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TECHNOLOGY FOR SPACE STATION EVOLUTION

OPTICAL DISK TECHNOLOGY

SPACEFLIGHT OPTICAL DISK RECORDER

SODR

PAMELA RINSLAND

NASA LANGLEY RESEARCH CENTER

January 16, 1990

A NASA program to develop a high performance (high rate, high capacity) rewriteable optical disk recorder focused on use aboard unmanned polar orbiting platforms is underway at Langley Research Center. An expandable system concept is proposed consisting of multiple drive modules and a modular controller. System goals are 160 gigabyte capacity at up to 1.2 gigabits per second, concurrent I/O, varying data rates, and five year operating life in orbit. Drive performance goals are 10 gigabyte capacity, 300 megabit/second transfer rate, 10^{-10} corrected BER and 250 millisecond access time.

Although development is currently focused on Eos polar orbiting platforms, the SODR is an enabling capability for many future missions, such as Space Shuttle and Space Station Freedom payloads, Mars Rover, and polar and geostationary orbiting platforms. A possible Space Station application for SODR is that of a dedicated resource to store the high speed optical data recorded and transmitted from microgravity science experiments. Surveys conducted for a workshop sponsored by NASA-Lewis in May 1988 show that a minimally configured SODR can meet the requirements of many of the investigators.

3.1--SPACEFLIGHT OPTICAL DISK RECORDER (SODR)

OBJECTIVE

Develop and demonstrate components and subsystems required to provide high-performance (high rate, high capacity) random file access storage systems based on erasable optical disk technology for future spaceflight missions. This includes development of magneto-optic disk media, diode laser array, write/read/erase electro-optic head, disk drive unit, and system controller.

DESCRIPTION

Key technologies that form the basis for the system are 14-inch magneto-optic media, 9-element diode laser arrays, multi-track electro-optic head, and versatile system controller. The areal density (bit/area) of optical media, is projected to be eight to twenty times that of magnetic media. The SODR goal is 10 gigabit per disk. The use of a diode array and supporting electro-optic head to write, read, and erase eight simultaneous data tracks on each surface provides high data rate. The per head goal is 150 megabits/sec or 300 megabit/drive. The concept is a dual-sided disk, two heads, and supporting electronics into a disk drive package. An associated modular controller is to be developed to produce a configurable, expandable system which can provide up to one gigabit/sec rates and 1.2 terabit capacities.

NASA RATIONALE AND BENEFIT

High performance random file access storage is an enhancing and enabling capability. The current program focus is application aboard Polar Orbiting Platforms in support of the Earth Observing System. High performance optical recording has potential payoff to many major NASA programs including the Space Transportation System, Space Station, including GEO and Polar Platforms, Space Science and Exploration (e.g., Mars Rover and Lunar Base). There are potential benefits to DoD space programs, ground based Government and commercial programs, and the establishment of national leadership in critical technology areas.

STATUS / ACCOMPLISHMENTS

Feasibility was demonstrated in the lab in 1988. This year the SODR program has developed a new laser structure, delivered improved lasers with 100 hour burn in, completed preliminary environmental testing of aluminum and glass media with glass selected as the new baseline, continued characterization and enhancement of the breadboard drive redefined goals of a drive brassboard reflecting DoD participation, established requirements and initiated breadboard controller design.

Technical Contact: Tom Shull, LaRC, (804)864-1874 (FTS 928-1874)

The SODR program is sponsored by NASA's Office of Aeronautics and Space Technology and managed by Langley Research Center. The objective is to develop and demonstrate the technology,components and subsystems needed to achieve rewriteable optical disk mass storage systems for space flight applications. The fundamental elements associated with this development include the following: a) 14 inch dual-sided magneto-optic (MO) media, b) independently addressable 10-element solid state laser diode arrays, c) an eight data track electro-optic (EO) head and d) electronic and mechanical drive subsystems.

Media studies have addressed the MO performance and suitability of glass versus aluminum substrates for harsh environments. Tests included vibration, thermal cycling and outgassing. A blank glass disk survived 62 G rms random vibration. Results indicate that glass is the preferred substrate from both a performance and cost viewpoint.

Laser development is focused on longevity and yield improvements. This includes fine tuning of the laser structure and process refinement. Conversion to a new growth technique is being considered. Techniques are being studied to stabilize the lasing frequency that can shift due to optical feedback and aging.

The current spot geometry and spacing on the 14 inch disk support a capacity of 5 gigabytes per side. The disk is formatted in a continuous spiral consisting of preformatted permanent pilot track that contains the radius (track number) identification data. This enables closed loop recording and playback that cannot be achieved with a concentric ring pattern. The permanent pilot track lies in the center of a data band of eight rewriteable tracks 1.4 μm apart. There is a 2.1 μm guard band between data bands to accommodate the laser's 0.7 μm spot diameter.

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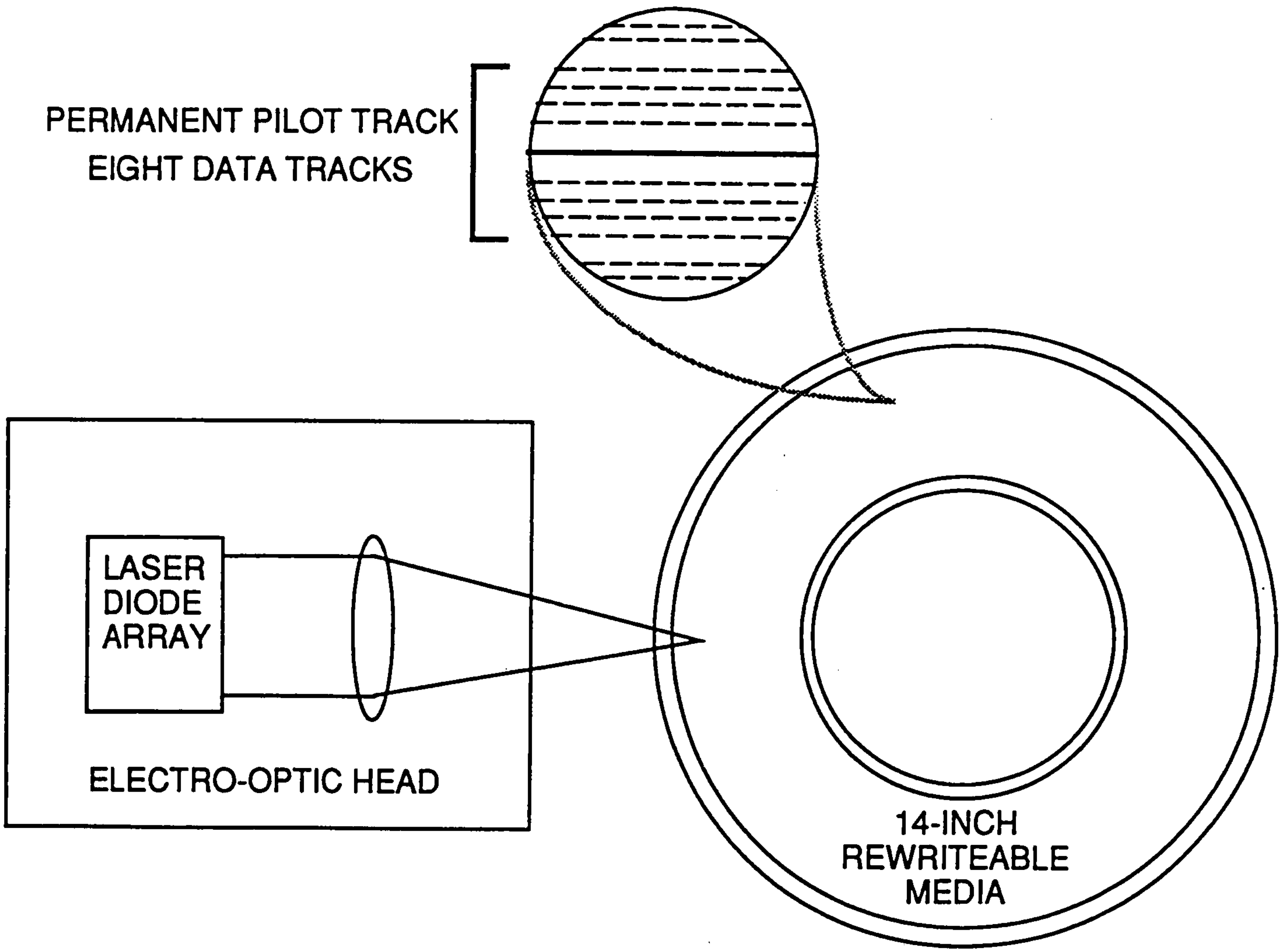
KEY TECHNOLOGIES



SPACEFLIGHT OPTICAL DISK RECORDER

Each SODR drive contains one 14" dual sided storage disk. The concept of a storage module refers to two drives mounted with counter rotating disks for angular momentum compensation. One disk surface and its associated hardware are referred to as a device (two devices per drive). In the current design the device is the minimum functional unit. The minimum deliverable physical unit is a drive. The physical device contains the media and its supporting mechanisms. This includes the optical heads, rotating disks, photodetectors, and the support subsystems (mechanical, optical and electronic) needed to read or write information on the media. The goal for each drive is 10 Gigabytes of data capacity and 300 Mbps data throughput.

Drive specific functions required to transfer data from the user to the medium will be performed within the storage module. These include sector mapping, data encoding, error detection and correction (EDAC), buffering, overhead formatting, and command interpretations (seek, read, write and erase).

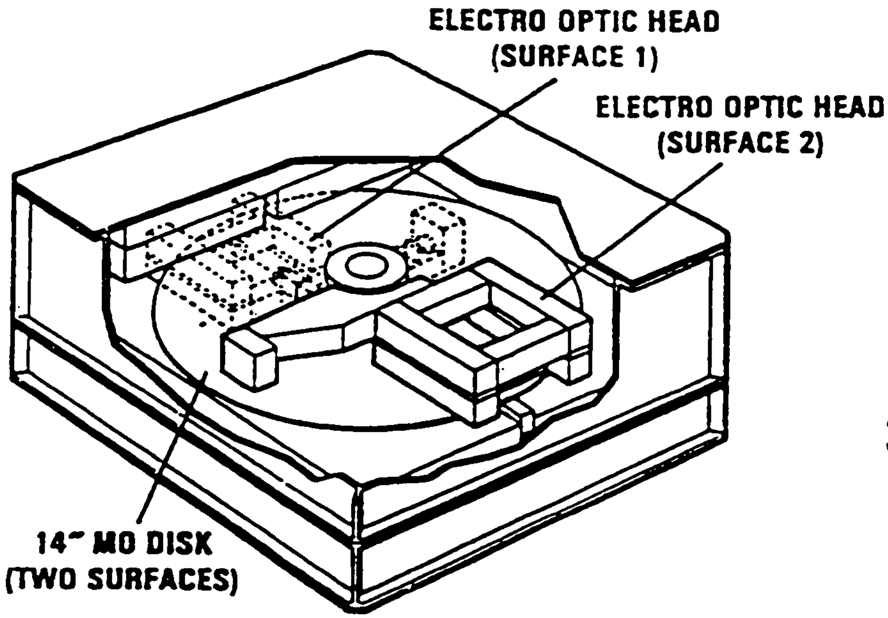
The physical characteristics of the projected flight drive (dual device and device controller) are as follows:

	DEVICE	CONTROLLER
SIZE:	3/4 FT	1/4 FT
WEIGHT:	45 LBS	15 LBS
POWER: Write 150	50 W	50 W
Write 300	70 W	100 W
Read 150	75 W	50 W
Read 300	130 W	100 W
Erase 300	70 W	0 W

ANGULAR MOMENTUM: 1 FT-LB-S

OVERALL DIMENSIONS: 15.3" x 6.5" x 17.9"

DISK DRIVE



PERFORMANCE GOALS

10 GIGABYTE CAPACITY

300 MEGABIT PER SECOND

250 MILLISECOND ACCESS

The SODR is an expandable modular system which consists of a modular SODR Controller and multiple storage modules. Current plans are to design and build the SODR Controller at LaRC and to obtain the storage module design and development through outside sources. The SODR can be modularly configured to provide up to 1.8 gigabits per second data transfer rate and up to 160 gigabyte capacity.

The primary functional requirements of the SODR Controller are flexibility, high data rate, high capacity, simultaneous I/O through multiple ports, random access to files, and high reliability. Flexibility will be provided by the system's modularity that allows the system to be configured to meet different application requirements. Random access to data is an inherent feature in disk storage systems. This feature will be provided by the controller in the form of random access to files. The primary goals for system reliability include up to 10^{-12} corrected BER and a minimum of two to five years operating life in orbit.

The SODR Controller will perform standard data transfer functions such as directory management, resource allocation and scheduling that remove the user from the physical details of the storage modules. There are differences between the SODR Controller and other high performance controllers. The SODR Controller also provides higher and variable data transfer rates, contains a greater number of modules (more than eight), and supports dynamic reconfiguration, fault tolerance, adaptable file management philosophy and reprogrammable system algorithms. Also, the command and data ports are separated to achieve the desired reconfigurability and data throughput.

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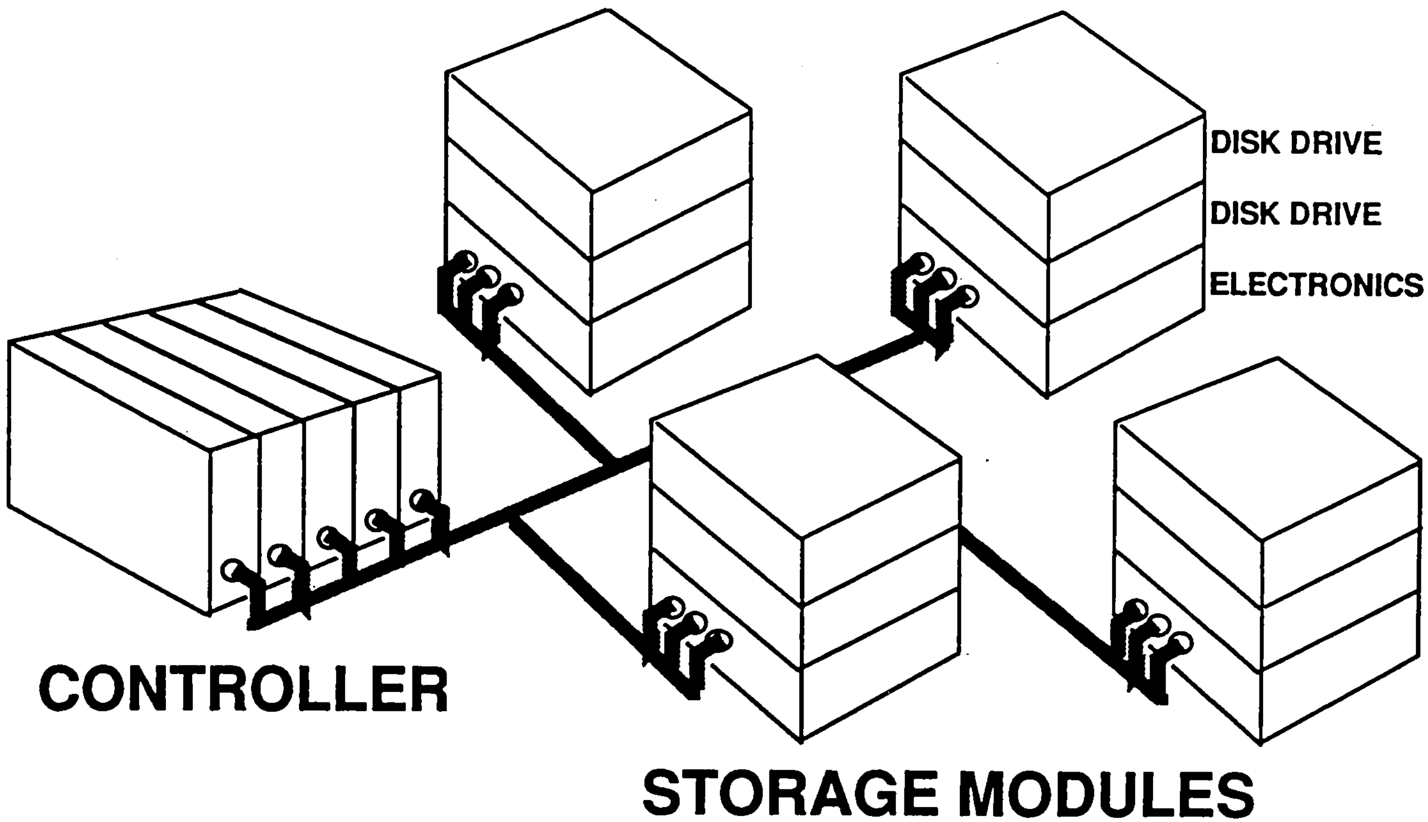
SYSTEM CONCEPT



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CONCLUSION

- TECHNOLOGIES FOR FLIGHT OPTICAL DISK RECORDER HAVE BEEN DEMONSTRATED
- BENEFITS TO SPACE STATION IN RELIABILITY, VERSATILITY, AND CAPABILITY
- PROGRAM SCHEDULE CAN BE MET WITH APPROPRIATE FUNDING