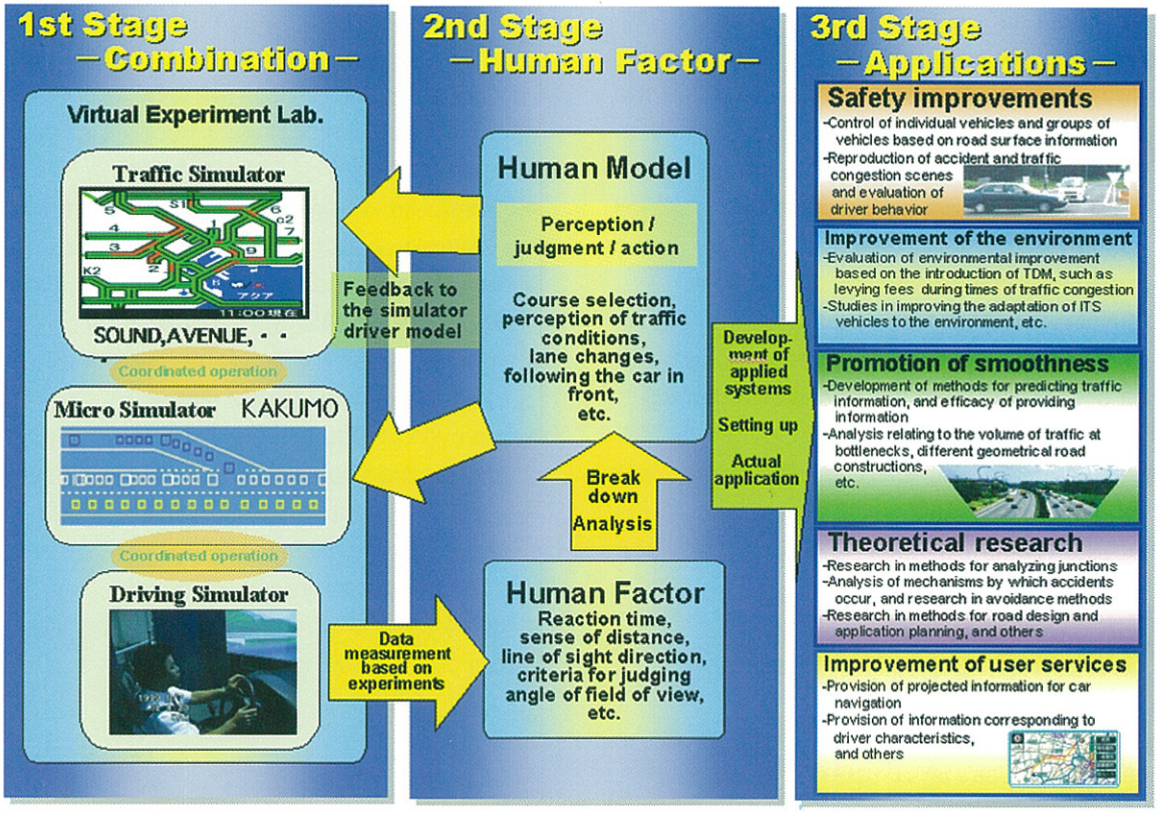
Volume 2 Number 1 March 1 2004

News letter

Sustainable ITS

Center for Collaborative Research
The University of Tokyo



Project Overview

The Sustainable ITS project was established as a partnership project among private, government and academic sectors at the Center for Collaborative Research (CCR), an international industrial and academic joint research center, in the Komaba Research Campus of the University of Tokyo. The project was launched in April 2003 with eight companies from the private sector taking part.

In this project, a new pattern is being woven in which collaborative research is being promoted. Diverse technical fields such as traffic engineering, vehicle control engineering, and electronic information engineering serve as the vertical threads, and tie-ups and cooperation among the private, government and academic sectors serve as the horizontal threads. Drawing on these collaborations, our aim in formulating this project is to develop and provide needs-oriented ITS technology and to usefully contribute to the cultivation of human resources by carrying out research and development, creating new ITS industries, ultimately helping to form a sustainable and livable society.

Elements of the project include the building of a complex realistic transportation experiment space that combines actual transportation spaces with virtual spaces. Also, we are designing and assessing sustainable ITS based on human factor characteristics (route choice, driving behavior, responses to information, etc.) that have been previously observed and analyzed. At the first stage, we built an actual observation laboratory where sensors are able to measure real subjects, created a Virtual Experiment Laboratory (VEL), and also created an environment in which the mutual interaction between human (drivers, pedestrians, etc.) and the vehicles and infrastructures around them could be considered.

At the first stage we construct the Virtual Experiment Laboratory, in which human behavior is controlled within a virtual space linked to the real world. At the second stage, we use the Virtual Experiment Laboratory to conduct fundamental research on human factors, and at the third stage, we expand the fundamental research and conduct applied ITS research.

The Virtual Experiment Laboratory

VEL:Virtual Experiment Laboratory

The Virtual Experiment Laboratory provides an environment in which people can actually drive, using a driving simulator contained within a traffic simulator using real-world data. As shown in the illustration, the Virtual Experiment Laboratory consists of four modules. The Driving Simulator (DS) provides an environment in which the test subject drives in the virtual space, and at the same time makes it possible to measure the driving behavior of the subject. The Traffic Simulator (TS) is a module that provides the driving conditions of the overall network in which the test subject is driving. Traffic conditions are sent to the DS through the KAKUMO.

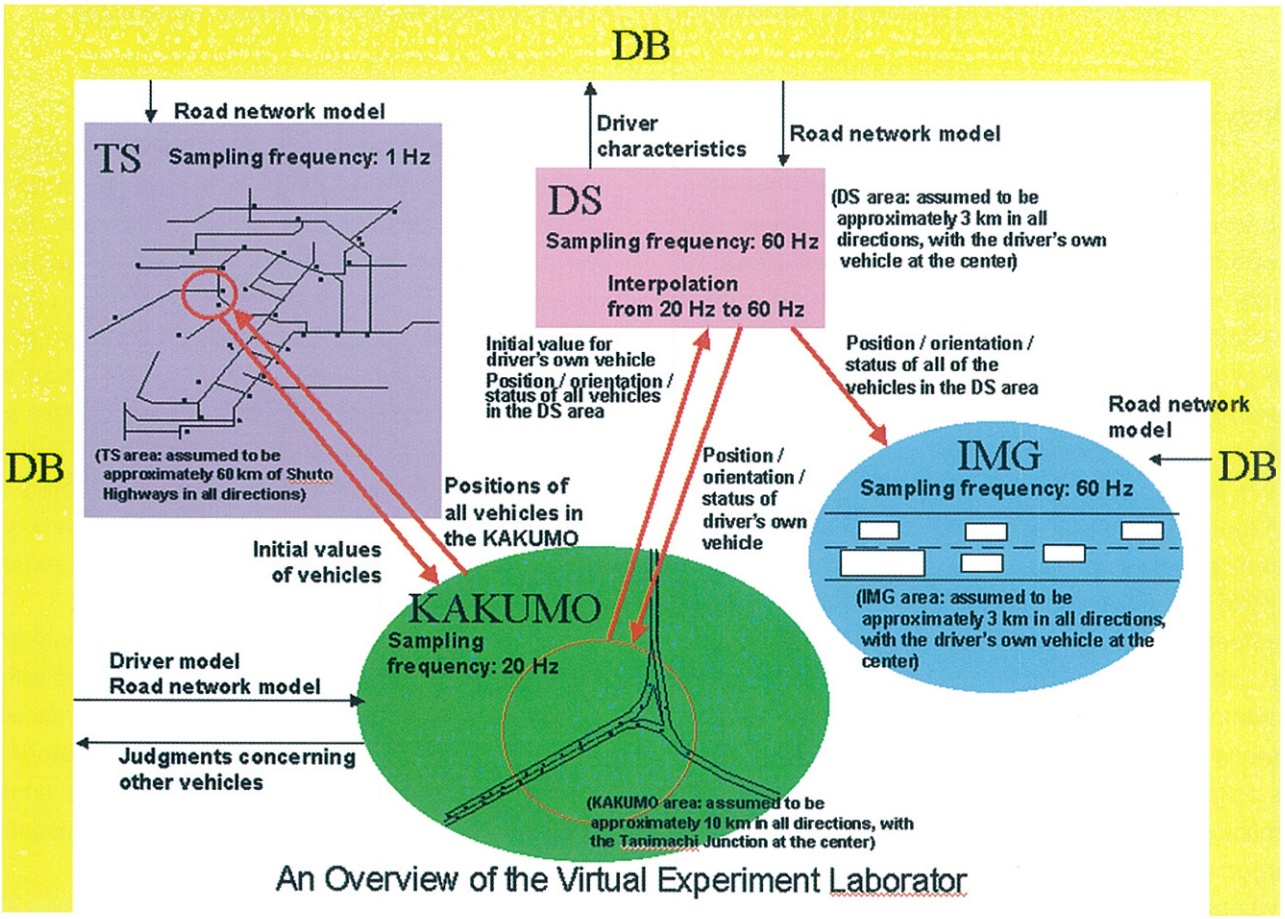
The KAKUMO is a module that links the TS and DS. Its function is to provide the TS with the test car behavior information obtained from the DS, and to provide the DS with the network traffic conditions obtained from the TS. The Image Generator (IMG) is a module that can rapidly display the simulator images to the test subject in the DS, while maintaining a realistic ambience of the images.

Driving Simulator

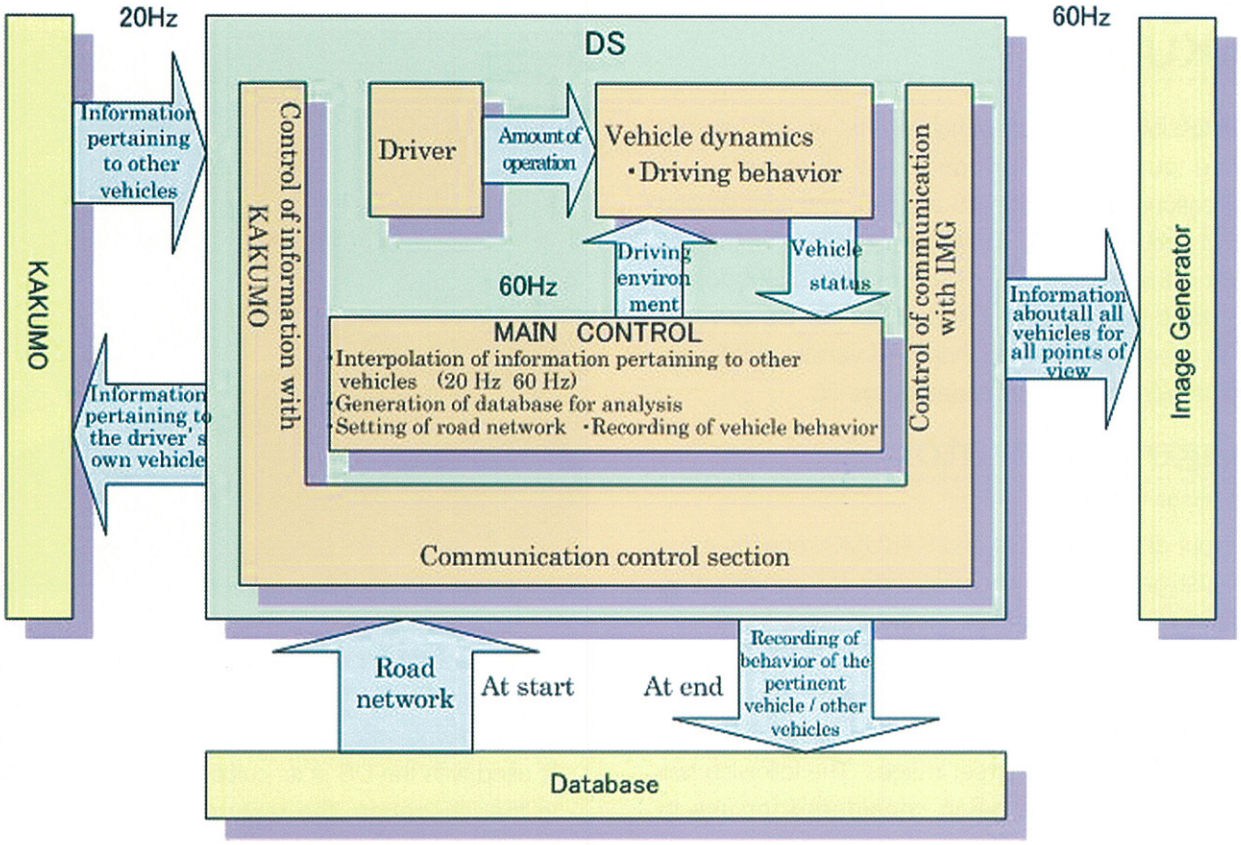
DS:Driving Simulator

One feature of this system is that the behavior of the driver driving the vehicle can be obtained, along with the parameters of the traffic environment, and the data can be analyzed. To achieve this, the data has to be sent from the KAKUMO to the DS, making sure that the data is transferred in real time. Communication between the KAKUMO and the DS is handled as UDP (User Datagram Protocol), and it was decided that the maximum size of the contents of one packet would be 1,400 bytes, allowing communication of data for 100 vehicles to be carried out at 20 Hz. Data refreshed at 20 Hz undergoes interpolation in the DS and is refreshed at 60 Hz. The driving simulator consists of the following elements.

- Construction of an image display system that assures a 360-degree field of view, with the driver at the center.
- Creation of image scenery that models the real world (Shuto Highway No. 3)
- Improved steering reaction mechanism with the aim of improving the sensation of driving
- Improved vehicle movement and vibration sensations that take the slope of the road into consideration
- Introduction of a vehicle body using a wire frame that allows the placement of driving operation mechanisms to be changed flexibly
- Introduction of a monitor system that allows overall control of the driving conditions



An Overview of the Virtual Experiment Laborator

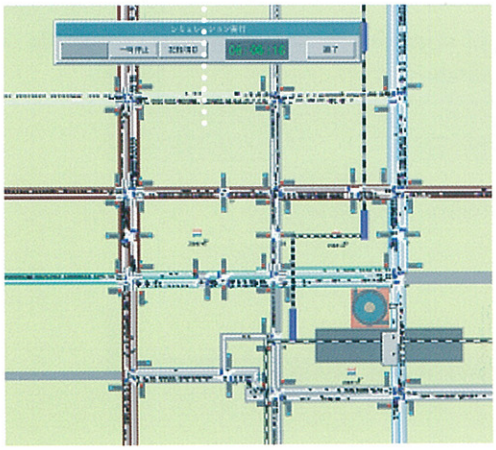


Traffic Simulator

TS:Traffic Simulator

This traffic flow simulator was developed and is being applied for the purpose of reproducing various traffic conditions in order to solve problems that arise with respect to road traffic, and to reproduce more sophisticated road traffic conditions. The Traffic Simulator is used in this project to reproduce the overall traffic conditions within the Virtual Experiment Laboratory, and provides a means for reproducing traffic elements such as the volume of traffic, traffic control, and congestion, and analyzing the choices made by the driver as he or she progresses along the road. The TS applied here is based on simulators used in the field of traffic engineering, and satisfies the following properties.

- It uses a micro-model that enables individual vehicles to be distinguished, and has a built-in function that dynamically determines the course taken by the vehicle.
- It uses a time-based scanning method, with one cycle comprising one second.
- Ordinary traffic control, including traffic signals, can be accommodated.
- If requested, a part of the study network is simulated using a different traffic model, and the traffic performance in the partial area can be shared by exchanging vehicle information.
- The simulator is designed so as to handle a reasonably large scale network with a few thousands links and nodes such as a whole Metropolitan expressway network.
- The traffic simulator has been verified according to the Traffic Simulation Validation Manual published by Japan Society of Traffic Engineers.



KAKUMO

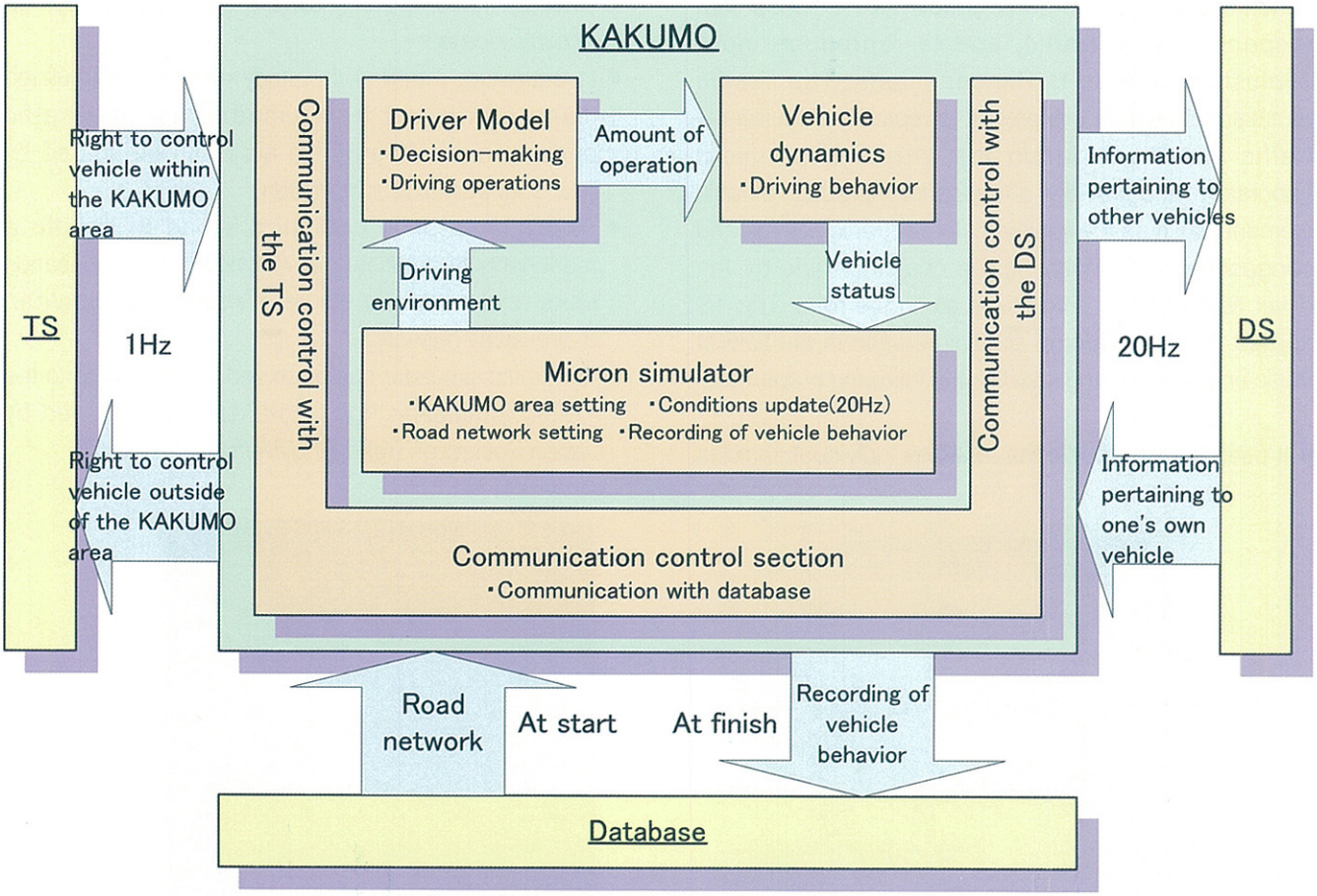
The KAKUMO is a micro-simulator that was developed for the purpose of bridging the differences in specifications between the TS and DS, and coordinating the two simulators. It is a module that links information between the TS and DS. Through this exchange of information between the TS and DS, the DS driver is able to drive the car as an individual vehicle amidst the traffic network conditions created by the TS.

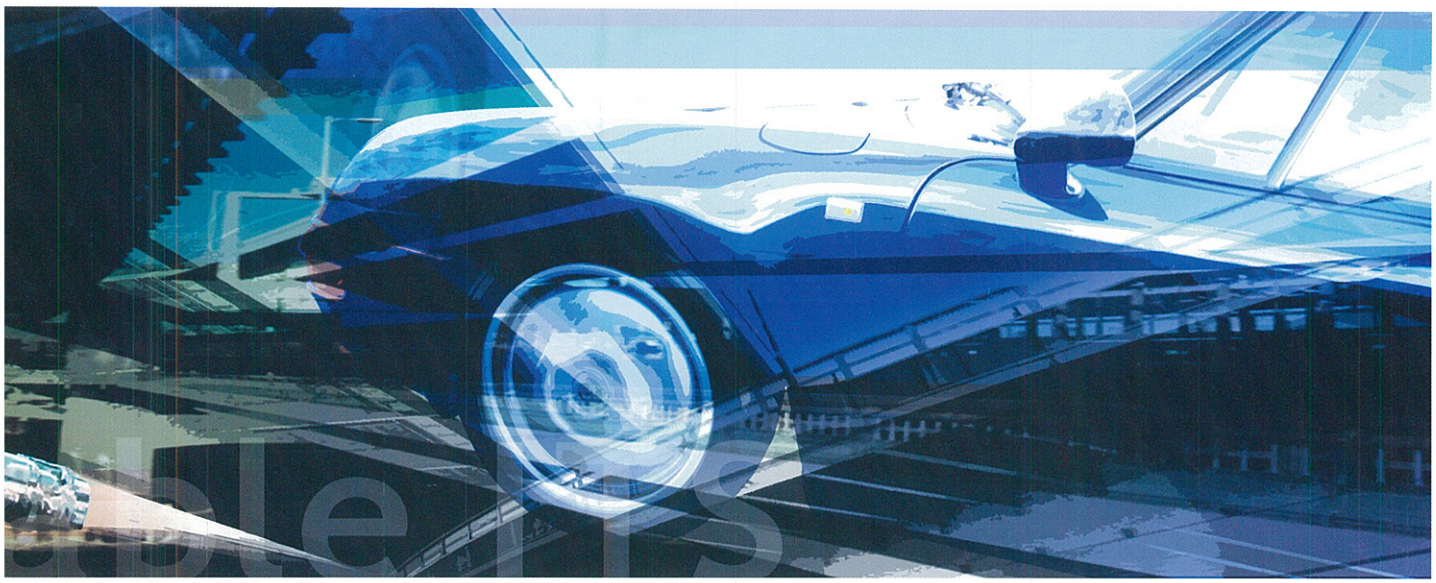
Image Generator

IMG : Image Generator

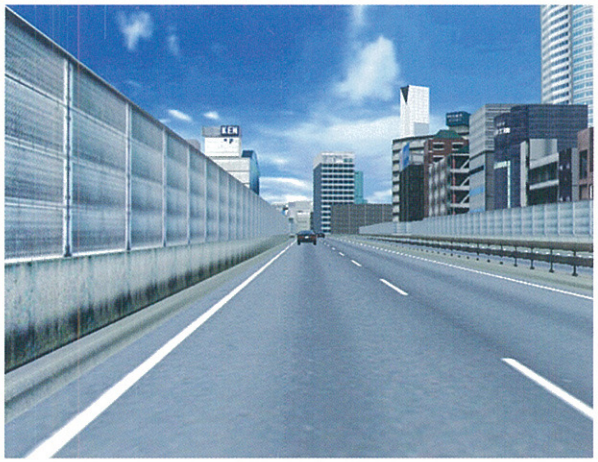
The input data for the DS and KAKUMO requires more than just geometric structural data for constructing detailed roads; it must also include data for three-dimensional objects such as buildings, road signs, trees lining the streets, and other visual elements. The IMG is a module that provides the most realistic possible images and uses actual street images. The following two types of systems are being considered for use in combination with the IMG.

- Model Based Rendering (MBR): This is a model-based system (texture added to a CAD model).
- Image Based Rendering (IBR): This is an image-based system (images with a high level of realism are created using only actual image examples). The MBR is used with the DS in its current state, and as shown in the illustration, the texture is created by using graphically designed images of cars as the computer graphics. For its part, the IBR is a system that enables images of any road course (such as different lanes





and lane changes) to be obtained simply by outfitting a vehicle with a video camera and driving along the road. The instrumented car shown in the illustration carries nine video cameras positioned perpendicular to the direction in which the vehicle is being driven, and if the images are properly synthesized, high-resolution, very realistic images can be displayed over a wide field of view.



Because the IBR images alone are not sufficient to display the moving car and other changes in the environment such as road signs or traffic signals, our research has focused on developing methods for using the MBR and IBR in combination to generate high-speed (30 fps or higher) images of high quality.

The Third Stage: Research in ITS Applications

In the third stage, ITS applied research was carried out, starting from the results of the analysis of various human factors (Stage 2) used in the complex realistic transportation laboratory (Stage 1).

This applied research is characterized not only by initiating ITS research over a broad spectrum of fields such as electrical and electronic engineering, vehicle control engineering and traffic engineering, but by incorporating the research needs of institutions in both the public and private sectors, and by implementing a research team that conducts cooperative research to traverse the borders between the fields.

The following topics are currently being advanced and studied as topics of ITS:

[Examples of ITS applied research topics]

- Research relating to the production of new road maps and information to provide driving support
- More efficient techniques to create 3D real-time image databases
- Development of devices that can be installed in the vehicle in order to collect positional information, and analytical methods to process this information.
- Research and development of driver models
- Construction of human factor data models
- Database structural design and construction of prototypes
- Construction of servers for analyzing simulation car data
- Research on traffic signal control, with the aim of helping to make driving safer
- Development of autonomous decentralized signal control systems
- Investigation of OD estimation methods using traffic monitoring data and course selection models
- Evaluation of traffic safety measures
- Provision of comfortable environments taking individual characteristics into consideration

CCR-IIS Interdisciplinary Engineering

【CCR】
Image Processing(Prof. Ikeuchi)
Traffic Engineering(Prof. Kuwahara)
Vehicle Dynamics & Control(Prof. Suda)

【Visiting Professors】
Prof. Tanaka(Toyota Map Master)
Prof. Edward Chung(Australia)
Prof. Tu That Ton(Australia)

【Laboratories】
Ikeuchi, Kuwahara and Suda Labs

Sustainable ITS

Private Companies

Toshiba
(Electronic, Communication)
Panasonic
(Electronic, Communication)
Aisin AW (Car Navigation)
Asia Air survey(GIS)
Mitsubishi Heavy Industries
(Electronic, Machinery)
Mitsubishi Precision (Simulator)
Social System Research Institute
(Consulting)
Chodai (Consulting)

Ministry・University・Industry

National Police Agency
Ministry of Economy, Trade and Industry
Ministry of Land Infrastructure and Transport
Metropolitan Expressway Public Corporation
Japan Highway Public Corporation
Nihon University
Tokyo Metropolitan University
Saitama University
Chiba Institute of Technology
TOYOTA
NISSAN

Contact

CCR Center for Collaborative Reseach The University of Tokyo

Sustainable ITS Industrial Collaborative Project

Center for Collaborative Research, The University of Tokyo
4-6-1 Komaba, Meguro-ku, Tokyo 153-8904
TEL: +81-3-5452-6565; FAX +81-3-5452-6800
E-mail: info@its.ccr.u-tokyo.ac.jp
http://www.its.ccr.u-tokyo.ac.jp