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KAIT
KANAGAWA INSTITUTE of TECHNOLOGY

ADVANCED TECHNOLOGY RESEARCH CENTER 2023

The Fourth Term's Research Themes (2023.4～)

- Practical application of a high-capacity communications processing platform using edge computing
- Social implementation of the bio-PET production from inedible biomass resources to mitigate global warming
- Enhancing Accuracy and Generalization in Methods for Evaluating Vehicle Steering Characteristics ("Referred to as 'TL Evaluation Open Innovation'")

The aim of the Advanced Technology Research Center at Kanagawa Institute of Technology (KAIT) is challenging to solve social issues by the practical application of research results.

The Fourth Term's Research Themes

Practical application of a high-capacity communications processing platform using edge computing

Realizing a cloud-based real-time editing service capable of processing high-definition 8K Video uncompressed and with low latency

Professor
Mitsuru Maruyama
(research representative),

Specially-appointed professor
Katsuhiro Sebayashi

Associate professor
Hajime Iwata

Department of Information Network and Communication, Faculty of Information Technology, Kanagawa Institute of Technology

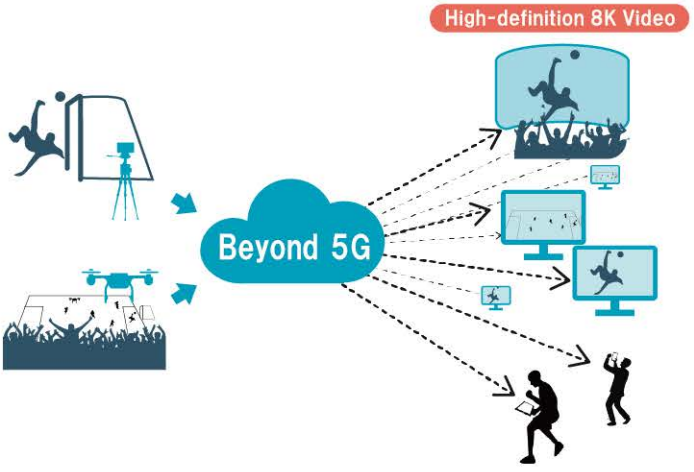
Envisioned Future

- People can participate in sporting and artist events from remote locations with a live and realistic feel as if they were there
- Anyone can easily edit and distribute high-definition 8K Video on their own devices
- Enables diagnosis and endoscopy without latency, even from remote locations

Social Background and Challenges

In the 2030s, Beyond 5G (6G), an even more advanced communications infrastructure than 5G, which is becoming the mainstream today, is projected to be introduced. Since the line speed of Beyond 5G (6G) is 10 times faster than that of 5G, it will be possible to shoot and distribute 8K Video, which is about 4 times larger than 4K, using Beyond 5G (6G) network terminals. The use of high-definition 8K Video, which are said to reach "the limit of human vision," is expected to expand to include sports, artists' live events, remote medical care, and remote classes, where immersive and realistic sensations are required.

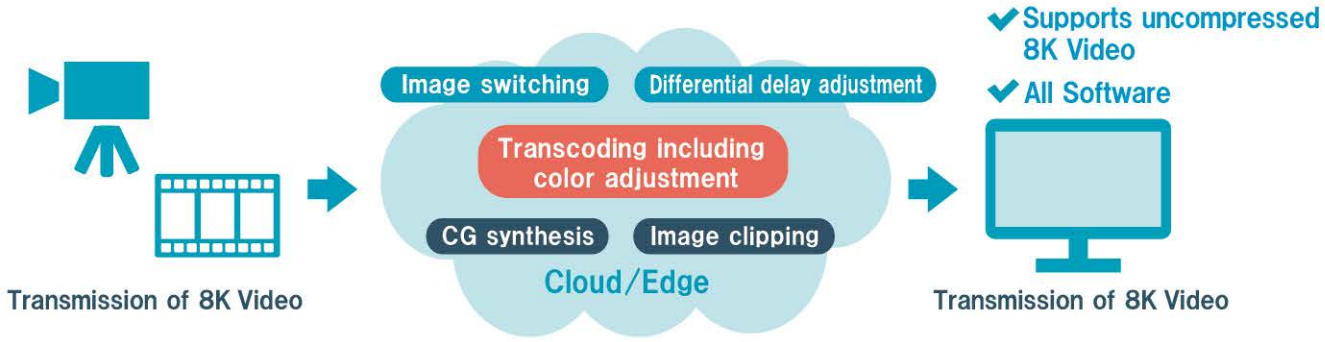
In such a society, a system that allows anyone to easily distribute high-definition images in real time will be crucial. At present, however, this requires expensive image processing equipment.



Research and Development to Solve the Challenges

In real-time delivery, the editing process involves switching the footage shot by cameras and other terminals, accumulating scenes and then cutting/pasting usable parts from them, as well as combining them with overlapping tickers and computer graphics. Equipment capable of processing high-definition images is extremely pricey, making it difficult for individuals or even companies to purchase it as a capital investment. If high-definition image processing technology can be made available as a network service in the cloud, users will only need to use the service for as long as they need it, and the hurdle will be lowered considerably.

In this context, we are conducting research and development of a platform that can process high-definition images in real time on a network consisting of general-purpose equipment, such as edge and cloud computing devices.



Research and development of the technology necessary to realize the platform has been underway since FY2014, and at each technology development milestone, a demonstration experiment is conducted to confirm that the platform works properly using an actual network. While continuing to collaborate with related parties, we aim to bring to market inexpensive appliance products incorporating the platform technology by FY2025. Furthermore, a cloud-based real-time editing service is targeted to be launched by FY2030.

SC22(Dallas, US)▶

◀Interop Tokyo 2023
(Makuhari Messe, Chiba)

Demonstration experiments at national and international events

Patents, Research Grants, Press Releases, etc.

- "Research and Development of a High-bandwidth, Low-latency and Real-time Distribution Processing Platform for Realizing a Highly Realistic Communications Environment (Adoption No. 03101)" commissioned by the National Institute of Information and Communications Technology (NICT)
- National Institute of Informatics Open Collaborative Research 2023 "Realization of a Highly Realistic Image Communications Environment Using the Edge Processing Section of SINET6 (23S0208)"
- Press Release "Realizing 8K Live Video Workflow for Online Live Broadcasting - Utilizes 8K Uncompressed Image Processing Capabilities of 400Gbps-capable Edge Computing Devices" (2023.7.13)

The Fourth Term's Research Themes

Social implementation of the bio-PET production from inedible biomass resources to mitigate global warming

Mitigating Global Warming through the Use of Biomass Resources

Professor **Seiji Nakagame**
Department of Applied Bioscience, Faculty of Applied Bioscience,
Kanagawa Institute of Technology

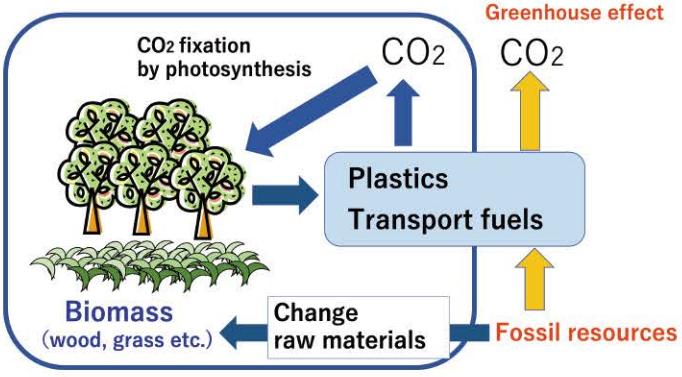
Envisioned Future

- Mitigating global warming by reducing CO_2
- Revitalization of the agriculture and forestry in rural areas

Social Background and Challenges

Due to the use of fossil resources since the Industrial Revolution, the concentration of carbon dioxide (CO_2) in the atmosphere has been increasing over the years. It is predicted that higher atmospheric CO_2 concentration will cause global warming due to the greenhouse effect, resulting in adverse effects such as sea level rises caused by melting glaciers/ice sheets on land, and changes in climate and vegetation. In addition, Japan's rural areas are facing the challenges of depopulation and aging.

To revitalize the rural areas in addition to mitigate global warming, the use of timber from forest thinning and biomass resources generated at lumber mills in the areas is being promoted. Biomass resources, plants and animals that can grow through photosynthesis, include timber and grass. They can fix CO_2 in the atmosphere through photosynthesis, so are considered to be more effective in reducing CO_2 emissions than the use of fossil resources. Currently in Japan, biomass resources are often used for heat and power generation by direct combustion. The reason that biomass resources are often used as energy resources for heat and power generation instead of raw materials for products is that they are physically solid and composed of multiple components, making it more expensive to use them as raw materials. To overcome this issue, it is necessary to manufacture high value-added products from biomass resources, the demand of which should be expected to increase.

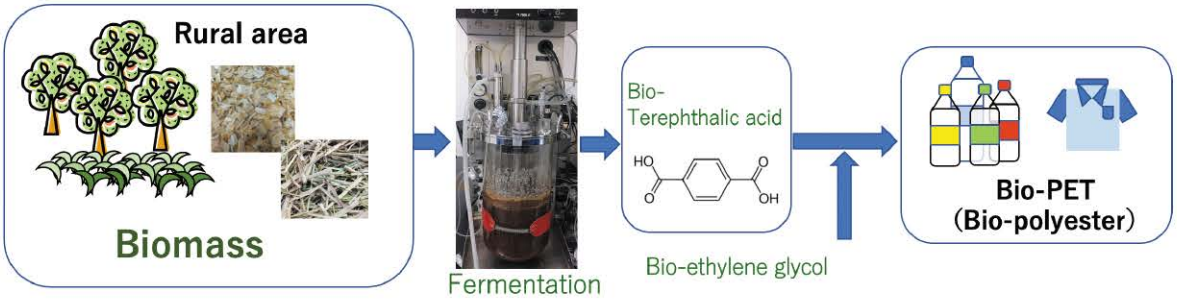


Reduction of CO_2 emission by biomass resources utilization

Research and Development to Solve the Challenges

This research aims to reduce CO_2 emissions that cause global warming and revitalize the agriculture and forestry industries by producing terephthalic acid, a raw material for polyethylene terephthalate (PET) used in beverage bottles, clothing, films, and other products, from biomass resources.

Global demand for terephthalic acid was 62 million tons/year in 2017, and is expected to increase to 80 million tons/year by 2023.While various companies and research institutes are conducting R&D to produce terephthalic acid from biomass resources, many of the technologies use chemical processes that use thermal reactions, which can lead to high energy consumption in the production of terephthalic acid. In addition, competing technologies require a large number of manufacturing processes in the production, which require high equipment costs. On the other hand, the manufacturing method used in this research has the potential to reduce energy consumption and manufacturing costs compared to competing technologies, because it uses a microbial fermentation method for producing terephthalic acid from biomass resources, which allows the reaction to conduct at room temperature, and also requires fewer manufacturing processes. In order to achieve this goal, we are working on the selection of suitable biomass resources for the production of terephthalic acid, the improvement of microorganism, and the establishment of mass production technology.



Revitalization of agriculture and forestry
Reduction of CO_2 emission

Process for the production of terephthalic acid,
a raw material for polyethylene terephthalate (PET) using biomass resources

Patents, Research Grants, Awards, etc.

Patents:
"Method for producing terephthalic acid and polyester from biomass resources (PCT/JP2022/5192)"

Research Grants:
Bio-oriented technology Research Advancement Institution (BRAIN), Small Business Innovation Research Support Program (SBIR Support)
Title: "Commercialization of terephthalic acid and polyester production technology from unutilized biomass resources to revitalize the agriculture and forestry industries"
Phase 0 (FY2021-FY2022), Phase 1 (FY2023)

Awards:
AgriFood SBIR Pitch Contest 2022 "Breakthrough Tech Award" (2022.4.25)

The Fourth Term's Research Themes

Enhancing Accuracy and Generalization in Methods for Evaluating Vehicle Steering Characteristics
("Referred to as 'TL Evaluation Open Innovation'")

Establishing and standardizing an approach for objectively quantifying and assessing subjective 'drivability'

Professor **Makoto Yamakado** (research representative),
Assistant professors **Yoshio Kano**
Honorary professor **Masato Abe**
Department of Vehicle System Engineering, Faculty of Creative Engineering, Kanagawa Institute of Technology

Envisioned Future

- Advancement of Accident and Motion Sickness Mitigation in Autonomous Vehicle Development
- Cultivating Open Innovation Across the Japanese Automotive Sector in Preparation for the Electric Vehicle Era

Social Background and Challenges

Do you know G-Vectoring Control (GVC)? It's a vehicle control technology designed with a human-centered development concept. GVC, which originated and was developed at the Kanagawa Institute of Technology, focuses on enhancing the driving experience by reducing the impact of G-forces on the driver and passengers during various driving maneuvers.

For instance, when GVC is engaged during actions like lane changes, it works to smooth out the changes in G-forces, thereby minimizing head and body movements for both the driver and passengers. This leads to a more comfortable and enjoyable driving experience, as the technology aims to make driving feel smoother and less physically taxing.

Many drivers have reported that when GVC is active, they find the driving experience to be effortless and the ride more comfortable. However, it's worth noting that the acceleration adjustments implemented by GVC are kept below 0.05G, which is the threshold of human perception. As a result, drivers might not tangibly feel the difference in acceleration caused by GVC.

Despite this, the intriguing aspect lies in understanding what factors contribute to the perceived "difference" by humans. By delving into this aspect and incorporating such insights into the development of vehicles and systems, it becomes conceivable to create vehicles that are not only easy and comfortable to drive but also align closely with human sensory expectations.

※It's also important to mention that G-Vectoring Control (GVC) is a trademark registered by Hitachi Astemo, Ltd.

Research and Development to Solve the Challenges

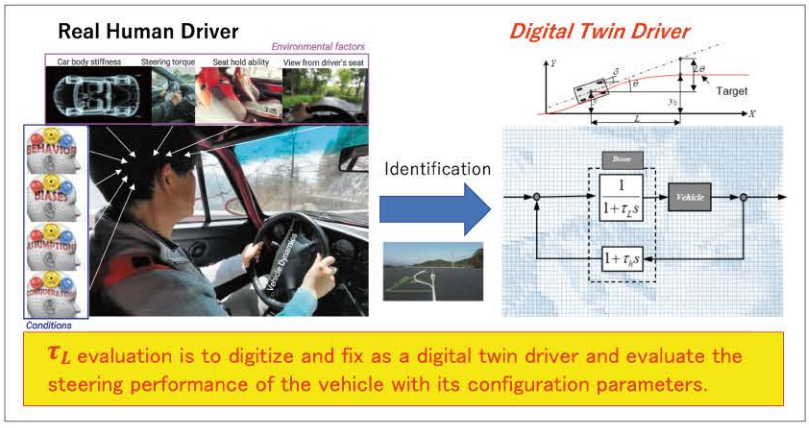
Measuring driving comfort and ride quality in terms of physical "values" can be complex due to factors often concealed by road undulations and surface irregularities. To address this challenge, the focus has shifted towards assessing the "quality" of these aspects. Among the trio of parameters that gauge a car's steering

characteristics—namely, driver forward anticipation time (T_h), gain (h), and driver delay time (T_L)—T_L emerges as the paramount parameter for quality assessment.

Previous research indicates that T_L plays a crucial role. A larger T_L implies that the car is easier to drive, as it allows the driver to manage tasks even in the presence of operational delays. This showcases how this parameter directly correlates with the driving experience's ease and overall quality.

Digital Twin Technology serves as the cornerstone for evaluating T_L. By constructing a driver model within the digital realm based on real drivers' driving behaviors and subsequently conducting driving simulations utilizing this model, it becomes feasible to assess T_L. For instance, during a lane change maneuver performed by an actual driver—an action susceptible to G-force changes—tracking the driving path through the driver model reveals that the driver's maneuvering alters depending on the activation of G-Vectoring Control (GVC). This, in turn, impacts the value of the T_L parameter.

Notably, a larger T_L directly corresponds to smoother driver operations. Interestingly, when GVC is engaged, T_L increases, signifying that drivers experience a sense of ease while driving. This connection highlights how the activation of GVC results in a heightened perception of "ease of driving" due to the expansion of the T_L parameter.

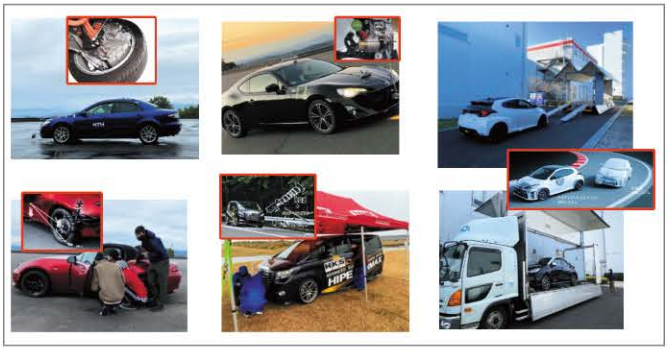


τ_L evaluation is to digitize and fix as a digital twin driver and evaluate the steering performance of the vehicle with its configuration parameters.

An Insightful Exploration of 'TL Evaluation' Leveraging the Potential of Digital Twin Technology

The evaluation of T_L extends beyond automotive control technologies like GVC, encompassing various aspects that vary according to vehicle types—such as seat comfort and visibility. This versatility has led to its application in the development of car bodies, equipment, and diverse products. Over the years, the Kanagawa Institute of Technology has meticulously crafted the "T_L Identification Manual" via numerous demonstration experiments.

Looking ahead, there's a plan to make this manual available to manufacturers seeking to harness its insights, aiming to enhance the technical prowess of the Japanese automobile industry. Additionally, there's a vision to design a demonstration apparatus for T_L measurement and assessment. This apparatus would be offered as a comprehensive package, complete with operators, to potential manufacturers. These proactive endeavors are intended to foster open innovation, centered around the university, ultimately contributing to the advancement of knowledge-sharing and collaborative progress within the automotive industry.



Example of T_L experiments

Patents, Research Grants, Awards, etc.

ASME (The American Society of Mechanical Engineers) The William F. Milliken Invited Lecture Award 2018
Professor Emeritus, Masato Abe
Driver Model Based Handling Quality Evaluation and Effects of Vehicle Body Motion on Handling Quality Improvement with G-Vectoring Control (GVC)

ADVANCED TECHNOLOGY RESEARCH CENTER

A list of themes adopted in the past

The Third Term's Research Themes (2020.4～2023.3)

Development of KAIT Mobility Research Campus
Toshihiro Wakita, *professor, Department of Vehicle System Engineering*

Symbiotic Robot AI to Extend Healthy Life Expectancy
Ryo Saegusa, *Department of Robotics and Mechatronics*

Development of Indoor Self-contained Mobile Robot
Tadashi Yoshidome, *associate professor, Department of Robotics and Mechatronics*

The Second Term's Research Themes (2017.4～2020.3)

Development of New Vehicle Motion Control Content
Makoto Yamakado, *professor, Department of Vehicle System Engineering*

Development of "Regional Physical Examination System" Utilizing AI and IoT
Katsumi Takahashi, *professor, Department of Robotics and Mechatronics*

Development of Ultra High-Definition 8K Video Processing Technologies Utilizing Cloud Infrastructure
Mitsuru Maruyama, *professor, Department of Information Network and Communication*

The First Term's Research Themes (2014.4～2017.3)

Development of Advanced Robot / Wearable Power Assist Robot
Keijiro Yamamoto, *specially-appointed professor, Advanced Technology Research Center*

Development of Advanced Robot / Development of Partner Robot
Kazuhito Hyodo, *professor, Department of Robotics and Mechatronics*

Development of 8K/4K Real-Time Network Content Creation Technology
Kazuya Kojima, *associate professor, Department of Information Media*

Development of Creative Acoustic System
Isoharu Nishiguchi, *associate professor, Department of Information Media*

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