Technical information release

January 31, 2017
Funai Electric Co., Ltd.
National Institute of Advanced Industrial Science and Technology

Development of a range finding sensor with a metal-based optical scanner:

Achievement of improved durability and large-area detection

- Applicable to panel touch sensing and motion detection for large-size digital signage boards -

(Translation of press release in Japan on December 21, 2016)

Funai Electric Co., Ltd. (Head office in Daito, Osaka; Representative Director, President and CEO: Tetsuhiro Maeda; hereafter "Funai Electric") released a prototype of a range finding sensor for large-area scanning, based on an optical scanning device (hereafter a "metal mirror") developed by the Advanced Coating Technology Research Center (Director: Jun Akedo) of the Department of Electronics and Manufacturing, the National Institute of Advanced Industrial Science and Technology (Headquarters in Chiyoda, Tokyo; President: Ryoji Chubachi; hereafter "AIST").

AIST has been conducting research on optical scanning devices utilizing piezoelectric films applying a unique ceramics coating technology, the aerosol deposition (AD) method, for more than 10 years. The research led to the development of the AIST-original Lamb-wave-resonance piezoelectric driving principle (*1) and a metal-based structure (*2), and AIST announced the achievement of higher performance and lower cost of optical scanning devices (AIST press release on February 9, 2010, "Development of a Novel Optical Scanning Device, a Core Component of a Projection Display, —High scanning speeds of more than 25 kHz as well as large scanning angles such as 100° or greater were achieved —").

The optical scanning devices scan laser beams. These devices are utilized in laser printers, projectors, etc. However, conventional optical scanning devices like MEMS mirrors (*3) and polygon mirrors (*4) are subject to constraints on performance and cost. The AIST-original metal mirror applying the Lamb-wave-resonance piezoelectric driving method (*5) has achieved both high-quality scanning speeds and large scanning angles at low cost, which have solved these technical challenges.

Funai Electric has been transferred technologies related to optical scanning devices applying the metal mirror method from AIST, proceeded with the development of products for practical applications, and finally announces the release of a range finding sensor prototype. This prototype is a range finding sensor with a TOF (Time of Flight) method (*6), which can not only be low cost but also has the advantage realized by the metal mirrors, such as the large-area detection of approximately 4 square meters.

The prototype of the optical scanning device used in this range finding sensor has a reflective mirror of a size of 20×25mm exceeding the limit of 10x10mm reported in the AIST press release on February 9, 2010, and resonates at 15Hz, which is far below the minimum frequency of 100Hz required for stable operation at that time. As a result, the prototype of the metal mirror has achieved enough sensitivity for the TOF method. There were practical concerns about its stability under environmental and temperature fluctuation. To address this challenge, Funai Electric has applied its unique structural design and control method and achieved under 1% of fluctuation in a wide temperature range. The mirror is now applicable to many products.

In the future, we will focus on continuing to test the prototype, aiming at improving the reliability of the metal mirrors as optical scanning devices. We will also work on the improvement of features and reliability of the applied devices while reflecting feedback from the market and the industry. Our goal is to create more useful and effective optical scanning devices and devices utilizing the metal mirrors.

This prototype will be demonstrated at CES 2017 (Las Vegas, Nevada, USA) from January 5 to 8, 2017. The sensors will be mounted on a large-size display as an add-on touch panel (the single range finding sensor within the panel can cover the whole display screen) and a motion detector. Demonstrations will be conducted under the assumption of use in digital signage.

【Features of the large-area detection sensor】

The first-generation prototype, a range finding sensor that adopts the TOF method to measure distance. Infrared laser light is pulse-radiated to an object, and the distance is calculated based on the length of time it takes for the light to reflect and return from the object (pulse phase difference). In general, the reflection of scanned laser light must be detected sensitively in order to conduct ranging widely. Wide range scanning can be realized by the metal mirror because its large scanning angle can scan laser light widely and its large-size mirror can receive the reflected light much more even from a distance.

【Features of the metal mirror】

- High-speed and wide-range scanning: Scanning speeds of 15Hz～25kHz, deflection angles of 140 degrees (silicon-based MEMS mirrors are under 60 degrees)
- The dimension of the reflective mirror can be increased (compared to silicon-based MEMS)
- Low power consumption
- High shock resistance:

  While silicon-based MEMS mirrors are fragile against external shock, the metal mirrors are highly resistant as they are made of metal spring steel.
- High reliability and high durability:

  The metal mirrors have completed more than 6 years of continuous durability testing (conducted at AIST) and twist testing performed over 10 million times (conducted at Funai Electrics).
- Low cost:

  Compared to silicon-based MEMS mirrors, both the material costs and the manufacturing costs have decreased.

Figure 1. Comparison of optical scanning devices

	Metal mirror	MEMS mirror	Polygon mirror
Material	Metal spring steel	Silicon	(mainly) Aluminum
Scanning angle	○	×	○
Scanning speed	○	○	×
Manufacturing cost	○	×	×
Shock resistance	○	×	×

【Technical features of applying the metal mirror】

- Solves technical challenges which conventional optical scanning devices are facing
- Offers versatile and various specifications which MEMS mirrors cannot achieve

  Frequency 15Hz (mirror size: 20mm×25mm) ～25kHz (mirror size: 1.2 mm×4mm) and scanning angles of 140 degrees are available (confirmed with the prototype metal mirror produced by Funai Electrics).
- Suitable for manufacturing compact products which also require high picture quality and high accuracy, such as laser printers, mobile projectors, range finders (LiDAR), etc.

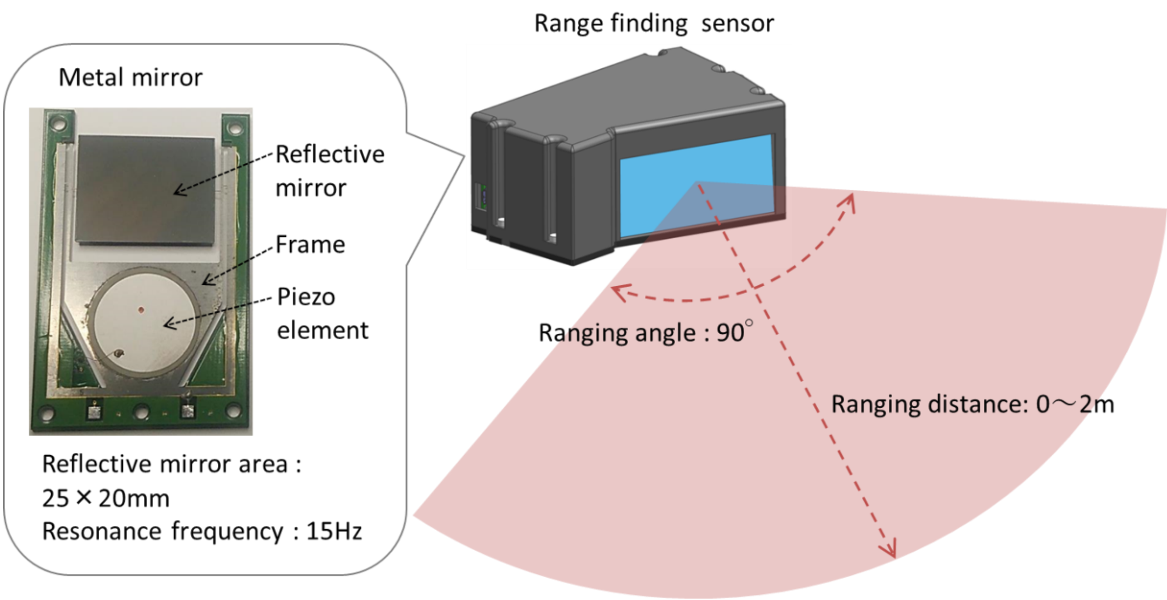


Figure 2. Function of a range finding sensor

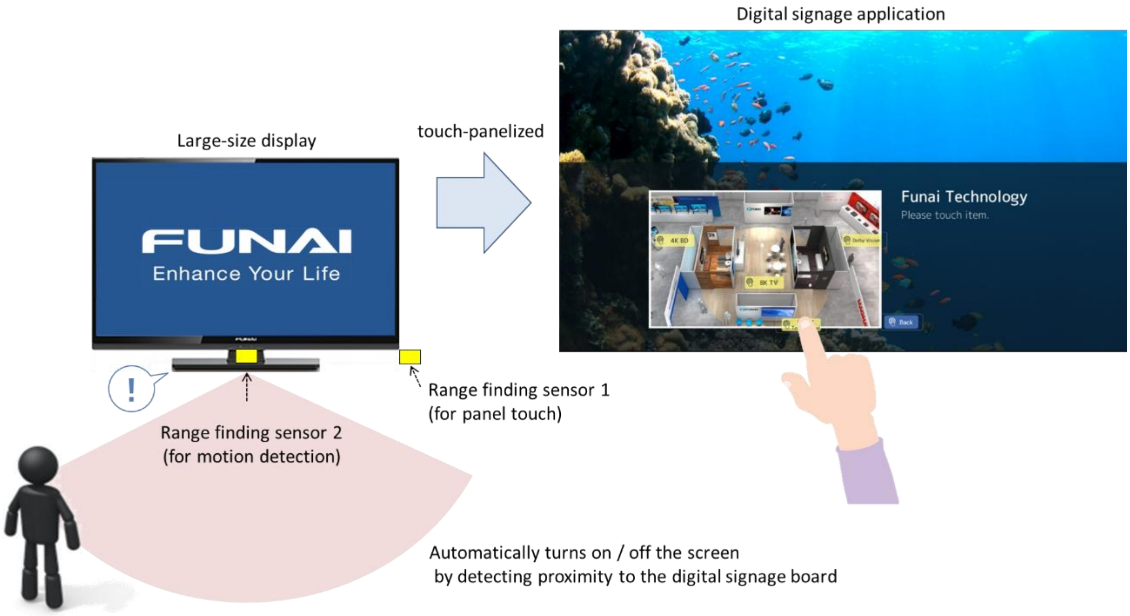


Figure 3. Application of range finding sensors to the digital signage

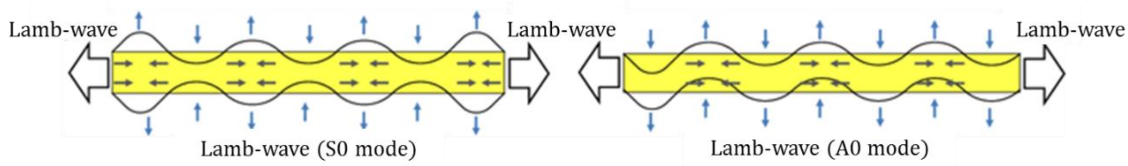
The specifications of our prototype are shown below. The performance of ranging can be enhanced in accuracy and speed by modifying the TOF processing circuit, and therefore the sensor can be applied to various products.

- Ranging method : TOF (Time of Flight)
- Light source : Infrared laser (Class 1)
- Ranging distance : 0～2m (Max.)
- Ranging angle (angle of view) : 90 degrees
- Ranging accuracy : ±60mm ⇒ ±6mm
- Response time : 500ms ⇒ 50ms
- Power : 5V (USB powered)
- Size : 146(W)x114(D)x61(H)mm

【Glossary】

*1 Lamb-wave-resonance piezoelectric driving principle

Lamb waves (plate waves) are a type of guided waves which propagate in solid plates. The waves vibrate perpendicularly to the plate and also propagate with the vibration component in the same direcftion. The difference of wave vibration types makes two kinds of wave modes; A0 mode (zero-order antisymmetric mode lamb waves) and S0 mode (zero-order symmetric mode lamb waves). The metal mirrors use the A0 mode. The torsional motion of the hinges can be induced efficiently by generating Lamb waves so that a node of waves (static points of the plate) coincides with the base of the hinges supporting the reflective mirror.



*2 metal-based structure

Spring steel is used as the main component of the metal mirrors while silicon is used in the most utilized optical scanning devices such as MEMS mirrors.

*3 MEMS mirrors

MEMS (micro electro-mechanical system) refers to devices integrating machinery parts and electronic circuits by applying microfabrication techniques. MEMS mirrors are devices, which consist of reflective mirrors and drive parts on mono-crystal silicon, to scan laser lights by inducing torsional motion to the hinges that support the reflective mirrors. The utilization of resonance phenomena can increase the scanning angle of the mirrors. MEMS mirrors are used for laser projectors, heads-up displays, range finders, etc. The maximum optical scanning angle is below 60 degrees.

*4 Polygon mirrors

Polygon mirrors are devices to scan laser lights by polygonal mirrors rotated by fast-spinning motors. Polygon mirrors are used for laser printers, photocopiers, etc.

*5 Lamb-wave-resonance piezoelectric driving method

The driving method applied to the prototype metal mirror. A piezoelectric material is equipped on the frame of the optical scanning device made of metal components. Lamb waves (plate waves) are generated through the bending vibration of the piezoelectric material, which results in the application of the Lamb-wave-resonance piezoelectric driving principle. The torsional resonance can be induced efficiently by allocating the torsional resonance system of the mirror distantly from the piezoelectric material on the Lamb-wave-resonance structure.

*6 TOF (Time of Flight) method

One of the optical ranging methods. The pulse light transmitted from the light source of the range finding sensor is reflected on the object. The distance is calculated based on the length of time it takes for the pulse light to reflect and return to the object.

【Inquiries about this report】

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