May 1990

Video Imagery Systems for Highway Applications

Office of Transportation Research
Iowa Department of Transportation
800 Lincoln Way
Ames, Iowa 50010

Principal Investigators: John Whited
Bill McCall

In Cooperation With
Federal Highway Administration
Demonstration Project 85
Work Order: DTFH71-87-970-IA-27

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-DP-90-085-004		

4. Title and Subtitle	5. Report Date
Demonstration Project 85, Video Imagery Systems for Highway Applications	May 1990
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Bill McCall, John Whited	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Iowa Department of Transportation Office of Transportation Research 800 Lincoln Way Ames, Iowa 50010	11. Contract or Grant No. DTFH71-87-970-IA-27
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Federal Highway Administration Demonstration Projects Division 400 Seventh Street, S.W. Washington, D.C. 20590	Final Report December 1987 - May 1990
	14. Sponsoring Agency Code HHO-43

15. Supplementary Notes

Prepared in cooperation with the U. S. Department of Transportation, Federal Highway Administration

16. Abstract

The report describes the state of the art video equipment used and experiences gained from the 6,800 mile field test. The first objective of this project was to determine if laser disc equipment could capture and store usable roadway images while operating in a mobile environment. The second objective was to evaluate methods of using optical disc storage and retrieval features to enhance highway planning and design function.

Several highway departments have attempted to use video technology to replace the traditional 16 and 35mm film format used in photologging. These attempts have met with limited success because of the distortion caused by video technology not being capable of dealing with highway speeds. The distortion has caused many highway signs to be unreadable and, therefore, clients have labeled the technology unusable.

Two methods of using optical laser disc storage and retrieval have been successfully demonstrated by Wisconsin and Connecticut Departments of Transportation. Each method provides instantaneous retrieval and linking of images with other information. However, both methods gather the images using 35mm film techniques. The 35mm film image is then transferred to laser disc. Eliminating the film conversion to laser disc has potential for saving $4 to $5 per logging mile. In addition to a cost savings, the image would be available immediately as opposed to delays caused by film developing and transferring to laser disc.

In June and November of 1986 Iowa DOT staff and cooperating equipment suppliers demonstrated the concept of direct image capture. The results from these tests were promising and a FHWA Demonstration program established. Since 1986 technology advancements have been incorporated into the design that further improves the image quality originally demonstrated.

17. Key Words	18. Distribution Statement
Laser disc Video technology Roadway imagery	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price

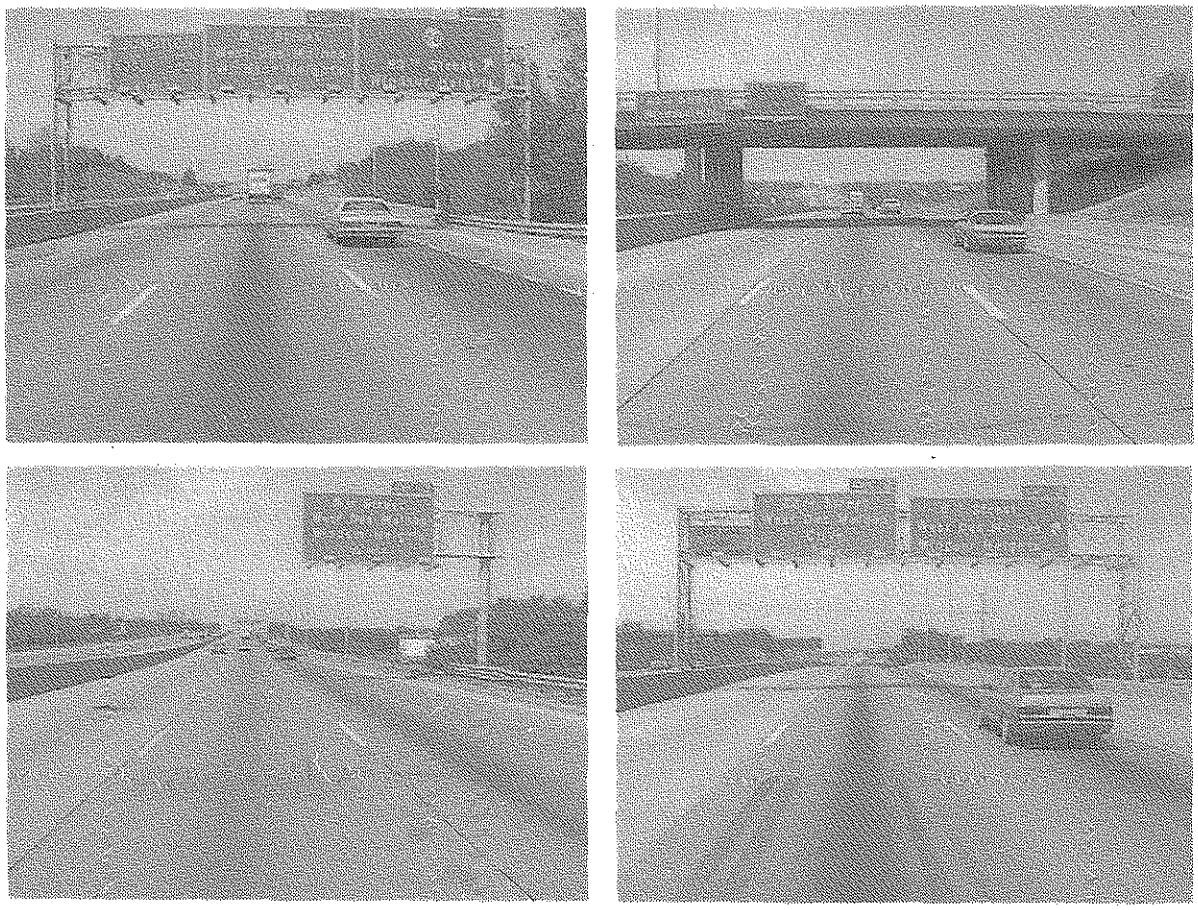
Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

1047

Demonstration Project No. 85

U.S. Department
of Transportation
**Federal Highway
Administration**

Video Imagery Systems For Highway Applications



REPORT NO. FHWA-DP-90-085-004

MAY 1990

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

LENGTH

Symbol	When You Know	Multiply By	To Find	Symbol
in	inches	25.4	millimetres	mm
ft	feet	0.305	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km

AREA

Symbol	When You Know	Multiply By	To Find	Symbol
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.093	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometres squared	km^2

VOLUME

Symbol	When You Know	Multiply By	To Find	Symbol
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.028	metres cubed	m^3
yd^3	cubic yards	0.765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

MASS

Symbol	When You Know	Multiply By	To Find	Symbol
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg

TEMPERATURE (exact)

Symbol	When You Know	Multiply By	To Find	Symbol
°F	Fahrenheit temperature	5(F-32)/9	Celcius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

LENGTH

Symbol	When You Know	Multiply By	To Find	Symbol
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi

AREA

Symbol	When You Know	Multiply By	To Find	Symbol
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometres squared	0.386	square miles	mi^2

VOLUME

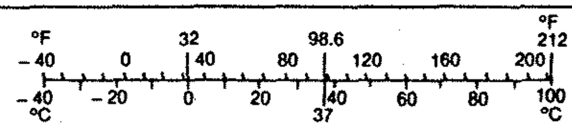
Symbol	When You Know	Multiply By	To Find	Symbol
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

MASS

Symbol	When You Know	Multiply By	To Find	Symbol
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T

TEMPERATURE (exact)

Symbol	When You Know	Multiply By	To Find	Symbol
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F



* SI is the symbol for the International System of Measurement

(Revised April 1989)

Notice

Acknowledgment

A note of appreciation is offered to the individuals and organizations who made this project possible. I am pleased to thank FHWA Demonstration Project Division, Steering State Members from Washington, Minnesota, Wisconsin, Connecticut and South Dakota DOTs, Iowa DOT offices of Maintenance, Road Design, Transportation Inventory and Bureau of Transportation Safety and Mandli Communications Inc. Without their enthusiasm and commitment to professional excellence this project would have fallen short of planned objectives.

I am particularly indebted to Pat Cain, Director of the Office of Inventory, and his staff for making resources available when required; and to Leroy Hamilton, Base Record Manager, for making adjustments to his schedule in order to meet critical deadlines. A special thanks also goes to Wayne Deal, Dwight Peters and Sheri Anderson who run the day to day operation. Their comments and suggestions greatly enhanced the final operating features of the van.

Finally, a special thanks goes to Raymond J. Mandli, Project Development Manager, Mandli Communications, Inc. which manufactured and installed the on-board video image system and developed the operating software for the on-board system and the office workstations (ROADVIEW III tm). The introduction of state-of-the-art equipment and placing new methods into practice presents many unforseen challenges. Throughout the project MCI eagerly responded to these requirements and provided invaluable support. I am particularly grateful for the many discussions that took place with all of the staff at MCI which have helped me understand the technology and how it was applied.

TABLE OF CONTENTS

List of Figures

Problem Statement

Image Collection

The object is to determine if video technology can be used as a resource for states to manage highway facilities. Clients have defined usable as being able to read and distinguish differences between signs.

For years film-based systems have dominated the collection of roadway images. One of the major drawbacks to a film-based system is the playback mode is serial. This has created a barrier which limits access to pictorial information. But the image quality of film, along with a viable replacement alternative, has kept film systems the preferred choice until now.

Video technology offers many of the features highway agencies are looking for in their road logging operations. First, the image can be viewed immediately in the field which avoids rescheduling and backtracking to fill in missed mileage. Second, it offers a lower cost option than 35mm film. The payback for direct laser disc capture is the elimination of the cost of film, processing and transferring the image from film to laser disc. The cost of a laser disc, when purchased in bulk quantities, is approximately $330 for a double sided disc. When recording in hi-resolution mode there are 36,000 frames available. Assuming a 25-foot sample rate, 212 frames are required per mile of roadway or 150 miles of roadway per side of disc, leaving over 4,000 frames per side for reserve. This equates to approximately one dollar per mile. The cost of 35mm film ranges from $4 to $5 per mile. Third, laser discs are easier to handle than rolls of film.

One potential disadvantage of video technology is the ability to read every roadway sign. Even with recent advancements in electronic image technology, developing an image to replace 35mm film quality is a difficult if not an impossible task. Fortunately, the capability of the human eye to distinguish images beyond a certain threshold makes this task easier. For example, the current image quality of a laser disc is about 450 horizontal resolution lines while standard VHS is 240 lines, a NTSC TV broadcast is 330 and S-VHS is 420 lines.[1] Each provides an acceptable image. However, when compared to 35mm film, which has a range of 1700 to 3,500 resolution lines, it is easy to see why film will continue to be the standard for comparison.

Storage/Retrieval

The key advantage optical disc storage and retrieval technology offers is to reduce the cost of collecting, storing and retrieving images, and to increase the ability to use visual information. In the high resolution mode, 36,000 frames of video can be stored per side of laser disc. Using a 25-foot sample rate one side of a 12-inch laser disc can store 150 miles of roadway. By linking image and alphanumeric data, a complete workstation can now support comprehensive analysis of highway applications. Rapid retrieval of over 150 miles of images in just a few seconds will increase the utilization of the file, which in turn increases the value of the database. While price and performance of the system dictates final acceptance, ease of use and rapid access to large quantities of images and alphanumeric data must also be included in the final benefit analysis.

Significant advancements are continually changing the performance and price of the components used in a video/laser disc image collection system. Therefore the following prices should be used as a guide and not for budgeting purposes. A 700-line 3-chip CCD broadcast quality camera with a lens costs $15,000. Process controller with video and graphic overlay cards cost $15,000. The 12" laser disc recorder-player with 450 lines of resolution cost $20,000, while an optical laser disc player costs $5,000. Distance Measuring Device, rack and camera mounting, power supply, cables, voice navigator system, S-VHS tape option, software and installation cost $50,000. Single sided 12" optical laser discs cost $220, while double sided 12" discs cost $330.

BACKGROUND

Video Technology

The process of taking video pictures while traveling at highway speeds is more complicated than placing a video camera and laser disc recorder in a van and driving down the road. While the image quality from this approach may satisfy a few clients in your organization, many applications require the entire image to be sharp and clear. To produce this image using video technology, several components must be linked together to capture a usable image. Many factors influence the quality of the image, and before being able to understand the process required to take pictures at highway speeds several concepts must be reviewed.

First, video technology is influenced by the National Television System Committee (NTSC) Standard. The NTSC Standard, in part, requires video images to be recorded at the rate of 30 frames (60 fields) per second, with each of the 30 frames interlaced by 2 fields (odd, even). Each field provides half of the information for each frame seen. Therefore, traveling at highway speeds the amount of movement in the objects between fields creates a condition known as field dominance where the frame appears jittery or flickers between each field when the odd and even fields are interlaced.[2] This occurs even if a single frame was displayed in freeze frame mode. The method selected to solve this phenomenon was to momentarily store a frame of video, select the odd field of the two-field pair, copy this field into the even field, and send the generated image to the recorder. The image created is still interlaced but each field contains the same information. The most noticeable difference between a standard interlaced image and an enhanced freeze frame image is the smoothness of the edges.

Usually when talking about rapid retrieval of a data file, it is in terms of digitally stored (zeros and ones) information. However, storing one frame of video in a digital format can take up to 20 megabytes of storage. So even though the video signal is generated digitally from a CCD (charged coupled device) computer chip it is converted to analog which is represented by directly measurable changes in the electronic signal. Compatibility with other systems, less storage space and file access speed are the main reasons why the signal is converted to analog.

Several factors define the sharpness or visual quality of the picture. Some of the factors include the density and quality of pixels on the CCD chip, availability of a electronic shutter, lines of resolution, scanning lines, range and availability of colors (chrominance and luminance), and filter pattern selected. Pixels are light-sensitive picture elements that react to the brightness and variations of light. Usually the higher the number of pixels the better the picture. Generally a camera with a higher line of resolution count produces more output in fine detail and therefore a clearer picture. In the high-end broadcast quality cameras the CCD chips are stacked to increase the number of pixels. The precision used to mount the chips also impacts the quality of the picture.

Another feature that improves the quality of the image is the electronic shutter. This device allows an image to be captured at a faster rate. The increased capture speed prevents blurring of the video image edge. This smearing condition can be found when a standard NTSC signal is used to videolog roadways. The electronic shutter increases the capture speed by regulating the electrical charge sent to the pixels on the computer chip.[3]

Laser Disc Technology

The Panasonic 12" laser disc recorder was selected because it had the highest lines of resolution available. It's capable of recording in two modes. The 400-line 54,000-frame low-resolution and the 450-line 36,000-frame hi-resolution modes. The 450-line format was selected as the Iowa DOT standard. Information is recorded by rapidly heating small areas in a thin layer of crystalline material using a high-powered laser beam. The differences in reflection, when viewed with a low-powered laser beam, are sufficient to reproduce the analog video signal.[4] The laser beam head in the equipment we are using is positioned by a frame code number embedded when the disc is manufactured.

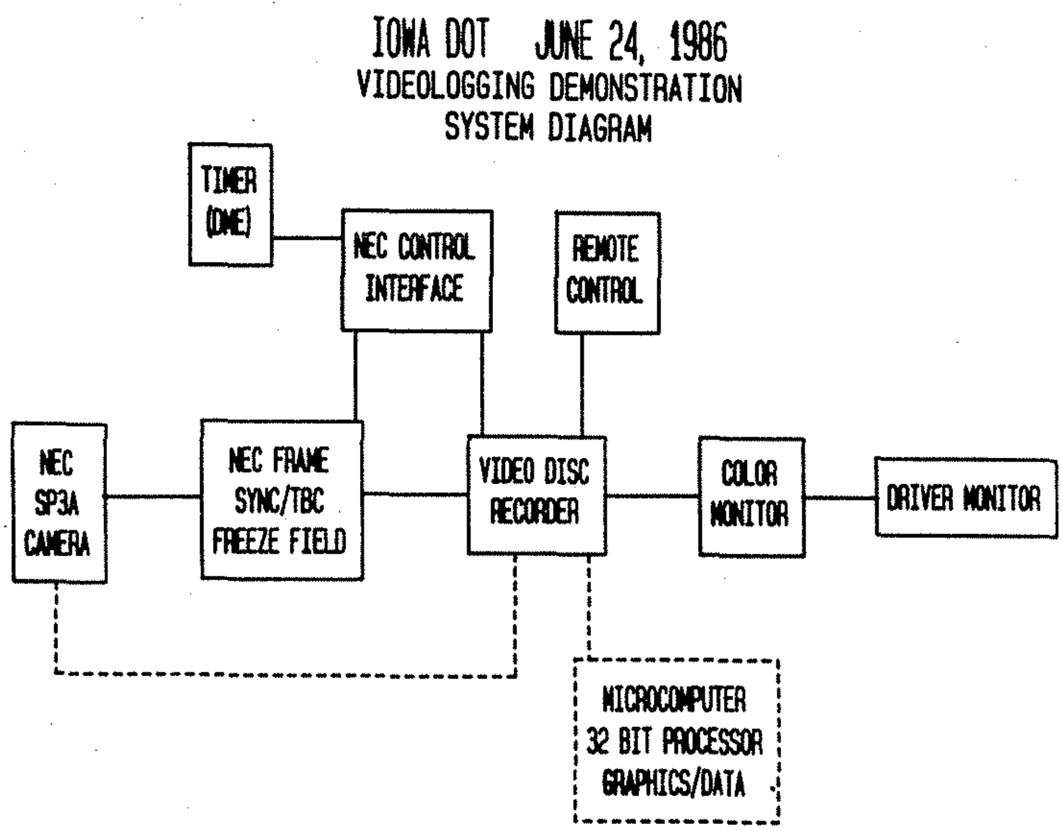
Major difference in laser disc formats can be grouped into the following areas:

1. Material used
2. Format size 8- or 12-inch
3. The way the information is written, i.e., CAV (constant angular velocity), which provides single frame recording, or CLV (constant linear velocity), which records in a serial/pressed disc format.

There are several playback and/or retrieval schemes that can be used. The most powerful is the dedicated workstation. The laser disc player can be controlled by a central processing unit (CPU) and can be linked with other databases. A remote controller can also be used to view the images a frame at a time or played forward or reverse in slow or fast mode. Laser discs can be loaded and unloaded in a few minutes and can access anywhere on the 36,000 frames in seconds.

Concept Proposal

The system components that were demonstrated June/November 1986 are shown in figure 1.



In order to determine the feasibility of recording usable video images of the highway on laser disc while in a mobile environment, several vendors[5] agreed to supply equipment and help in the experiment. The equipment was temporarily mounted in a mini motorhome and driven at highway speeds. The resolution of the electronic shuttered NEC SP3A camera was 500 lines, while the Panasonic optical laser disc recorder/player had 300 lines of resolution. All of the equipment had to work within close tolerances so a time base corrector, along with a freeze frame unit, was used to eliminate the field jitter problems in the video signal. The image was recorded on a 8-inch laser disc. The results from the test were reviewed by staff from the offices of Road Design, Safety, Maintenance, Legal, Planning and FHWA who routinely use the photologging files. Their comments on the quality of the image were very encouraging and provided a basis to further develop the concept.

A proposal was submitted by Iowa Department of Transportation and approved by FHWA Demonstrations Projects Division to evaluate the performance characteristics of the video image collection and optical image storage equipment. The results from the project would be transferred to all interested agencies. Assisting the Iowa DOT in the identification of new techniques and procedures was a steering committee. The committee comprised of representatives from Washington, Minnesota, Wisconsin, Connecticut and South Dakota DOTs, as well as an internal Iowa DOT group. The advisory groups assisted in completing project objectives, facilitate the transfer of video technology and increase user confidence in the results.

On October 31, 1988, a request for proposal was released by the Iowa DOT resulting in five companies responding with bids. Three out of the 5 bids complied with biding instructions and were evaluated. Mandli Communications Inc. ranked the highest and a contract was signed with MCI in December 1988.

The video and recording equipment was installed on-board a 1988 Ford E150 Econoline van and operated in a highway data gathering environment for approximately 6,800 miles.

Iowa Videologging System Design & Features

Figure 2 provides a schematic of the the videologging system. Each subsystem is hardwired into the mobile system. Twelve inch optical disc, SVHS tape, and 3 1/2 inch floppy disk outputs are removed from the van for use in analysis at a workstation. Following this diagram is a brief description of each major component in the system. Attachment One lists manufacturers and model numbers for each major subsystem.

Figure 2

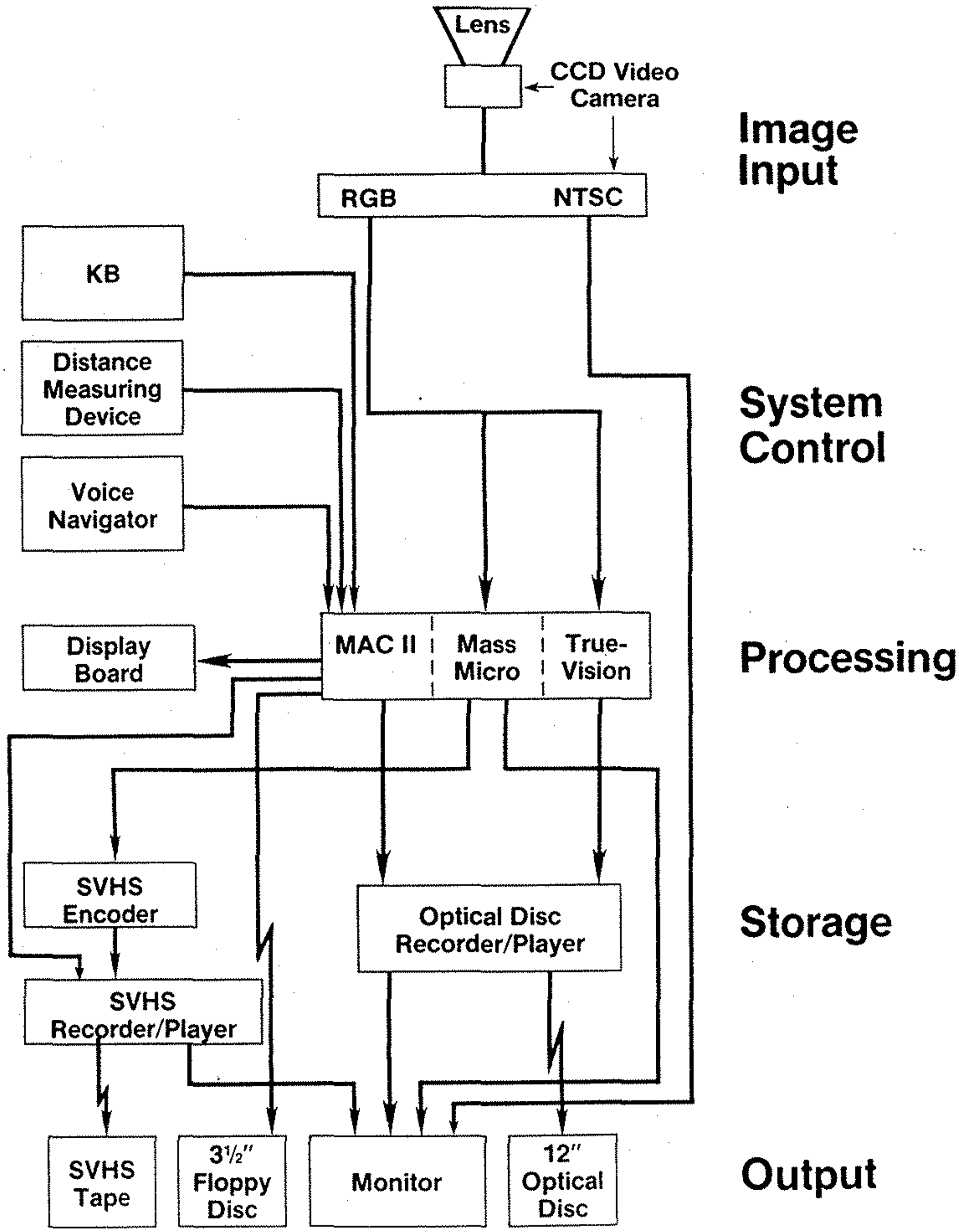


Image Input

Two devices comprise the image input subsystem used to gather the video image. A Sony DXC-750 broadcast quality camera and a Fujinon Eagle II CCD compatible lens were used in the demonstration.

The Sony DXC-750 camera uses three CCD (charge coupled device) computer chips and has over 700 lines of horizontal resolution to capture the image. The CCD chip was preferred over the MOS (metal oxide semiconductor) because of its stated ability to deliver a cleaner picture under lower lighting conditions. The image from the lens focuses on the CCD chip, which contains thousands of light-sensitive picture elements called pixels. The pixels react to the brightness variations and send an electronic signal to the pick-up device. The electronic shutter works as a timer that controls the sampling rate of the signal from the CCD chip. By increasing the shutter speed, picture blurring due to vehicle speed is reduced. However, every 1/250th of a second increase in shutter speed increases the f-stop by one, which reduces depth of field. So, a wider lens aperture decreases the sharpness of foreground to background objects. To provide a balance between these issues several shutter speeds were tested. 1/500th of a second provided satisfactory results and has been used through most of the testing.

The Fujinon Eagle II camera lens has a focal length range of 9.5mm to 152mm and a manual or automatic iris control. The internal Iowa DOT steering group defined two viewing perspectives. One for interstate or multi-lane facilities and another for two lane primary routes. Each perspective uses the wide angle lens setting which provide a field of view beginning approximately 10 feet in front of the vehicle focused at 100 feet.

System Control

DMD (distance measuring device) generates a pulse and has been calibrated to trigger the capture of the image. The central processing unit (CPU) is used to control the input/output signal of the DMD.

The CPU can be controlled by voice or direct keyboard input from the rear workstation or from the front driver's seat. The Voice Navigator is a commercially available hardware and software package that enables the driver to operate the system without diverting attention from the task of driving. Each operator must train his/her voice so the system can recognize the voice pattern for each command. The system uses a 15-word vocabulary, and after repeating each word 5 to 6 times the voice file is saved and loaded when the operator starts the system.

Processing

The videologging system uses a Motorola 68030 chip to store roadway data and control the video gathering process. The CPU processes the RGB video signal using a modified Truevision video field correlation board (frame/field grabber), selecting the 756 x 486 NuVista video driver option and a MassMicro graphics overlay board to generate roadway reference information that is overlaid on the image stored on the backup S-VHS recorder. Data relating to the roadway being videologged is also stored on the hard disk.

The display board layout is shown in Figure 3. The data displayed provides the operator with information to assist in matching other data with the videologging file. It also provides messages about the status of the system.

DISPLAY BOARD LAYOUT

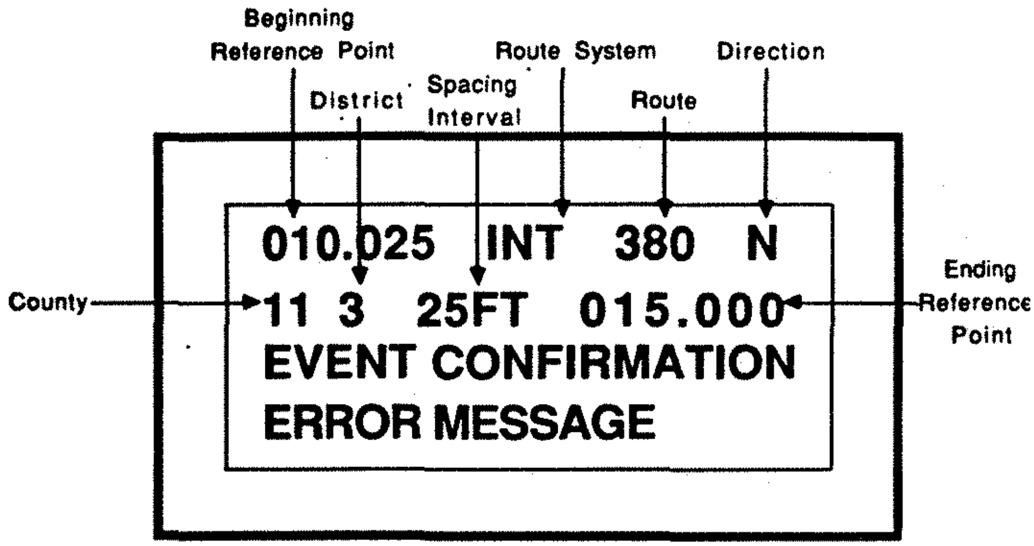


Figure 3

Storage

The system design incorporates a 12-inch laser disc recorder which has 450 lines of resolution in the hi-res mode and a S-VHS tape recorder with over 400 lines of resolution. The operator can preselect a 50- or 25-foot sample rate to store a image for the laser disc system while the S-VHS system records continuously. The internal Iowa DOT steering group decided a 25-foot sample rate would be used as the standard for the laser disc format.

Incorporating two storage formats in the design allows greater flexibility in user defined application of the image files. The operator can choose to record on the laser disc and the S-VHS tape recorder simultaneously or select either device to run independently for special studies. The laser optical disc is the primary storage format because of the instant access to exact sections of highway. This system will satisfy many of the users. When information is missed with the 25-foot sample rate or special studies, i.e., guard rail, work zone safety, etc., the S-VHS tape provides a relatively low-cost backup which eliminates additional trips to a study area.

Output

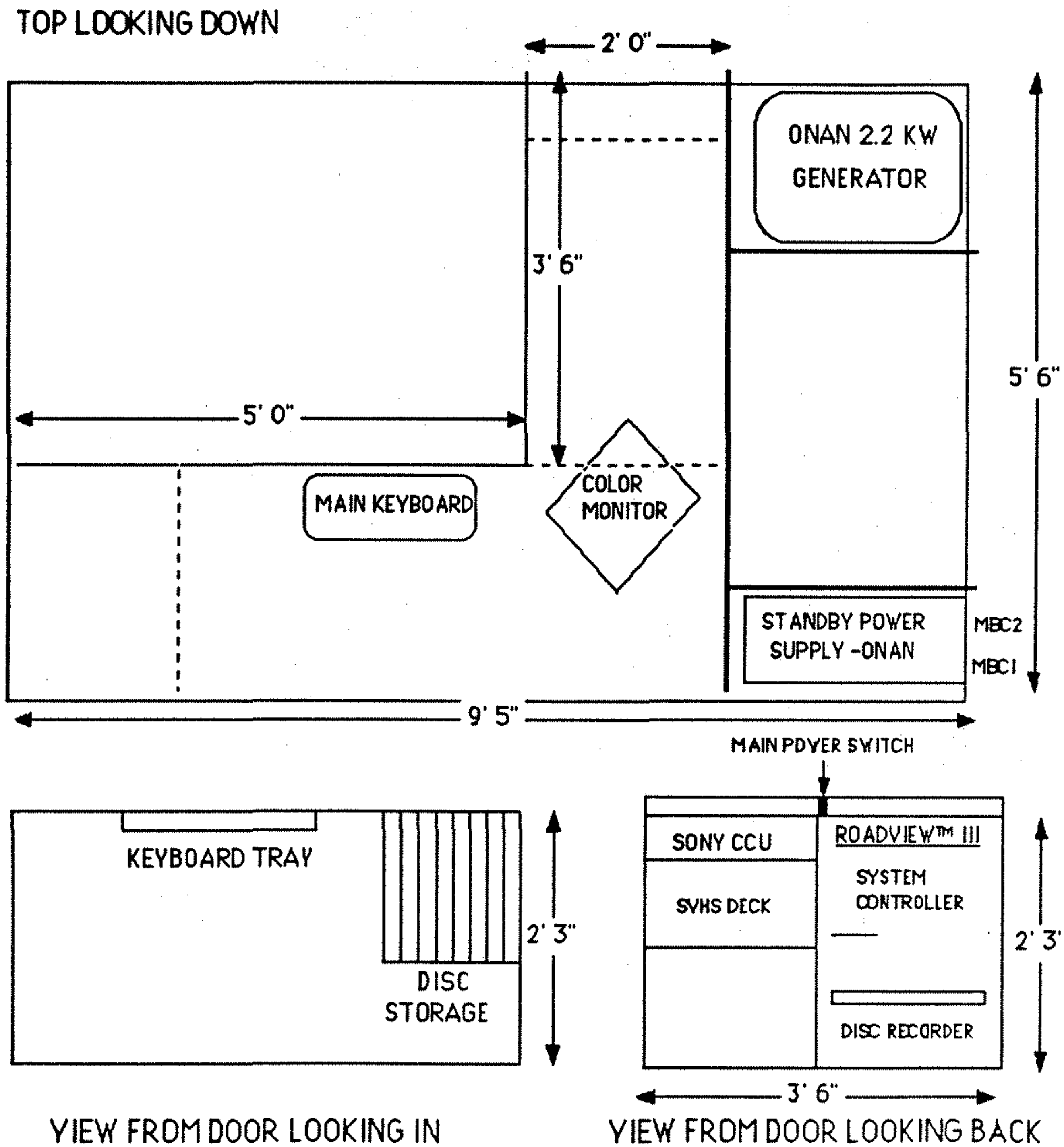
Images are stored on removable 12-inch optical laser discs and 120-minute S-VHS tapes. District, county, route and milepoint data are stored on the hard disk which the operator can download to a 3 1/2-inch floppy disk. A sample of the data file has been included in Attachment Two. The on-board workstation also has a Sony PVM-1344Q monitor for playback of S-VHS and laser disc images. The monitor can also be used as a diagnostic tool to aid in troubleshooting of the video signal.

Vehicle Design

Layout

Figure four provides three viewpoints: Top looking down, side door looking in and side door looking back.[6]

Figure 4



The overall equipment layout and operation of the Iowa videologging design was influenced by the requirement that this vehicle would be operated by one person. Considerable attention was given to separating driving tasks and the operation of the videologging equipment. All start-up activities are performed in the area behind the driver's seat. The voice control also relieves the driver from manual input tasks while videologging.

A 1988 Ford Econoline van was selected because it offered a shorter distance from the windshield to the bumper while also providing sufficient floor area in the front cab to mount the camera. A safety cage was installed behind the driver's seat, along with an air-ride seat to reduce driver fatigue. A carbon monoxide monitor was also installed to detect fumes from the on-board gas generator.

All of the electronic equipment was rack-mounted with shock pads installed. A L-shaped work surface was attached to the racks, which also provided storage space for the laser discs and video tapes.

Typical Mobile System Operating Procedures

Iowa's videologging program mileage is based on the boundaries of the six Iowa DOT's management districts as well as three roadway categories. Each category represents mileage for both directions. The first group is the interstate mileage and represents 1600 miles. The second category is the commercial network with 4,400 miles and the last group is approximately 14,000 miles and includes all remaining primary routes. By separating the mileage, different frequencies can be used to update the image files.

Once the system is powered up, the operator performs a system check which involves focusing the camera, checking white/black balance of camera, verifying shutter speed and iris setting, and selecting appropriate voice file. The entire system is menu driven and prompts the operator with the next set of options and guides the operator through the remaining start-up procedures. The first window checks to see if you want to use an existing work file. The work files contain all of the routes which have been separated into route type, district and county. The file also contains beginning and ending reference points direction of travel and the sampling interval selected for the laser disc. This on-board database allows the operator to create a temporary work file of highway segments by pointing and clicking the mouse. This feature not only reduces the chance of a typing error but allows the operator to quickly adjust planned activities if the need arises.

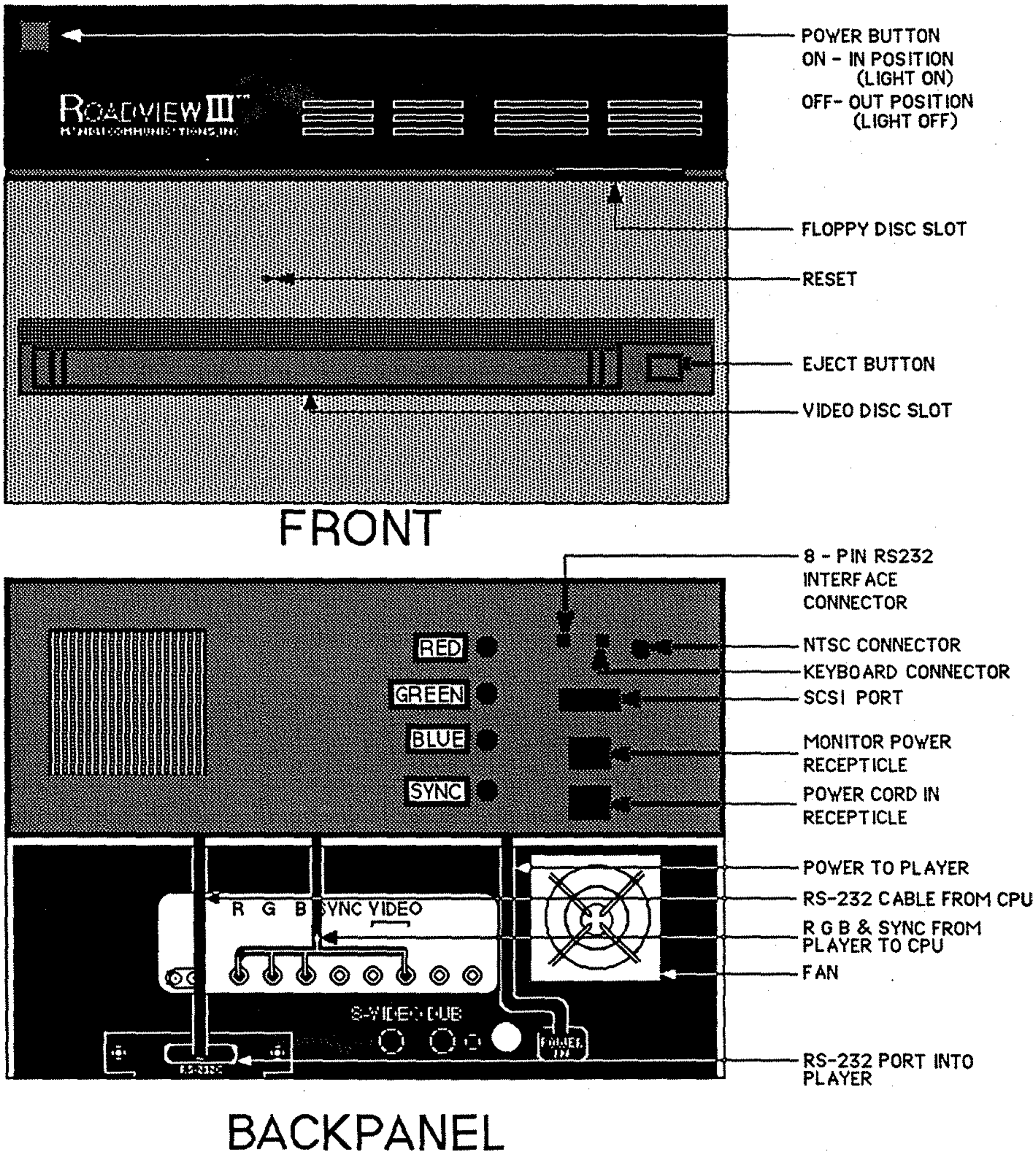
Office Work Station Design

Hardware

While defining the scope of this project it became apparent that one of the major benefits of this technology was the rapid access of image information. This information could be even more powerful if it was linked to other data files and incorporated into a management reporting/monitoring system.

The office workstation used in this demonstration is the ROADVIEW III TM. The ROADVIEW III TM work station manufactured by Mandli Communication Inc. consists of a 12-inch optical disc player which is interfaced with a 68030 microprocessor. The system is self contained except for a monitor, keyboard and mouse which sits along side the system case. Figure five provides a front view and a rear view of the unit.[7]

Figure 5

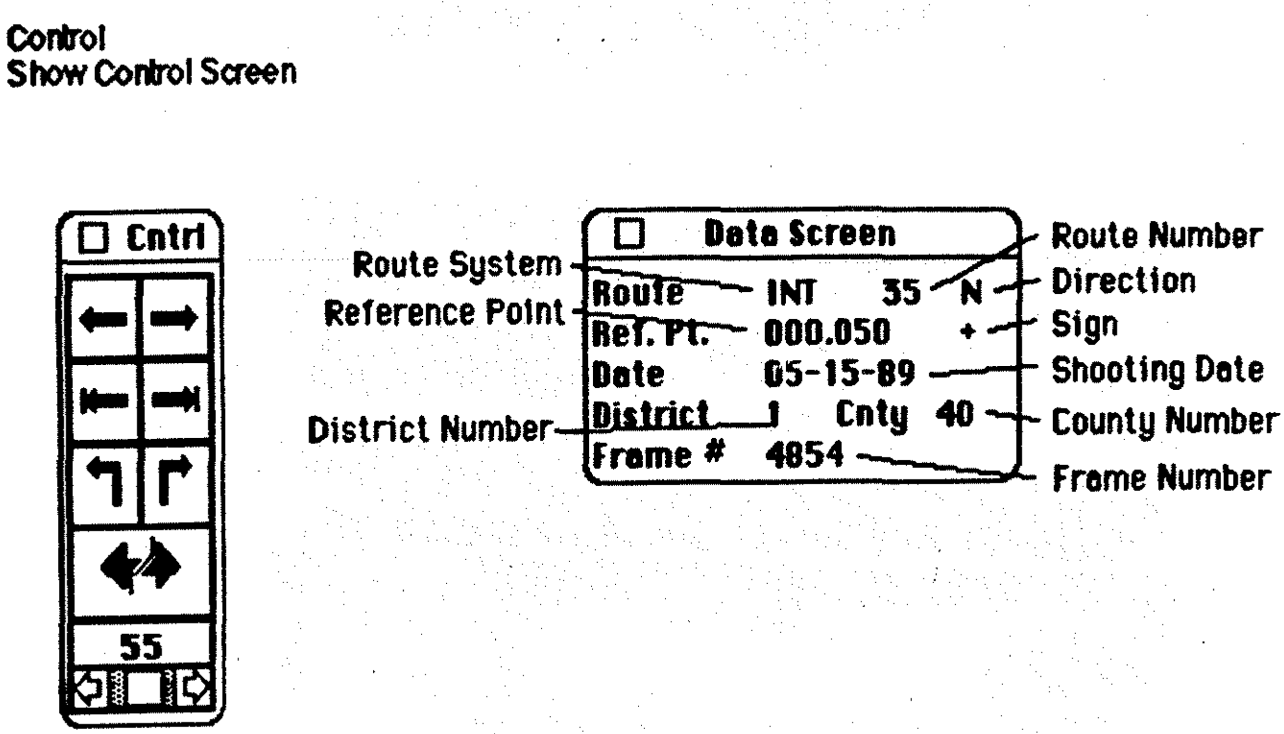


POWER BUTTON
ON - IN POSITION
(LIGHT ON)
OFF- OUT POSITION
(LIGHT OFF)
FLOPPY DISC SLOT
RESET
EJECT BUTTON
VIDEO DISC SLOT
FRONT
8 - PIN RS232
INTERFACE
CONNECTOR
NTSC CONNECTOR
KEYBOARD CONNECTOR
SCSI PORT
MONITOR POWER
RECEPTICLE
POWER CORD IN
RECEPTICLE
POWER TO PLAYER
RS-232 CABLE FROM CPU
R G B & SYNC FROM
PLAYER TO CPU
FAN
RS-232 PORT INTO
PLAYER
RED
GREEN
BLUE
SYNC
R G B SYNC VIDEO
S-VIDEO DUB
BACKPANEL

Software

After images have been collected the next step is to index the images before the disc is placed into the work station library. The Roadview III TM software package allows the user to select the facility, district, route and county. The operator is then instructed to insert the appropriate disc into the video disc slot. Once the operator has done this, a menu bar will appear on the top of the screen. The menu bar allows the user to display a data screen and control screen; index and search a disc; display roadway alphanumeric data generated from other databases; and create a temporary playback file of user-selected images. Another key feature of the work station is the ability to organize image data to facilitate analysis. The operator can view the opposing direction by pushing one button. While special analysis requirements may cause some changes in the way the image data is gathered (i.e., to match up road mileage both views should be on the same side of a disc), it greatly increases the flexibility of accessing information. Other features of the system is the ability of the user to define the speed of viewing the images. The system can be played back at various speeds. Each of these features can be overlaid on top of the images and can be hidden from view by the user. Figure six shows the data and control screen.

Figure 6



The laser disc workstation is the primary retrieval system because of its storage capacity and instant access to exact sections of highway. The S-VHS tape is used to supplement the laser disc information.

Results

System Design

The video image from this design has proven to be acceptable for highway department use. A 25-foot sample rate provides a satisfactory image that can support management of the roadway environment. Placing the image directly on laser disc has proven the potential for offering a lower cost alternative to film or film to laser disc conversion. At this time laser disc technology continues to be a highly desirable storage medium for large amounts of data and provides easy access to visual information.

Lessons Learned

After a few weeks of videologging, several changes were made to the operating procedures. The purpose of these changes is to assist the operator in making adjustments to the image and mileage files without stopping. Also, these changes could eliminate some of the editing of the laser disc. Several commands have been added to the system control software. The "extra" command allowed the operator to adjust the reference point mileage if the as driven highway mileage was shorter than known points. The "next record" option allowed the operator to adjust for longer sections by advancing to the next segment in the work file. The "pause" command allowed the operator to pick a point along the roadway and put the system in standby mode, drive further, and come back to the break and continue without reentering reference data. If planned activities were disrupted, a feature was added that allowed the operator to change the beginning reference point.

The following observations were made during the 6,800 mile test:

1. The fine adjustment control for the automatic iris on the Sony DXC-750 needs a wider range. Currently the half-step range doesn't always adequately handle the changing lighting conditions.

2. The optical disc has been ejected from the recorder three times, twice due to large pot holes and once while crossing a deep-grooved warning rumble strip.

3. Once the laser recorder has jumped over a frame and recorded out of sequence, which caused the system to shut down. It has not been determined if it was caused by the recorder or by a bad spot on the optical disc.

4. Sync errors occurred intermittently. The problem didn't cause the system to shut down and the pictures recorded were acceptable, but the system appeared to lose several frames of video during each occurrence before it recovered and began to record images. This may occur three or four times during a 100-mile run. Some possible causes investigated by MCI included vibration, interference with the sync signal, and an alignment problem with the linear motor in the laser disc recorder.

The Accident

The Iowa videologging van only completed 6,800 miles of the planned 7,500-mile field test because of an accident. The van was being transported to the central office with the videologging equipment shut off when another vehicle crossed the center line and hit the van head on. The operator had his seat belt on and walked away from the accident. The van is a total loss as well as the video logging system.

The accident has caused several changes to the outcome of the project. First, it prevents an accurate assessment of the durability of the videologging components. Each component in the image gathering system was to be tested to see if it was still generating a signal within specifications. One of the key components in the laser disc recorder is the linear motor which keeps the laser head in position. This unit was to be checked for wear and estimates made on the operating life after 7,500 miles of operation.

Second, it prevents verifying proposed solutions to the videologging system design.

Proposed Modifications

1) To handle the power fluctuations of the gas generator, an uniterruptable power source (UPS) was installed to stabilize the power. Based on the additional cost of the UPS and maintenance of the gas generator, the preferred choice for on-board power is an inverter. This will require the videologging van to be equipped with a larger engine and a minimum of a 190-amp alternator.

2) Shock mounting of the video equipment is probably the most critical design issue that must be addressed. The rack design should provide a lower center of gravity and be moved from the rear axle.

3) All components should be incorporated into a rack, i.e., monitor.

4) Include a safety screen for entire front compartment to separate equipment and driver/passenger area.

5) Simplify operator controls.

References

1. Anderson, Paul, "Electronic Still Photography: Where It Stands Now", ADVANCED IMAGING. Jan. 1989, page 24.

2. Fink, D.G., "Section 20 Television and Facsimile Systems", Electronics ENGINEER'S HANDBOOK.

3. Woodcock, Roderick, "A Tale of Two Chips", VIDEO, April 1988, pages 28 and 29.

4. Philips Research Holland, "Erasable Optical Discs", Electronics-Technology Today. Sept. 1987, page 49.

5. Skriba, Lou, Optical Disc Duplication Services, (312) 680-7794.

   Schutte, Gary, NEC America, Inc., Broadcast Equipment Division, (312) 860-7600, Ext. 3820.

   Yamamoto Setsuo Nec Corporation, Video Development.

6. Mandli Communication Inc. (608-836-3344), Draft Instructional Manual for the Operational Procedure to be Employed in the Use of the Iowa DOT Photolog Van". Oct. 1989.

7. Mandli Communication Inc. Draft, "Instructional Manual For the Operational Procedure to be Employed in the Use of the Work Station Known as Roadview III TM".

ATTACHMENT ONE

List of Manufacturers and Contacts

Image Input

Fujinon TV Zoom Lens A16 x 9.5 BRM-88

Service Center
Fujinon Inc.
10 High Point Drive
Wayne, New Jersey 07470

201-633-5600

Sony Video

Camera DXC-750
Service Representative
Pat Barrett

312-733-6043

Processing

Macintoch IIx
TrueVision NuVista
MassMicro Graphic

Contact: Mandli Communication Inc.

608-836-3344

Storage

Panasonic Optica Disc Recorder TQ3031F

Service Representative
Panasonic Industrial Co.
Division of Matsushita
Secumcus, New Jersey 07094

201-348-7837

S-VHS Video Cassette Recorder

JVC BR-S610U
Service Center
Kent Audio Visual

402-551-9379

Output

Sony Trinitron Colored Video Monitor PVM 1244Q

Pat Barrett
Itasca, IL

312-773-6043

ATTACHMENT TWO

SAMPLE DATA FILE

```
*    1INT  8077 1 15.760E+89062713 7 7 200
*  169INT  8077 1 16.096E+89062713 734 200
#BRIDGE         INT  8077 1 17.502E+89062713 913
*  658INT  8077 1 18.541E+890627131028 200
*  820INT  8077 1 18.865E+890627131052 200
#STRUCTURE      INT  8077 1 19.655E+890627131148
#BRIDGE         INT  8077 1 20.065E+890627131217
#BRIDGE         INT  8077 1 21.826E+890627131415
* 1420INT  8077 1 21.865E+890627131419 200
* 1421INT  8050 1  0.000E+890627131419 200
#STRUCTURE      INT  8050 1  2.936E+890627131736
#STRUCTURE      INT  8050 1  4.926E+890627131946
* 2411INT  8050 1  5.000E+890627131951 200
* 2604INT  8050 1  5.961E+890627132218 200
* 2605INT  8050 1  0.000E+890627132815 200
#STRUCTURE      INT  8050 1  2.501E+8906271331 1
#BRIDGE         INT  8050 1  2.851E+890627133124
#BRIDGE         INT  8050 1  4.326E+890627133258
* 3605INT  8050 1  5.000E+890627133340 200
#STRUCTURE      INT  8050 1  5.301E+890627133359
#BRIDGE         INT  8050 1  6.915E+890627133541
#BRIDGE         INT  8050 1  7.890E+890627133642
#INTERCHANGE    INT  8050 1  8.931E+890627133749
#BRIDGE         INT  8050 1  9.550E+890627133829
* 4605INT  8050 1 10.000E+890627133859 200
```

FILE FORMATS FOR REFERENCE LINE (*) & OPERATOR COMMENTS (#)

* COLUMN	* LENGTH	DESCRIPTION	# COLUMN	# LENGTH
1	1	LINE TYPE (* #)	1	1
		EVENT	2	15
2	5	FRAME NUMBER		
7	3	ROUTE SYSTEM: INT=INTERSTATE COM=COMMERCIAL OTP=OTHER PRIMARY	17	3
10	4	ROUTE NUMBER	20	4
14	2	COUNTY NUMBER	24	2
16	2	DISTRICT NUMBER	26	2
18	7	REF PT (XXX.XXX)	28	7
25	1	DIRECTION	35	1
26	1	SIGN	36	1
27	6	DATE (YY/MM/DD)	37	6
33	6	TIME (HH:MM:SS)	43	6
39	4	PICTURES PER MILE		