thereby improving well productivity.

Photo courtesy of Halliburton/Sperry Drilling Services



## ● UT/HDS HAND

Equipped with an ultra-high-speed motion sensor, this robotic hand can catch a ball falling at a speed of 4m/s in less than 0.01 of a second (faster than the human eye can see). Every joint of the device is fitted with HarmonicDrive® actuators.

Photo courtesy of the University of Tokyo Graduate School Ishikawa and Namiki Laboratory

## Innovation Supported by Total Motion Control