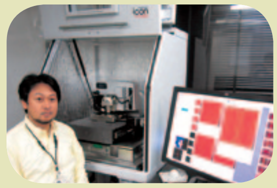
R&D

Ultrahigh-speed Recording Device Utilizing Magnetic Nanowires



Yasuyoshi Miyamoto, Principal Research Engineer, Imaging & Storage Devices Research Division

The data transfer rate*1 for video signal of Super Hi-Vision (SHV) is up to 144 Gbps (144×10^9 bit/second), whereas the maximum data transfer rates for the present recording devices are approximately 1 Gbps for hard disk drives and 3 Gbps for SSDs*2. This means that it would possibly hundreds of recording devices operating in parallel would be needed to make one SHV video recording. Thus to meet the challenge of building compact SHV recording systems, STRL is proceeding with the development of a new type of ultrahigh-speed recording device.

Recording Speed for Magnetic Recording

A hard disk drive records data by sequentially changing the directions of small magnets along the data track. The changing time for the direction of above small magnets is essentially ultra fast, however, mechanical operation such as data-seeking movements by the recording heads and rotation of disks by the motor are necessary for the operation of hard disk drives, thus to cause a drastic reduction in the effective recording speed. This suggested to us to the idea of a "hard disk drive with no moving parts" as a way of ultrahigh-speed recording.

Ultrahigh-speed Recording Device using Magnetic Nanowires

A magnetic nanowire consists of numerous small sequentially aligned magnets whose width is only a few thousandths the width of a human hair, set in a line. The difference from the current hard disk drive is that the data recorded by each magnet in the nanowire moves to the next magnet when a current is applied along the length direction of the magnetic nanowire without any mechanical operations (Figure 1). The potential exists for ultrahigh-speed continuous recording because the speed of the data shift by the current occurs more than ten times faster than the relative rotation speed between the recording head and the disk in a conventional hard disk drive.

Not having any moving parts also helps the device to be durable. We constructed a prototype magnetic nanowire device in which cobalt and palladium are alternately layered in several atom thicknesses to form atomic scale artificial crystallite lattices. This prototype nanowire was used to verify that multiple pieces of data in a wire could be collectively shifted when a current was applied to the nanowire (Figure 2). Our future work will involve the development of recording/reproduction functions suited to magnetic nanowires with the goal of constructing a small SHV recording device in the near future.

*1 Data amount per time unit.

*2 Solid State Drive: a recording device that uses nonvolatile semiconductor memory.

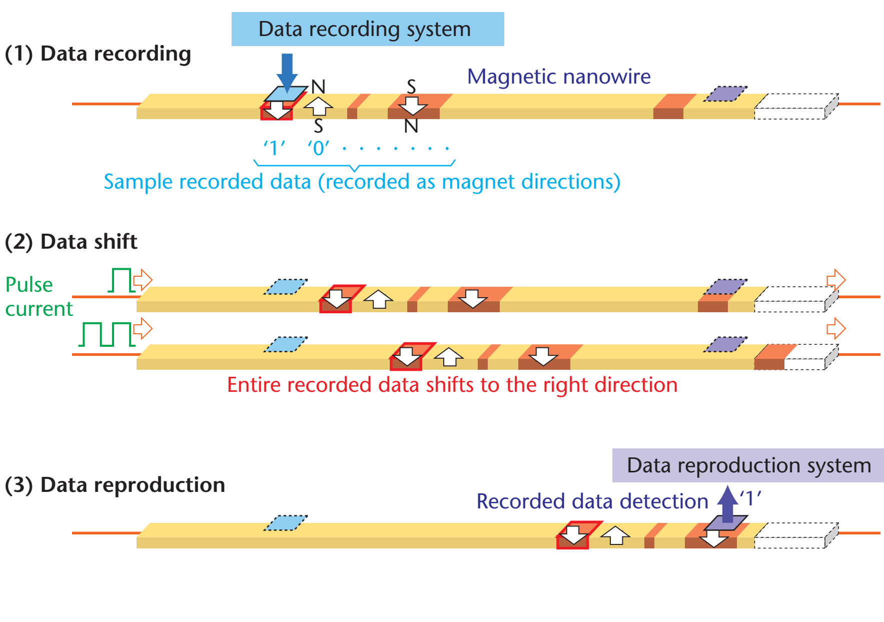


Figure 1: Overview of new magnetic recording device using a magnetic nanowire

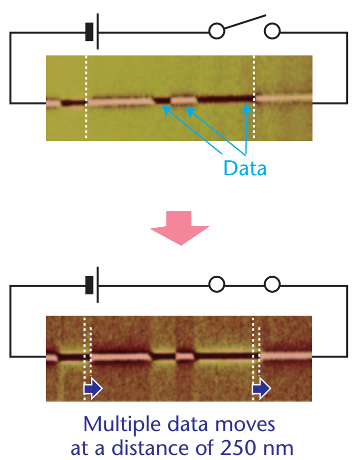


Figure 2: Current-driven Data shift in a magnetic nanowire

Large Capacity Transmission Technology for Next Generation Terrestrial Broadcasting

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On July 24, 2011, analog terrestrial television broadcasting terminated (in three prefectures in the Tohoku region ended on March 31, 2012), and the transition to all-digital television broadcasting was completed. The NHK Science & Technology Research Laboratories (STRL) is now looking to the future and has started researching large-capacity transmission technology with the eventual goal of delivering Super Hi-Vision (SHV) programs to homes.

Large-capacity Transmission Technology

The current digital terrestrial broadcasting is capable of broadcasting one Hi-Vision (HDTV) program over a single channel. SHV is an advanced audio and video system that consists of ultra-high definition video with a pixel number that is 16 times that of HDTV and 22.2 multi-channel audio. In comparison with HDTV, it requires a much larger transmittable data capacity per channel. For this reason, we are researching large-capacity transmission technology composed of two key technologies: "Dual-polarized MIMO[*1]" and "Ultra-multilevel OFDM[*2]."

【Dual-polarized MIMO Technology】

The current digital terrestrial broadcasting avoids mutual interference by broadcasting either horizontally or vertically polarized waves. In contrast, the dual-polarized MIMO technology utilizes both horizontally and vertically polarized waves to transmit different sets of signals on individual polarized waves simultaneously, thus attaining the ability to transmit more information. Our experiment, illustrated in Figure 1, employed an antenna designed to receive both horizontally and vertically polarized waves simultaneously.

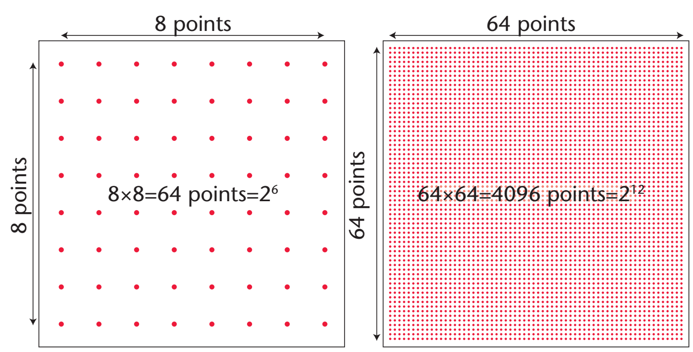
【Ultra-multilevel OFDM Technology】

Digital terrestrial broadcasting in current use transmits a maximum of 64 signal points per single OFDM carrier symbol, as indicated in Figure 2-(a), to transmit 6 bits of data. Our ultra-multilevel OFDM technology sends 12 bits of data using 4096 signal points, as shown in Figure 2-(b). The shorter distance between signal points produced by the larger signal point count makes the signal prone to errors caused by noise and distortion, so research is being done on countermeasures involving new equalization technology and high-performance error correction coding.

Our future work will focus on enhancement of the noise and distortion resistance, together with an examination of the transmission parameters, such as a modulated multi-level value, suitable for an actual broadcasting system.

*1 MIMO: Multiple-Input Multiple-Output
*2 Orthogonal Frequency Division Multiplexing

Figure 1: Dual polarized Yagi antenna



(a) Current digital terrestrial broadcasting 64QAM

(b) 4096QAM

Figure 2: Signal point arrangements

Tactile Presentation Technology for Three-dimensional Objects

-Building a TV system that delivers information by touch

Takuya Handa, Human & Information Science Research Division

Television delivers information primarily through video images and audio. For instance, it can display a piece of art that has a shape that is hard to express in words. Advances are being made at the Science & Technology Research Laboratories to present such shape information that is hard to express verbally to people with visual impairments by using tactile and force sensations.

Our newly developed tactile display system enables a user to recognize the shape of a computer-reproduced virtual object by their placing three fingertips (index finger, thumb, and middle finger) and palm on the device. A virtual object is generated (Figure 1) from shape data on an actual object that has been recorded using a three-dimensional digitizer. Virtual object control software adds surface data to the virtual object, such as friction and hardness information, to reproduce a tactile sensation that is close to that of the original object.

The multi-finger tactile display has a brace attached to the three fingertips and the palm. The brace pushes on the hand with a force corresponding to the counteraction involved in touching an actual object when it is positioned such that fingers match the virtual object's surface coordinates. The user recognizes the virtual object's shape by feeling this counteraction force with the fingertips or palm. To produce the perception of touching a continuous surface, it is necessary to control the force applied to the fingertips at a sufficiently high speed. This device measures the fingertip position every millisecond and applies a controlled counteraction force that is appropriate for the position of the fingertips and palm. This produces a contiguous sensation of touching an object at the four locations on the hand.

Our current study involves an examination of the conditions required to convey an object's shape by using only tactile sensation. Past experiments comparing the tactile sensations of actual and virtual objects evaluated how accurately an object's size and shape could be perceived by using different parts of the hand. The results revealed that an object's shape could be accurately recognized using three fingers and the palm, and perception of the object's shape could be improved by making the braced fingers and palm harder to remove from the virtual object's surface.

Tactile presentation technology has the potential of delivering the sensations of a material's texture and feel that are not visually apparent. We will clarify the requirements for conveying shape and hardness information and construct a device capable of displaying more complex shapes.

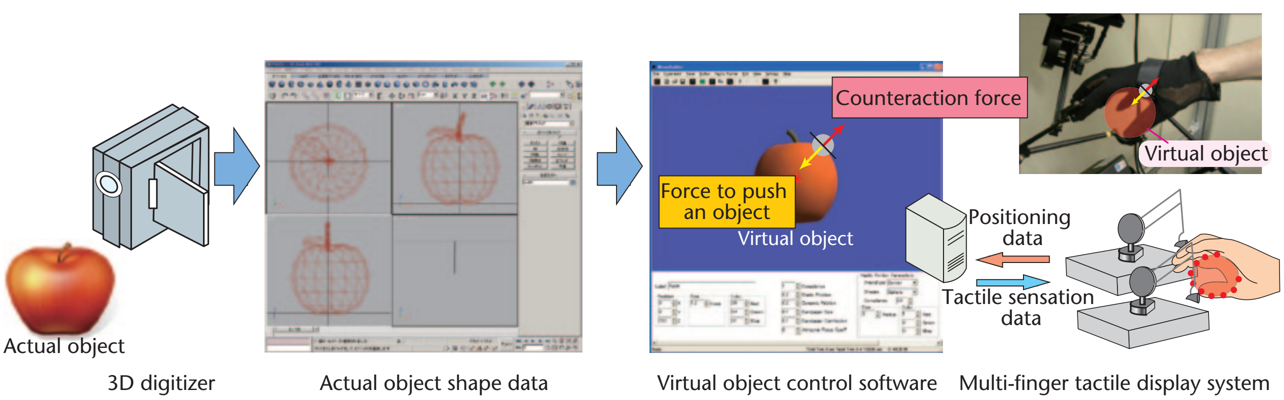


Figure 1: Prototype tactile display system

