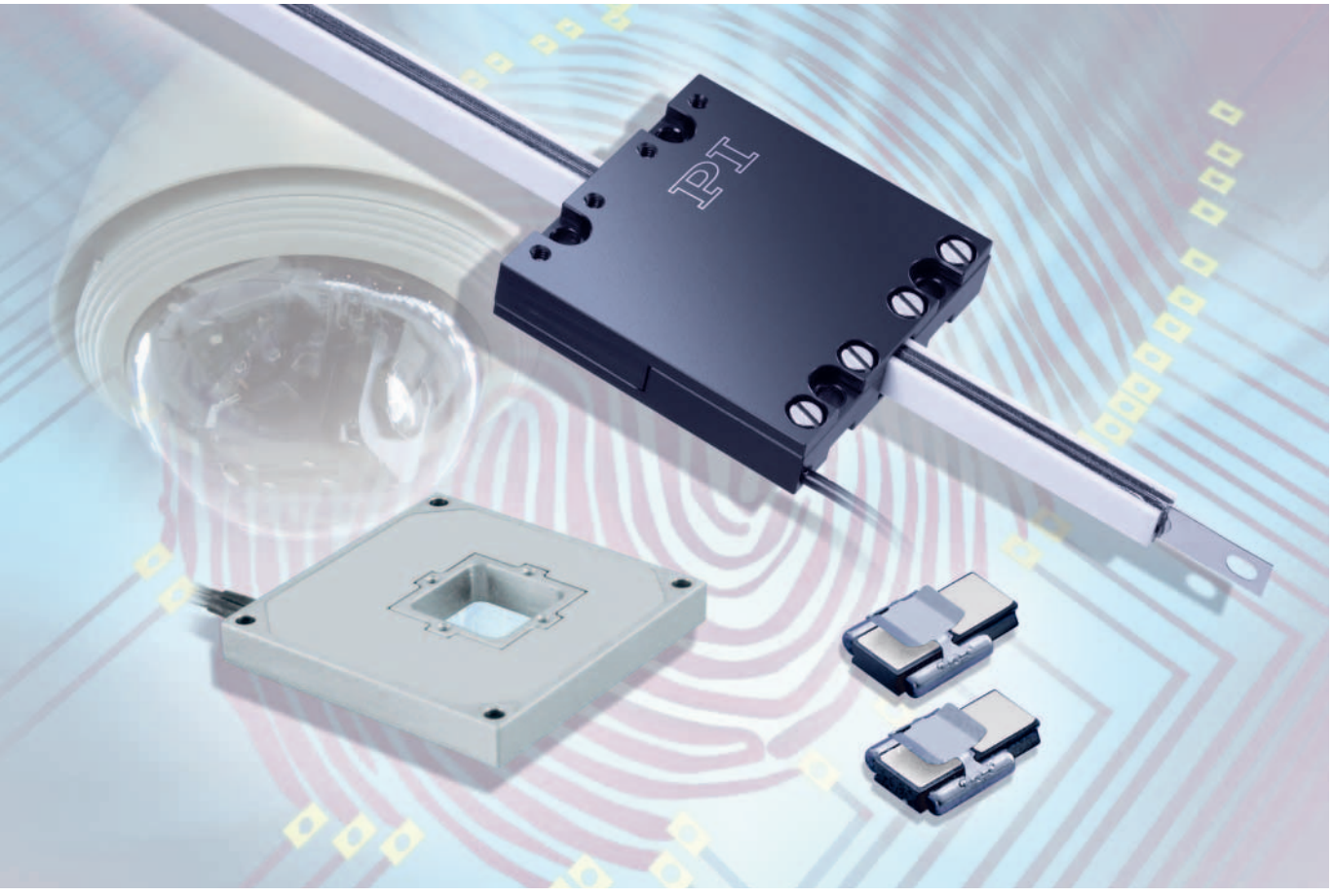
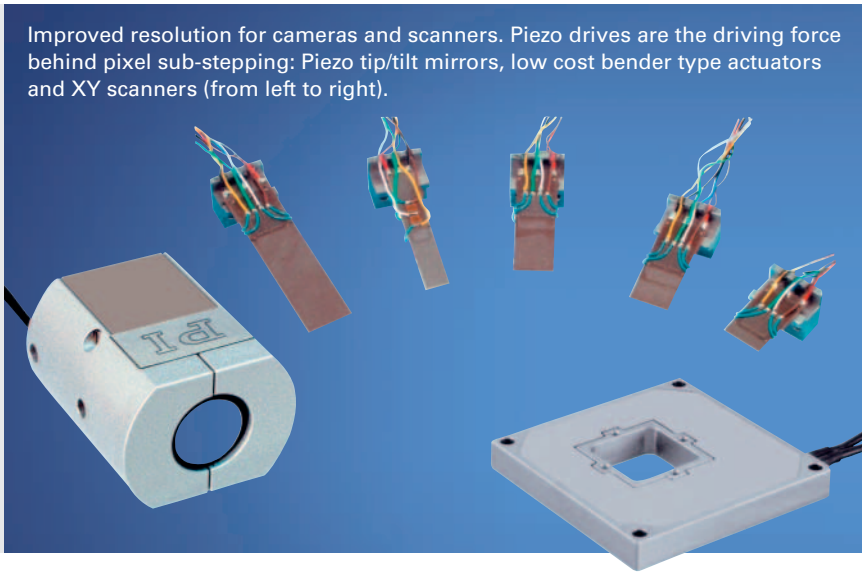
Piezo P`^kkbop)Ĥ J lqlop)ĤActuators for Pixel Sub-Stepping



Increasing the Resolution of Sensor Chips

Increasing the Resolution of Sensor Chips

Applications of Pixel Sub-Stepping



Improved resolution for cameras and scanners. Piezo drives are the driving force behind pixel sub-stepping: Piezo tip/tilt mirrors, low cost bender type actuators and XY scanners (from left to right).

Super-Resolution with Pixel Sub-Stepping

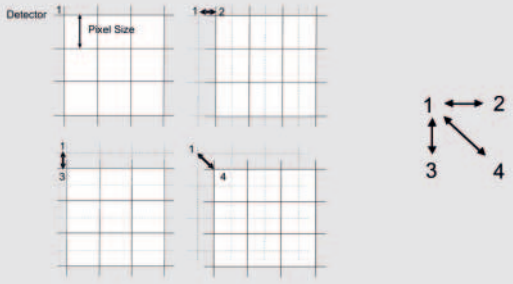
With so-called pixel sub-stepping, the recording area is moved on predefined paths with a defined frequency. This "dithering", where the travel is less than the size of a pixel, causes the pixel to be exposed several times on the recording area, producing a virtual "pixel multiplier" which can significantly improve the resolution. The rest is data processing. The various images produced in this way are subsequently "superimposed" to form the final, high-resolution image, a process also known as "super resolution".

Optical Resolution in Imaging Applications

Camera systems and scanners must have high resolutions. This creates difficulties for all applications where low light intensity means neither the resolution of the chip nor the exposure time for changing or moving objects can be freely chosen. Typical applications are fluorescence microscopy, white-light interferometry (OCT in medical technology or general surface structural analysis), or surveillance cameras and cameras for aerial photography. Further fields of application are scanners used to digitize data, e.g. for plans, technical drawings etc. Pixel sub-stepping makes it possible to significantly improve the resolution with relatively little effort.

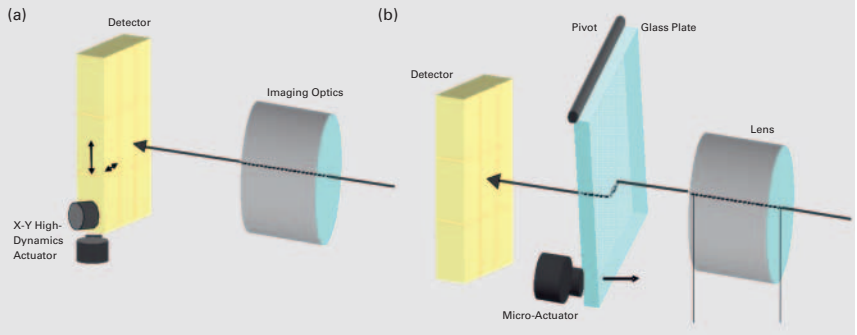
Restrictions with High-Resolution Chips

The resolution of digital recording methods is determined by the number of imaging pixels of a CCD or CMOS chip, for example. If one wishes to increase the resolution, the number of imaging pixels must be increased. There are basically two ways of doing this, both of which are relatively expensive and require a lot of effort: Either one increases the size of the recording chip or one decreases the size of the pixel. The first case requires a larger recording device and also different imaging optics. In the second case, the light sensitivity decreases with the pixel size. This reduces the separation between image signal and noise signal which, in the end, may even decrease the image quality in spite of the higher resolution.



Moving the detector chip by half a pixel width in the horizontal, vertical and diagonal directions produces 4 different images which can be computed back to an image with increased resolution.

Schematic diagram for moving a sensor chip (a) or the imaging beam onto the sensor (b).



Piezo Scanner

Novel Drive Technologies Put to Good Use

Piezo Scanner for Pixel Sub-Stepping

Since this method uses motion, a drive is required which meets all the performance criteria necessary for this motion. The drives can differ, depending upon the application, but they have crucial features in common: The motion of the sensor chips must be reproducible in two dimensions with sufficient linearity. The travel is of the order of the pixel size, i.e. a few tens of micrometers or even less.

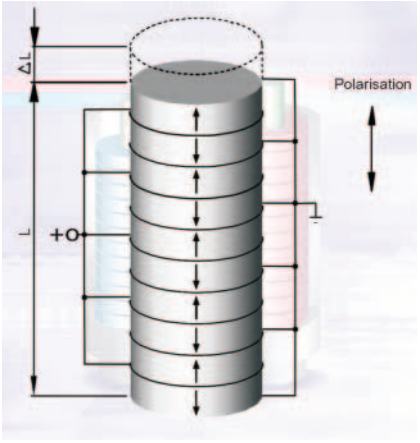
The dynamics required range from a few hertz for still images up to the kilohertz range for video recordings. The basic requirement for high-resolution biometric CCD/CMOS scanners used to identify persons by their fingerprints is a scanning frequency of between 1 and 5 Hz at a response time of less than 1 ms, for example. The travel for the drives is between 5 µm and 15 µm with a precision of better than 0.5 µm. The drive solution must occupy the smallest possible mounting space.

Low cost XY piezo scanner for increasing the resolution of optical sensors.

Piezo Actuators: Fast, Reliable and Easy to Integrate

Piezo actuators convert electrical energy directly into mechanical energy and vice versa. Travel ranges of up to one millimeter or so can typically be achieved with resolutions down to the nanometer range, and high dynamics with scanning frequencies of up to several kilohertz are also achievable. The motion is based on crystalline effects and there are consequently no rotating parts or friction; piezo actuators are therefore maintenance-free and non-wearing and because no lubrication is required, they are vacuum compatible. They can move large loads and have a very compact design. They can therefore even be retrofitted. It is possible, for example, to fit high-quality specialist cameras with a digital add-on operating on the pixel sub-stepping principle and to then benefit from the virtually increased resolution.

The inverse piezoelectric effect: Piezoceramic discs expand when an electric field is applied, causing the actuator to move.




Aerial photograph of a building (PI Ceramic in Lederhose /Thuringia): Improved resolution allows better recognition of details.

PI – A Company Introduces Itself

Inspiration from the Market Leader for Piezo-Ceramic Drives

PI Head Office in Karlsruhe/Germany

Competitive Advantages thanks to New Drive Technologies

Nothing is as safe as the use of tried-and-tested technology. If a manufacturing company knows which improvements to a product are necessary to satisfy the market requirements, however, then innovative thinking secures the competitive edge. Small fast scanners based on piezo technology make it possible to increase the resolution of CCD or CMOS sensor chips. The technology behind this is "pixel sub-stepping", where rapid movement of the sensor produces virtual images which can be superimposed to give a higher-resolution image.

Secure Your Competitive Edge with the Market Leader

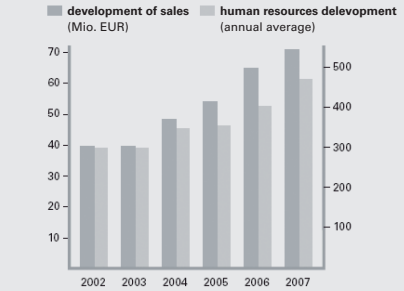
Physik Instrumente (PI) is the market leader for piezo-ceramic drive technology, which is used mainly for high-precision positioning tasks, for example in quality assurance or the semiconductor industry. The latter, in particular, places extremely high demands on reliability: The stoppage of a production unit can cost the chip manufacturer hundreds of thousands of dollars and cannot be tolerated.

PI: Competence in the Piezo Business

Physik Instrumente was founded in 1969 and specialized in high-precision positioning systems with piezo-ceramic drives at a very early stage. In 1992, the subsidiary company PICeramic was founded as the development and production facility for piezo drives. PI is therefore the only manufacturer of positioning systems in the world to develop and produce its own ceramics. This secures a great technological and production depth for PI, enabling it to react flexibly to customer requirements and to develop new drive systems for existing markets.

Integration Capabilities

PI not only manufactures the drives but also integrates them into mechanical motion systems. Moreover, PI also develops the controller and, if applicable, the regulation system to suit the requirements of the complete system.



Physik Instrumente (PI) GmbH & Co. KG

Auf der Römerstrasse 1
D-76228 Karlsruhe

Tel. +49 721 4846-0
Fax +49 721 4846-100
info@pi.ws
www.pi.ws

PI Ceramic GmbH

Lindenstrasse
D-07589 Lederhose

Tel. +49 36604 882-0
Fax +49 36604 882-25
info@piceramic.de
www.piceramic.de