Internet Mobile Information Retrieval System and its Traffic Analysis

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Abstract

This paper describes an information retrieval system which offers real time information about mobile vehicles through the Internet.

In order to evaluate the efficiency of solar batteries and feasibility of electric vehicles, four crews of Tokyo Denki University made a round trip through the North American Continent by their handmade solar electric vehicles last summer. In accordance with this project, an information retrieval system which offers the daily drive information through the Internet to the public was constructed. The system configuration and operating results of this system are reported.

1 Introduction

The Internet is a data communication network which connects computer networks installed in every university and enterprise. It enables us to send electronic mails and files to arbitrary members affiliated to this network. We can also utilize the computer resourses of this network under the permission of members.

The installation of the Internet began about 30 years ago mainly in the United States. After that, the network area has been covering the world. Currently, the number of the affiliations is said to be more than 50 millions.

The information transfered through the Internet contains not only characters or numerics but also audio and visual information if they are represented by a digital data format. Every member is authorized to open his/her own home page on the network and present his/her various information to all other members on the network. Simply, every member can offer his/her informative data to every member in the world.

This paper describes an information retrival system which offers real time information about mobile objects such as automobile, planes, and so on to every member in the network.

Last summer, four crews from Tokyo Denki University (TDU) made a round trip through the North American Continent by their handmade solar electric vehicle in order to get the technical data about solar batteries and electric vehicles. In accordance with this project, a Mobile Information Retrieval System (MIRS) which offers the daily drive information about the electric vehicle through the Internet to the public was constructed. Using this system, the crews of the solar electric vehicle send their daily messages, pictures and drive information about their electric vehicle

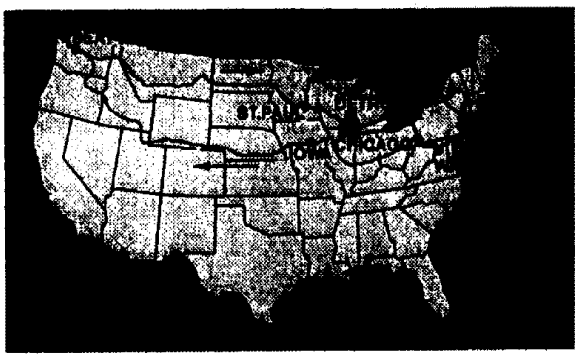

Figure 1: The route of the round trip

through a wireless telephone network or a satellite communication link to TDU. The members of TDU transformed the data into a World Wide Web (WWW) page data format and registered them in the network.

Through this experiment, the multi-modal, real time and world wide information retrieval capabilities of Internet have been verified.

2 Round trip project by solar electric vehicle through the North American Continent

2.1 Outline of the project

Round-trip through North American Continent by solar electric vehicle was planned to evaluate the performance of solar battery and electric vehicle remodeled from an ordinary small gasoline automobile by students and a professor of TDU.

The route of this project is shown in Fig. 1.

After leaving Seattle, the trial run team traveled through the northern part of the United States and the southern part of Canada. After arriving in New York, they turned back toward Seattle via the University of Iowa at Iowa State. Total amount of days for this round trip project was about 70 days. Table 1 shows the purpose of this project.

Table 2 shows the constituents of the running team.

Table 1: Purpose of project

- Verification of solar battery performance
  - Solar electric panel
  - Car mounted solar battery
- Applicability verification of solar batteries to electric vehicle
  - Maximum driving distance (Under fully charged condition)
  - Applicability verification of solar battery under various weather conditions
  - Applicability verification of rechargeable lead battery
- Verification of electric vehicle
  - Maximum speed
  - Driving performance on rough road, ascending or descending slopes
- Evaluation of Mobile Information Retrieval System
  - Real time transmission capability of driving data
  - Transmission performance of characters and images

Table 2: Constituents of running team

- Running crew
  - Captain: a professor of TDU
  - Crew: 3 students of TDU
- Solar electric vehicle
  - Vehicle driven by an electric motor
  - Vehicle remodeled from an ordinary small sized car
  - Vehicle equipped with rechargeable lead batteries charged by solar cells
- Support car
  - Commercially available middle sized van
  - Ordinary car driven by gasoline engine

2.2 Specification of solar electric vehicle and it's running results

Table 3 shows the specification of the solar electric vehicle.

Based on the performance (shown in Table 3) of the

Table 3: Specification of solar electric vehicle

Items	Contents
Weight	980kg
Physical dimension	length: 3,295mm width: 1,395mm height: 1,390mm
Maximum speed	115km/h
Maximum mileage	300km (at 40km/h running)
Maximum number of drivers	2
Maximum power of Electric motor	Rating output 12.8kw
Maximum output power of solar battery	200w
Efficiency of solar battery	16%

Table 4: Running result of project

Items	Contents
Total mileage	11,280km
Total amount of days	69 days (24/Jul. - 30/Sep.)
Total amount of power consumption	798kWh
Average fuel consumption	14.1 km/kWh

solar electric vehicle, it averaged 150–200 km per day. Rechargeable fuel lead batteries were charged by the solar cells mounted on the vehicle. But they were also charged by the solar panels and commercial power supply of gas stations or motels in case of a power shortage of the solar cells.

Table 4 shows the running results of this project.

3 Mobile Information Retrieval System through Internet

3.1 Outline of the system.

Figure 2 shows the system configuration of the MIRS.

Three transmission routes for the solar electric vehicle information were arranged as shown in table 5.

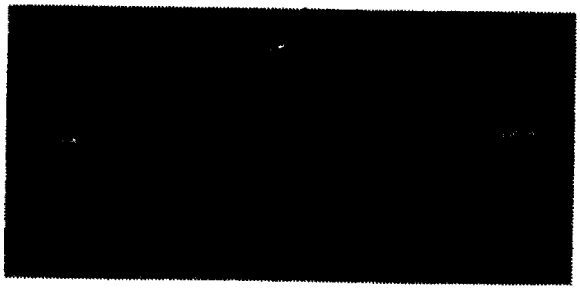

Figure 2: Mobile information retrieval system

The first route is through the Internet. The information of a solar electric vehicle is first transmitted to NTT America office in California by using a modem and cellular phone. Then, the information is transmitted again to the WWW server of TDU through the Internet.

The second route uses an international telephone network. Information in the personal computer of the running team is directly transmitted to the WWW server of TDU by remote login procedures. This route was arranged as a supplement to the Internet route.

The third route is by way of communication satellites. As the running team had been equipped with a small-sized satellite communication apparatus, the information in the personal computer is directly transmitted to the WWW server of TDU through the satellite communication links. This route is also arranged as a supplement to the Internet route, when the solar electric vehicle goes out of cellular phone range.

The information from the solar electric vehicle was registered on the home-page of the WWW server of TDU, which offers the information to the public through the Internet. The public users who accessed to the home-page of TDU could find the entry of this project, and get this interesting information.

3.2 Objective information and its transmission method

The media of this information retrieval system is shown in table 6.

In table 6, the image and character informations are transformed into home page data everyday by TDU

Table 5: Transmission route

Transmission route	Detail
Internet route	Cellular phone → EWS at NTT America → Internet → WWW server of TDU
International telephone network route	Cellular phone → Telephone network in the U.S.A → International telephone network → Telephone network in Japan → WWW server of TDU
Satellite communication route	(a) Satellite communication apparatus → INMAR Sat. → Satellite ground office in the U.S.A. → International telephone network → Telephone network in Japan → WWW server of TDU (b) Satellite communication apparatus → Satellite ground office in Japan → Telephone network in Japan → WWW server of TDU

Table 6: Kinds of Information media

Items	Contents
Photographic image (Landscape picture)	Color still picture Resolution:300x200 Coding method:GIF
Illustration (Route map)	Color illustration
Characters (Daily message)	Coding method:Shift JIS

staff based on the transmission data from the running crew. Table 7 shows the equipment mounted on the solar electric vehicle for the transmission of the information.

The software for document editing, image processing and data transmission was installed in a personal computer mounted on the solar electric vehicle. A member of the running crew took turns writing and editing the manuscript everyday on the personal computer. The manuscripts were transmitted through a data modem of a cellular phone. Images were picked up by a digital still camera and encoded into digital codes using a JPEG format. The image data were transmitted through a data modem of a cellular phone as well.

3.3 Evaluation of transmission performance

Among the arranged three routes, the Internet route was mainly used for the transmission of driving data. The other two routes had problems as shown bellow. In the transmission of data through the international telephone network:

(a) Transmission errors caused by channel noise prevented the correct data transmission.

(b) Instantaneous channel breaks occurred several times in the satellite route.

In the transmission of data through satellite communication:

(a) Echoes in a channel interfered with correct data transmission.

(b) The data transfer bit rates were as low as 600 to 1,200 bps.

Table 7: Transmission Equipments

- Personal computer
  - Word processing
  - Pre-processing of photographic image
  - Data transmission
- Digital still camera
  - Landscape pick up
  - Image coding (JPEG coding)
- Mobile telephone (Cellular phone)
  - Speech communication
  - Data transmission through data modem
- Satellite communication apparatus
  - Speech communication
  - Data transmission through data modem

Table 8: Contents of information pages

Items	Contents
Introductory page	· Page index · Access method
Out line of the project	· Round trip of solar vehicle through the North American Continent
Solar electric vehicle	· Structure and performance of solar vehicle · Performance of solar cell
Round trip route	· Route map of the round trip project
Crew	· Profiles of running crews
Data transmission	· Data transmission routes
Drive data	· Daily drive data
Messages	· Daily messages from running crews
Sponsors	· Sponsors names
Back up staff	· Names of TDU back up staffs

(c) Channel establishment is difficult when a satellite is situated in a very low angle from a horizontal direction.

Because of these reasons, international telephone network route and satellite route were used only experimentally.

3.4 Offerered pages and access method

We prepared 10 kinds of information pages for our WWW server as shown in table 8.

These information pages are classified into two categories. One is an explanatory page for our MIRS and round trip plan, which were prepared in advance and registered in our WWW server. The other one is travel information pages updated everyday based on the data transmitted from the running crews. Every page was constructed in a manner which included at least one visual document such as photographic pictures or illustrations. These visual information were very helpful for public users to understand the general aspect of the system and the circumstances of running crews.

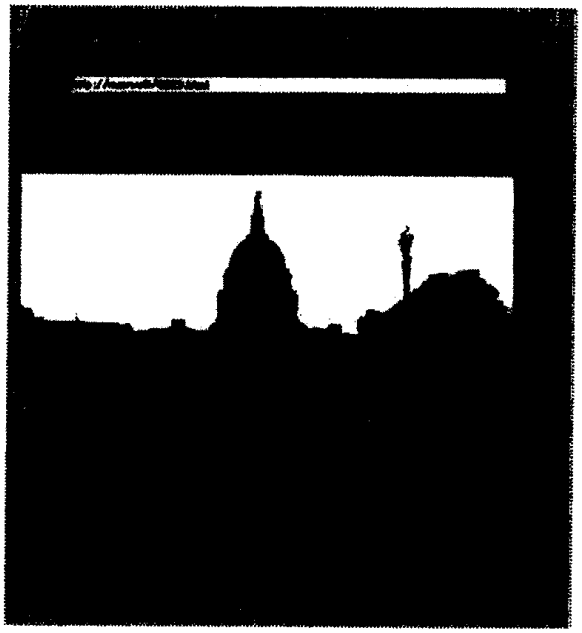

Figure 3: Example of offered page

For example, the running route and the daily location of the solar electric vehicle was shown on an illustrated map. Moreover, messages from the running crew were offered with their photographic images. Example of an offered page is shown in figure 3.

3.5 Page update and information retrieval method

The data from running crew were transmitted to WWW server of TDU through the Internet. Then, the TDU staffs decoded the data and constructed screen pages based on the data. Namely, the transmitted image data were represented by JPEG format. The TDU staffs decoded them and edited their sizes in order to match the size of screen pages. Then, the image data were transformed into GIF format and saved. The document information was also inserted in a space of screen pages with photographic images. In this way, html file for WWW server was constructed everyday, and was registered. The, the old page file for drive data and messages were replaced by new one everyday.

The old replaced html file was structured and stored again as a back number file. For easy access to the old data file, html file was structered hierarchically as

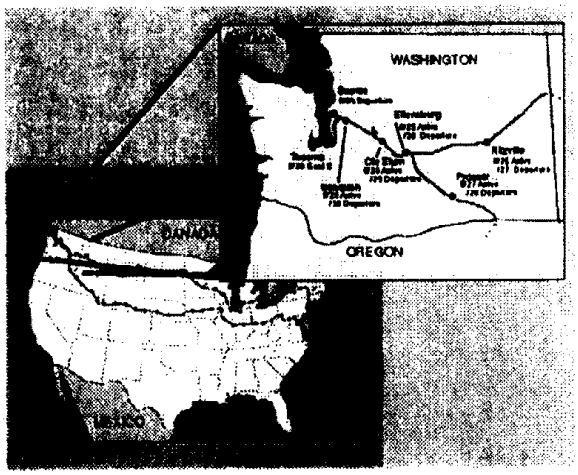

Figure 4: Hierarchical structure of back number file

shown in figure 4.

Access to the old data file could be obtained as follows.

(a) User selects the back number section in the introductory page.

(b) A map screen of North American continent appears on the display. The route and point where the solar electric vehicle has already passed is drawn on the map.

(c) When the user points at a position on the route by mouse, a more detailed (state level) map appears on the screen. The city names and dates visited are shown on this state map.

(d) By clicking a city position indicated by a solid circle, the user can retrieve the image and document information of that place.

4 Operating results of the system

4.1 An amount of information

The information or data transmitted from the crew in the US was classifed into two categories: one is character data including driving position, car status and crew messages, the other is image data or pictures taken by the crews.

Table 9: Amount of transmitted data and home page data

Items	Count	Total Amount	Average
Message	36	98,287	2,730
	36	90,621	2,517
Image	103	7,483,752	62,658
	65	4,404,613	67,763

Table 10: Access number to MIRS

Total access number	8,049
Total transmitted data (byte)	326MByte
Total number of hosts accessed to the system	1,288

Receiving this information, the TDU-staffs in Japan edited them and transformed them into WWW pages.

Table 9 shows the amount of data transmitted from the US(upper line) and home page data reconstructed from them(lower line).

4.2 Statistics of access

Table 10 shows the access number to the MIRS in the period from Jul/20 to Dec/31.

Figure 5 shows the weekly access number to the MIRS.

During the period shown in Fig. 5, the WWW server of TDU was out of service from August 12th to August 16th because of a system maintenance.

Table 11 shows the categories of accessors and the number of access times.

4.3 Analysis of access traffic

From fig. 5 we can find that the MIRS is consistently accessed during the whole period. Moreover, detailed analysis shows that there are no obvious tendencies for access with respect to day of the week and time of the day.

Figure 6 shows the number of accesses to all pages and the access ratio between the total accesses and daily updated page accesses. Figure 7 shows ratio of number of access pages. From figure 6 we can find that daily updated pages for driving route and messages

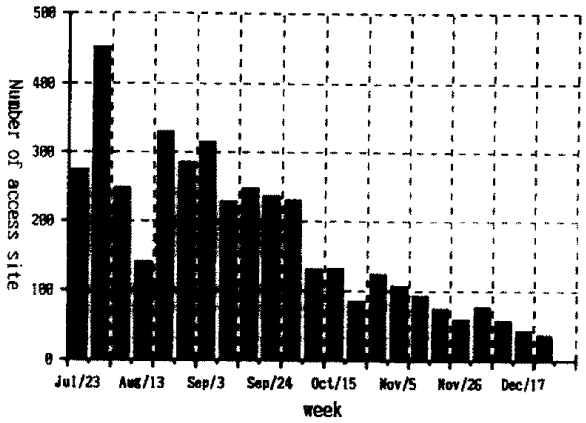

Figure 5: Weekly Access number to MIRS

Table 11: Category of Accessors

Category	Number of access
jp	636 (100*)
numerical IP	350 (115*)
com	150
net	35
edu	31
ca	10
org	8
au, uk	6
gov	5
se	4
de	3
arpa, th, us	2
ar, fi, fr, it	1
kr, kw, my, nl	

*: sites in TDU

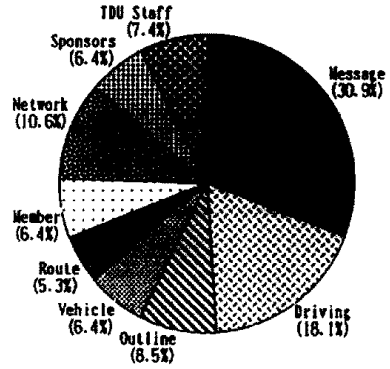

Figure 6: Access number to pages

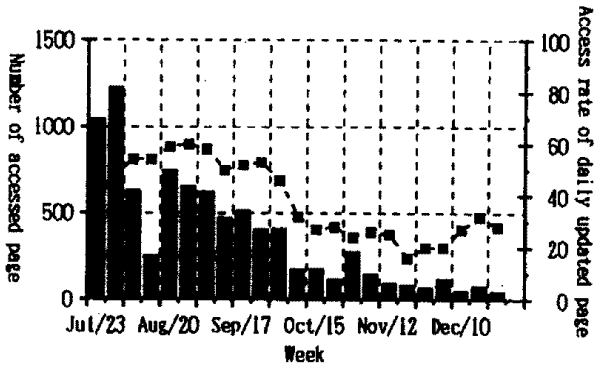

Figure 7: Access ratio of pages

with pictures are accessed frequently. And from Jul/30 to Sep/24 , the access ratio is over 50%. This is because the repeated accessors knew that pages were updated daily and then accessed the pages mainly.

We also analyzed the transition sequences of access between pages. Table 12 shows the access transitions from one page to another.

From table 12 we can find that the direct paths from the introductory page to the driving route or message pages were selscted frequently. This is because those pages are updated daily and contain many photographic images, which are attractive to most users.

5 Conclusion

This paper introduced a real time mobile information retrieval system which offered daily driving data from a solar electric vehicle to the public by way of the Internet. During the two month trip, this system offered a total of 50 pages and data, composed of 35 daily-transfered messages with 103 pictures and 15 pages of stationary (explanatory) data. During this period, 12,699 accesses to this system were made from 11 countries all over the world. The traffic analysis shows that the number of accesses to daily refreshed pages were more than that of stationary pages. And it also shows that the picture pages were more popular than the pages composed of only characters and

Table 12: Access transition between pages

From/To	intro	car	route	member	network	record	sponsor	staff	driving	message
intro	0	10	5	17	15	3	6	3	21	19
car	16	0	10	8	6	3	9	7	20	18
route	14	8	0	18	10	4	9	7	21	10
member	12	7	7	0	18	2	10	9	18	18
network	12	14	9	8	0	7	10	8	21	10
record	20	8	12	5	10	0	29	17	0	0
sponsor	15	7	5	6	6	2	0	33	15	11
staff	19	7	5	8	6	5	12	0	19	18
driving	7	5	4	3	4	0	5	5	0	68
message	12	7	5	4	5	0	14	12	41	0

numerics.

Through these experiments, it was shown that the information retrieval system using the Internet realizes a useful means for offering multimodal, real time and world wide information to the public. And it was also shown that this kind of information retrieval system can be easily installed on the Internet.

The system data shown in this paper, such as traffic data, system parameters, and so on are the direct results derived from a real system. They seem to give good suggestions to designers for a similar type of information retrieval system.

Remarks: We would like to express our great thanks to members in several enterprises who offered electrical and mechanical devices for the solar electric vehicle. And also, we would like to give thanks to the members of TDU who took part in this project for their endeavours in making WWW page data.