Piezo Ceramic Motors Improve Phone Camera Auto Focus and Zoom

Tiny motor offers ten times better precision and five times greater power efficiency than electromagnetic motors.

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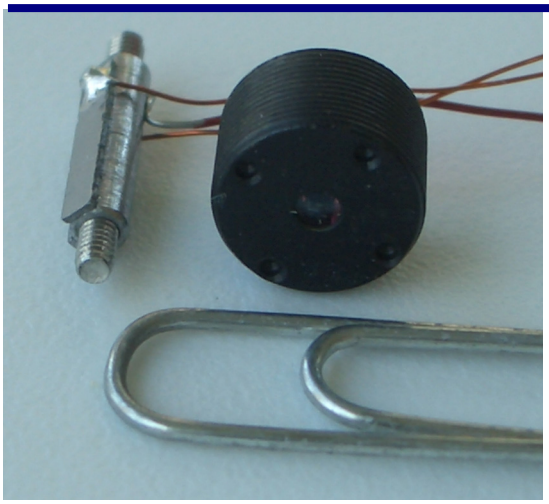


A tiny SQUIGGLE motor (4 mm diameter) is shown next to a phone camera lens. The patented piezoelectric motor uses ultrasonic vibrations in a threaded nut to directly rotate a mating screw, producing precise linear motion.

| May 16, 2005 | The market for mobile phone cameras has exploded in the past few years. More than 300 million mobile phone cameras will be produced in 2005, according to *Future Image's* 2005 Mobile Imaging Report. By the year 2007, that number is expected to grow to more than 500 million.

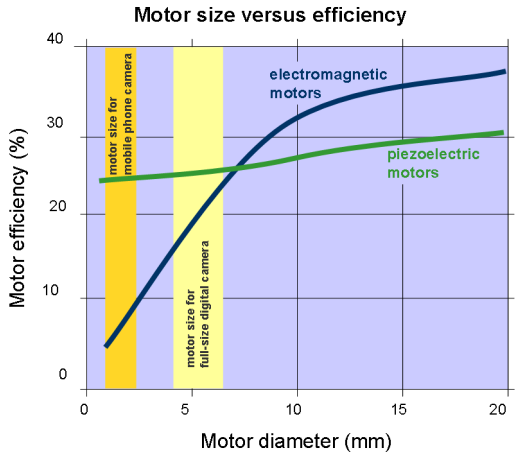
Today, nearly all mobile phone cameras have fixed optics, and produce mediocre pictures. But the industry is racing to improve image quality. Motorized auto focus (AF) and optical zoom (OZ) are proven solutions for making better pictures. It is projected that by the year 2007, 20% of phone cameras will include AF and OZ features.

New miniature motor technology is needed to achieve this ambitious growth.

Electromechanical motors reach their limit

Today's digital cameras use electromagnetic motors for AF and OZ lens motion. Examples include rotary stepping and DC motors. These motors are a mature technology with more 150 years of continuous development.

Electromagnetic motors contain hundreds of parts, including iron cores, copper windings and permanent magnets. Miniature stepper and DC motors are marvels of precision engineering, and millions are produced at small size and low cost. Unfortunately, they have reached their limits in terms of miniaturization. Phone camera designers need motors that are four times smaller than traditional technology can deliver.



Piezoelectric motors are scalable – Unlike electromagnetic motors, SQUIGGLE motors retain their efficiency as size decreases.

Another limitation of electromagnetic motors is that they become less efficient at smaller sizes. This is because more and more of the electrical drive power is converted to heat rather than to mechanical motion *(see chart)*. For mobile phone cameras, this means greater drain on the batteries. It also results in lower reliability, because less torque is available to overcome friction in micro-gear mechanisms.

Smaller motors must also operate at higher speeds to produce significant mechanical power. Therefore even greater gear ratio reduction is needed, which increases system complexity, adds parts, further reduces efficiency and degrades precision.

Piezoelectric motors meet mobile phone camera needs

Piezoelectric ultrasonic motors offer a novel alternative to electromechanical motors for mobile phone cameras and other miniature product applications. One product, the SQUIGGLE motor produced by New Scale Technologies, is easily miniaturized to phone camera dimensions. Currently these unique piezoelectric motors are being made with diameters less than 4 mm.

In addition, the SQUIGGLE motor offers ten times better precision and five times greater power efficiency than electromagnetic motors. It uses 90 percent fewer parts, making it more reliable and easier to produce in volume at a cost of a few dollars per motor.

Its superior power efficiency results in longer battery life for mobile devices. And because the motion is created by ultrasonic vibrations, the motor is very quiet in operation.

How it works

The SQUIGGLE motor is a simple patented design that uses ultrasonic vibrations to directly produce linear movement, without gears or other additional parts. The assembly includes a threaded nut with mating screw. The nut is supported by piezoelectric ceramic actuators. The nut vibrates in a “hula hoop” motion at the mechanical resonant frequency. At resonance the vibration amplitude is only a few micrometers, but each cycle adds together to produce continuous bi-directional movement of the screw.

Two-phase sinusoidal drive signals power the piezoelectric actuators at frequencies approaching 100 kHz. The drive frequency is fixed to the motor resonant frequency. The drive amplitude controls speed, and the phase determines direction. These drive circuits are easily integrated in a single-chip ASIC using well-established semiconductor design and manufacturing processes. New Scale Technologies already working with several semiconductor suppliers to create customized ASIC solutions for cell phone cameras.

SQUIGGLE motors provide micrometer resolution, but a position sensor is needed to produce repeatable steps. Several position sensor options are available to measure the screw rotation or the linear movement. The sensing technology options include inductive, Hall Effect, and opto-interrupters.

Reference phone camera design in development

New Scale Technologies is currently developing a SQUIGGLE phone camera reference design to demonstrate the advantages of our unique piezoelectric motor design. The reference camera includes micro position sensors, lens translation mechanism, and single-chip ASIC drive and control electronics.

The SQUIGGLE motor must also be integrated with a translation mechanism to achieve AF or OZ movements. The end of the SQUIGGLE screw moves the lens mechanism, which may be a slide or flexure. The lens speed and position are precisely controlled. The screw holds position when the power is turned off, so the camera optics stay in zoom and focused position without requiring continuous power.