

Recently, such representative car computer systems as car navigation systems have been improving at a very rapid pace. As a result, by as early as the beginning of the 21st century, we will likely see the arrival of automatic payment systems and automatic driving systems, otherwise referred to as "Intelligent Transport Systems" (ITSs). One of the main purposes of ITS is to make vehicles high information-oriented forms of transportation. An example of this is the appearance of built-in systems providing on a real-time basis traffic information that is useful to the driver, a system realized by linking the vehicle's car navigation system with its communications equipment. The ATIS which was introduced in 1995 and the VICS which made its appearance in 1996 provide mainly traffic information. Automobile manufacturers, however, have started working on building systems that provide drivers with other categories of useful information such as weather forecasts and news reports.

This paper introduces MONET, a new information service system that has been jointly provided by Toyota Motor Corporation, Fujitsu Limited, and Fujitsu TEN Limited since November 1977.

Information and Communications Systems (VICS), systems that offer drivers information about accidents and traffic jam on a real-time basis. Coincidentally, at about the same time, the number of users of cellular telephones (especially digital versions) grew rapidly. (Currently, cellular telephone service subscribers number 25 million.)

Under these circumstances, the Intelligent Traffic Guidance Service (ITGS), a new service for Mercedes Benz automobiles became available in 1997. This service uses the car's cellular telephone system to provide (via the car navigation equipment) drivers with not only traffic information, but also news, weather forecasts, and other information.

Other Japanese automobile manufacturers, led by Toyota Motor Corporation became actively involved in building systems offering similar information services. Since 1994, Fujitsu TEN Limited, with the cooperation of Fujitsu Limited and Toyota Motor Corporation, has been working on realizing a practical information service system.

This joint effort led to the establishment of Toyota Media Station Inc. in July, 1997. In November of that year, the new company began offering a new service called MONET (an acronym for MOBILE NETwork that has the same pronunciation and spelling of the well-known painter).

2. Characteristics of the MONET-compatible hands-free ECU

2.1 Overall system

Information that can be handled by the MONET-compatible hands-free ECU includes traffic-related information on such as that on accidents, traffic jams; information on facilities such as parking facilities and restaurants; entertainment-related information such as upcoming events; and general information such as news and weather forecasts; and personal-use information including electronic mail.

These pieces of information are collected by Toyota Media Station Inc. from information providers or via the Internet, then transmitted to users on request (See Figure 1).

2.2 Function overview

The MONET ECU, a sophisticated information terminal, works with cellular telephones and navigation equipment to collect information in types, forms, and quantities required by the driver and passengers when necessary (See Figure 2).

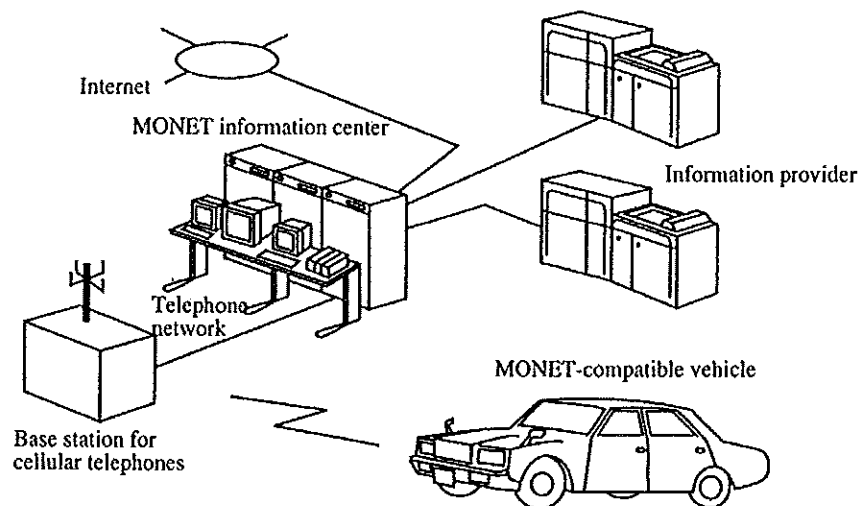


Figure 1 Configuration of a MONET system

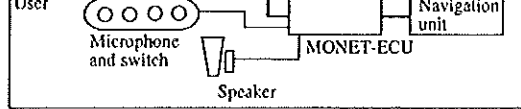


Figure 2 Components of the MONET car-mounted equipment

The MONET ECU has the following two major functions:

- Obtaining MONET information
- Serving as a hands-free telephone

2.2.1 Obtaining MONET information

The user can retrieve MONET information by originating a call after selecting the type of information desired, from the menu displayed on the terminal. Types of frequently used information or services can be registered in advance so that a request for the desired information/service can be issued with a few actions (See Figure 3, 4).

Information obtained may be text or image data. It is presented on the display installed in the passenger compartment.



Figure 3 MONET initial screen

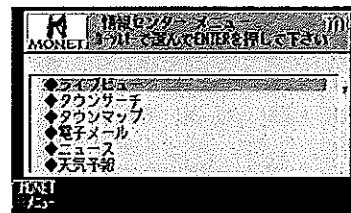


Figure 4 Menu for making a request

designed for compatibility with any manufacturer's cellular telephone. It contains software that allows it to work as an adapter controlling data communications to and from the cellular telephone.

The protocol for communications between the center and the car-mounted product is the Mobile Network Communications Protocol (MNCP) developed jointly between Toyota Motor Corp. and Fujitsu Limited. Innovations have been made to the protocol to shorten line connection times.

② Linkup with navigation equipment

When obtaining information, the MONET ECU uses as key data the vehicle's destination and current location set on the navigation equipment. For example, if a restaurant close to the destination is selected, position information (latitude and longitude) on the destination is obtained from the navigation system. This information is then transmitted to the information center as key data for information retrieval.

If the information received contains position information, the position information is passed to the navigation equipment. For example, position information (latitude and longitude) about a restaurant is passed to the navigation equipment so that the position of the restaurant can be displayed on the navigation map (See Figure 5).

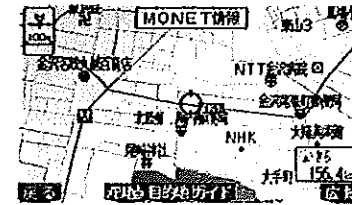


Figure 5 Display of specific location on MONET map

③ Data retrieval via voice synthesis

To ensure safe driving when the vehicle is traveling, the MONET ECU has a function that uses voice synthesis to read the text data out loud.

Since the data to be read out loud is transmitted from the center separately from the data to be displayed, there is no reading error (See Figure 6).



Figure 6 Screen displayed when text is being read aloud

④ Information storage

Information once retrieved can be stored in a nonvolatile memory so that it can be viewed at a later time. This means that the user need not down-load information from the information center each time such information is required. Instead, the user can view the information by retrieving it from the memory in the terminal.

⑤ Types of information

The types of information currently available are given below. The information menu is managed by the center and updated automatically when appropriate.

- Road traffic information (See Figure 7)
- Facility information (parking facilities, gas stations, restaurants, ski resorts, interesting town spots and others) (See Figure 8)
- Town map
- Japan Automobile Federation (JAF) guide
- Hospitals
- Police stations
- Live images
- Electronic mail (See Figure 9)
- News (See Figure 10)
- Weather forecast (See Figure 11)

Typical information screens are shown below.

<Road traffic information>

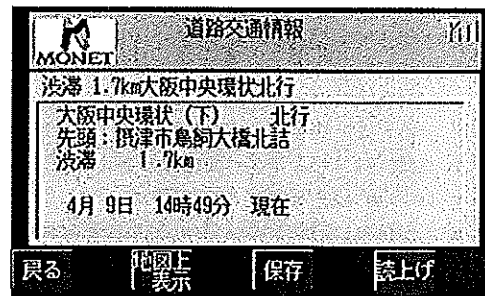


Figure 7 Traffic information screen

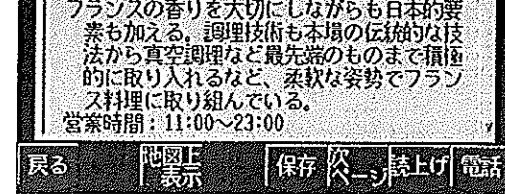


Figure 8 Restaurant information screen

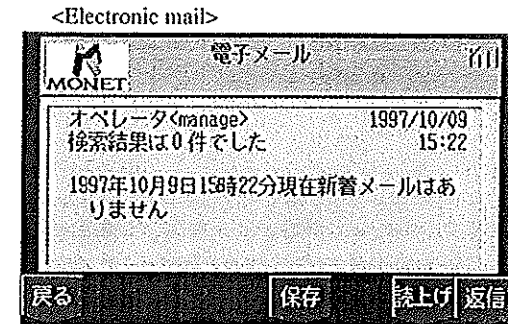


Figure 9 E-mail screen

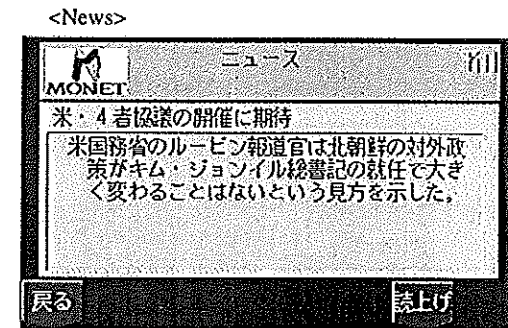


Figure 10 News screen

<Weather forecast>

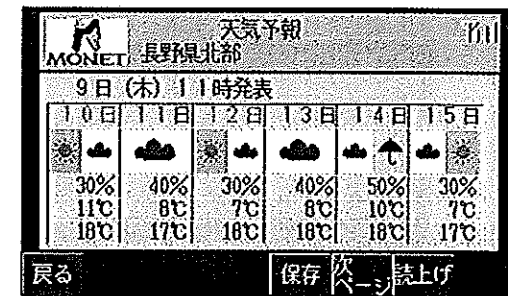


Figure 11 Weather forecast screen

to minimize the driver's operation loads when using telephone.

The driver does not need to operate the cellular phone directly. The driver only needs to use certain screen buttons, an attached microphone, and a switch for either making a call or responding to an incoming call. Using a microphone and loudspeaker installed in the vehicle interior allows the driver to operate the cellular phone in a hands-free manner.

The MONET ECU is also equipped with standard functions a typical cellular telephone would have plus a function for transferring data to or from the cellular telephone.

① Dialing

The user enters a telephone number to make a phone call (Figure 12).

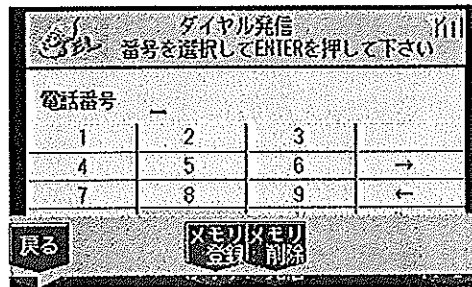


Figure 12 Dialing screen

② Automatic dialing

For automatic dialing, you simply select a telephone number registered in advance in the memory. The selected number is then automatically dialed (Figure 13).

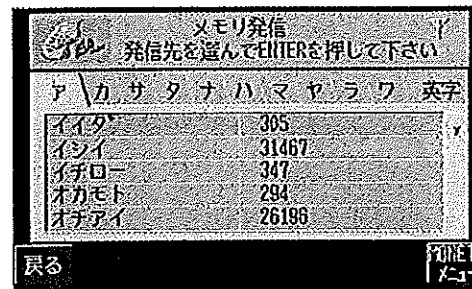


Figure 13 Screen for calling from memory

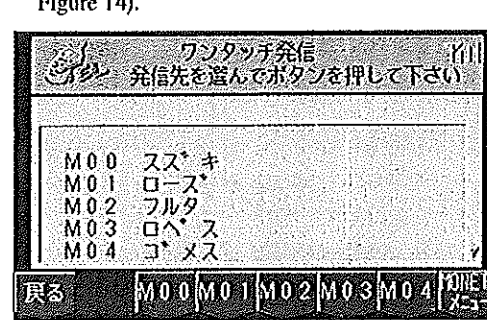


Figure 14 Screen for one-touch dialing

- ④ Answering incoming calls
You simply touch a switch to answer an incoming call.
- ⑤ Registering telephone numbers in the memory
You can register telephone numbers and names in the memory.
- ⑥ Transferring phone numbers from the cellular telephone to the terminal
You can transfer to the terminal those telephone numbers already registered in the cellular telephone.

3.1 Hardware characteristics

The MONET ECU uses Fujitsu's 32-bit CPU (SPARClite) and a newly developed MM-ASIC (MB87F116). A recent trend in implementing a function in a product is to design software specifically for that function. When developing the MONET ECU, we also designed software for a number of functions, including a digital data adapter (soft modem), voice synthesis, and image drawing control.

In the conceptual design stage, when we selected the components for the MONET ECU, we took into consideration the memory and CPU power required to run the software implementing these functions.

Figure 15 is a block diagram showing the internal components of the MONET ECU. The memory (flash memory, SDRAM, and SRAM) is arranged around the CPU and ASIC. The peripherals consist only of the required interfaces.

The cellular telephone (including the modem) and hands-free features incorporated in the MONET ECU are compatible with a good number of cellular telephone models.

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