Advanced Mobility Research for Sustainable Transportation

Prof. Yoshihiro SUDA

Director of Chiba Experiment Stations
Director of Advanced Mobility Research Center
Institute of Industrial Science,
The University of Tokyo

東京大学
THE UNIVERSITY OF TOKYO

ITS Center
THE UNIVERSITY OF TOKYO
先進モビリティ連携研究センター

Outline

- Background and Sustainable transportation
- Advanced mobility research center

- ITS (Intelligent Transport System)
- Virtual Proving Ground with Driving simulator
- Advanced Automobile Research
- Self-powered Control & Electromagnetic suspension

- Modal Shift to Public Transport System
- LRT, Advanced Railway System and Eco-Ride

- Personal Mobility with Robotic Vehicle
- Experimental facilities and fields

- Concluding Remark

Energy Consumption in Japan

- Transportation: 20% of Total Energy
  - Automobile:　88% of Transportation
    - Private passenger car:　49%
    - Track for logistics: 35%
  - Railway (Passenger & Freight) : only 3%

- Transport share　(people x travel distance)
  - Private passenger car 60%
  - Railway and public transit :30%
    - Efficiency 1: 9

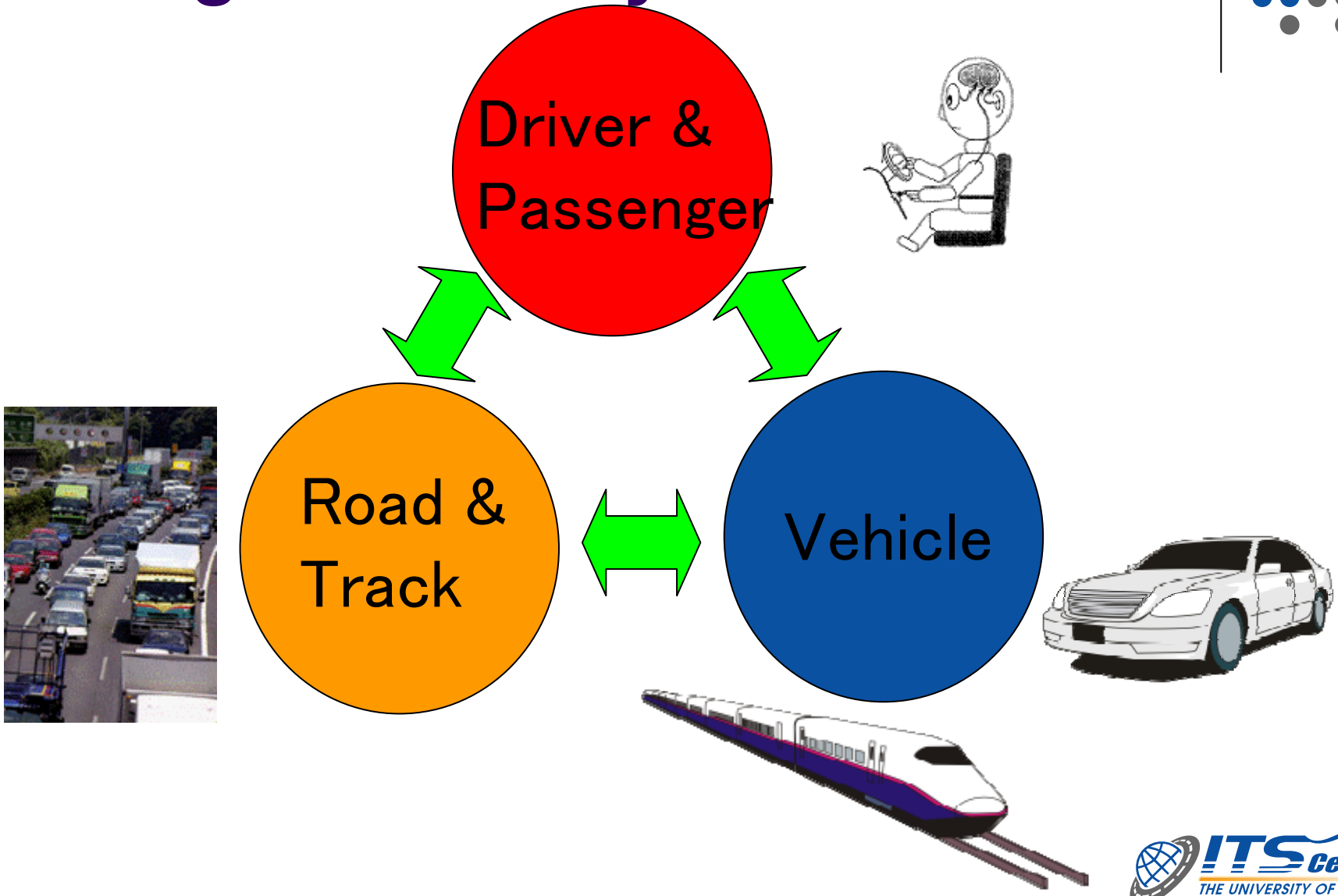
Strategy

- Innovation of automobile
  - Improve energy efficiency
- Innovation of road traffic
  - Prevent traffic congestion
  - Promote Eco-drive
- Modal shift to Railway and Public Transit
  - Motivation for public transit
    - Convenient, comfort, cost down
  - Innovation of guide way transit
  - Collaboration and innovation of Personal Mobility

Sustainable Transportation

- Low Emission & Energy Saving
- Safety & Security
- Comfort & Healthy

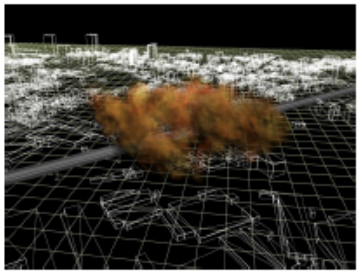
Integration & Synthesis



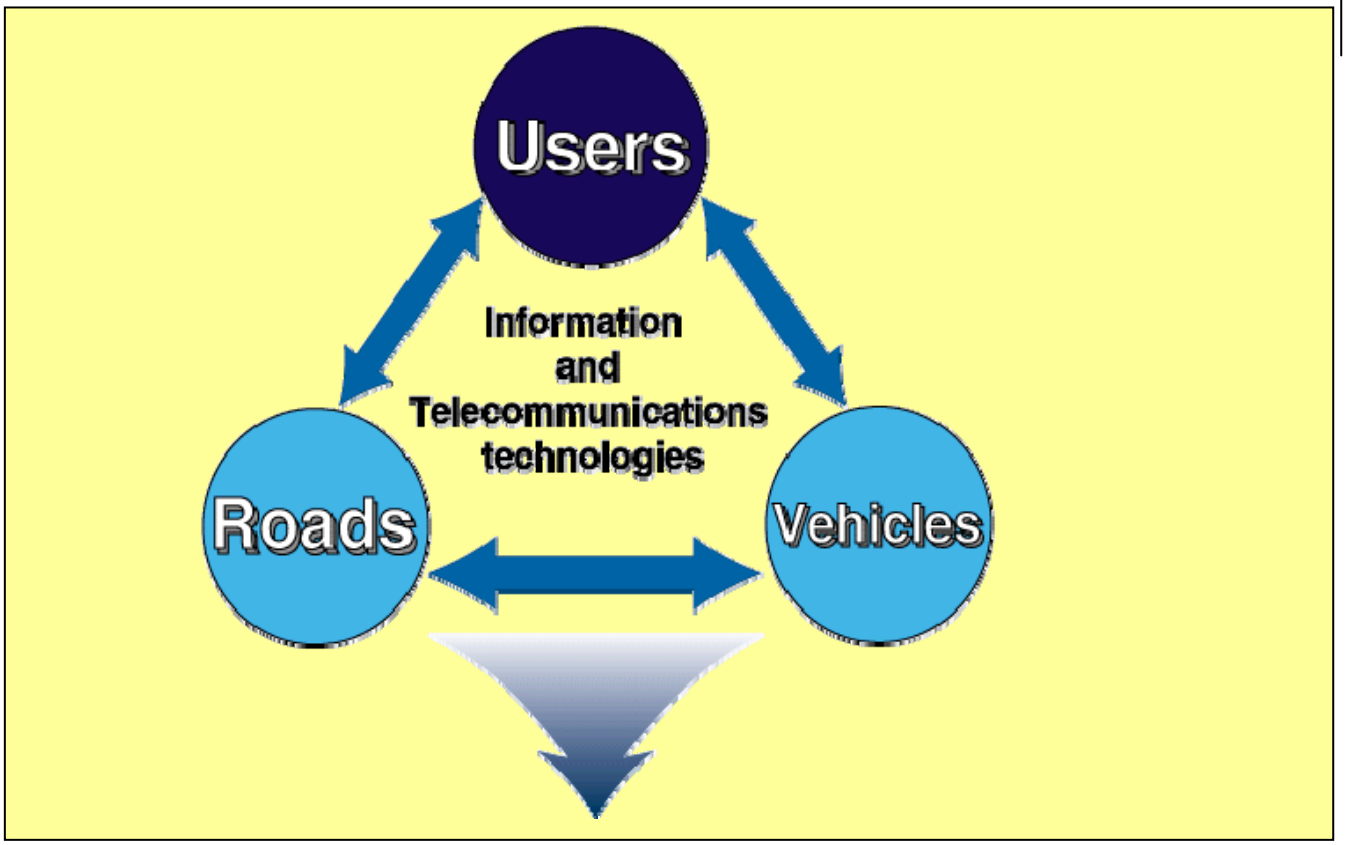
Establishment of Advanced Mobility Research Center

- Institute of Industrial Science established in April, 2009
- 16 Professors form Mechanical, Electrical and Civil Engineering Departments
- 51 Professors for collaborative member in Japanese Universities
- 20 members form Government and Industry





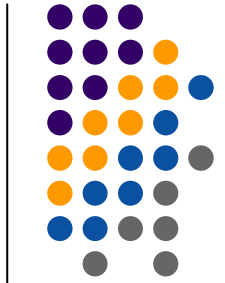

ITS (Intelligent Transport System)
Advanced Road Traffic System



Safety　Traffic efficiency　Comfort(convenience)

Solve Environment　　Creating new industries/business

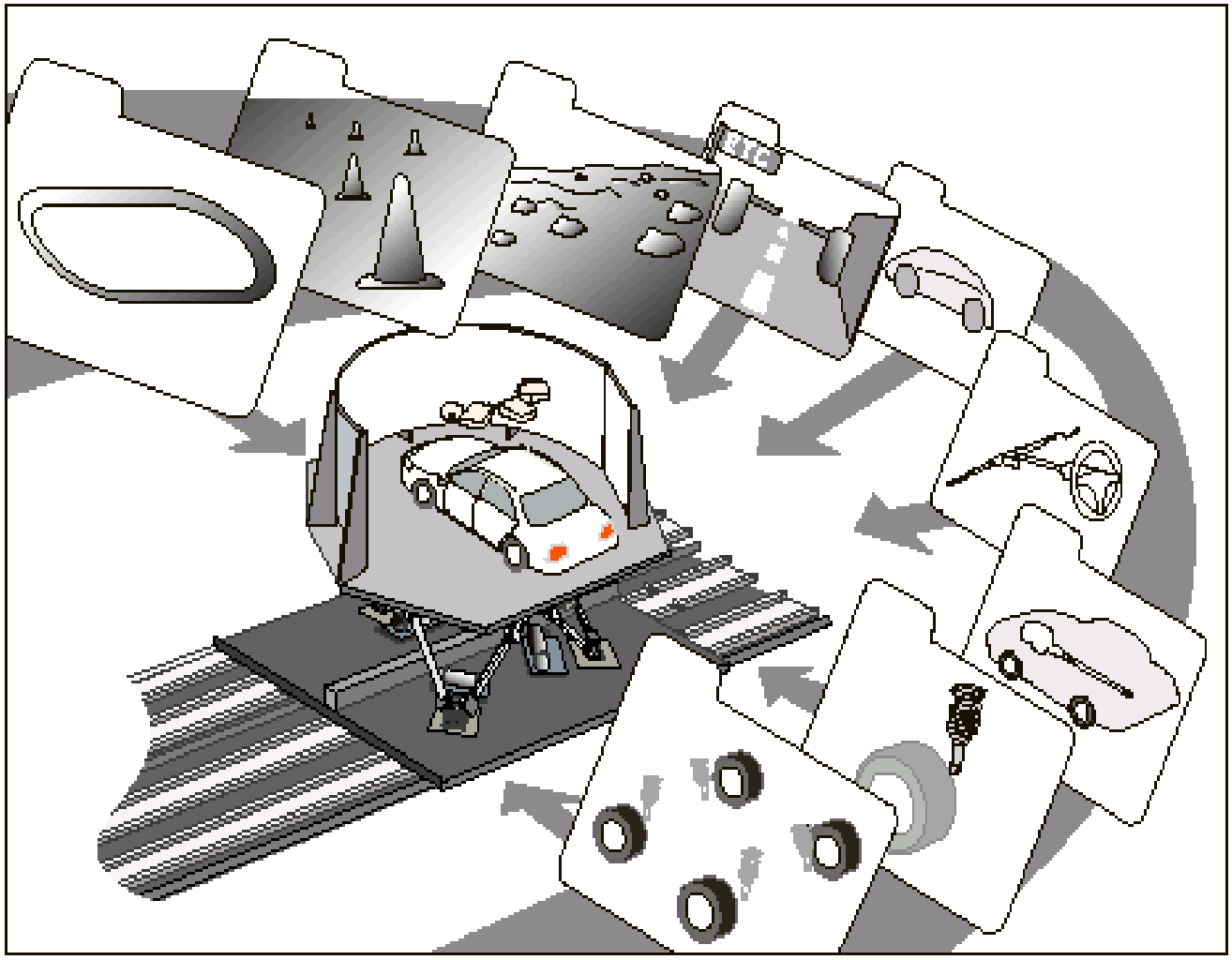
Main Activity for ITS Research on Our Center



- Development of Virtual Experimental Transport Experimental Space
  - Driving simulator + Traffic simulation
  - Evaluation of research output for real world
- Energy ITS project

- Eco-drive and Safety project
- Traffic management

Concept of Virtual Proving Ground
Using Driving Simulator



ITS Center
THE UNIVERSITY OF TOKYO
先進モビリティ研究センター

Development of ITS Mixed Realty Transportation Experimental Space

Advanced Mobility Research Center,
Institute of Industrial Science, The University of Tokyo

Traffic Simulation ⟷ **Real time connection** ⟷ **Driving Simulator**

Collaboration with 8 Companies, 5 Ministries

NEDO Energy ITS Project
Autonomous Driving System

Safety, Driverless

↓

Eco mobility

Platoon of Heavy Truck Highway

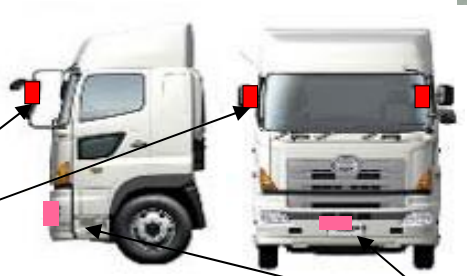
Small Truck

Urban traffic

- **Eco evaluation**
- **Adaptation for mixed traffic with human driver**
- **Effect on platoon driver and HMI**
- **Road Map for realization**

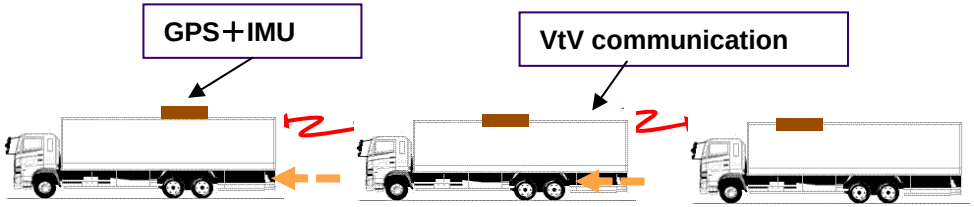
USA and EU has/had Platoon projects

Experiments



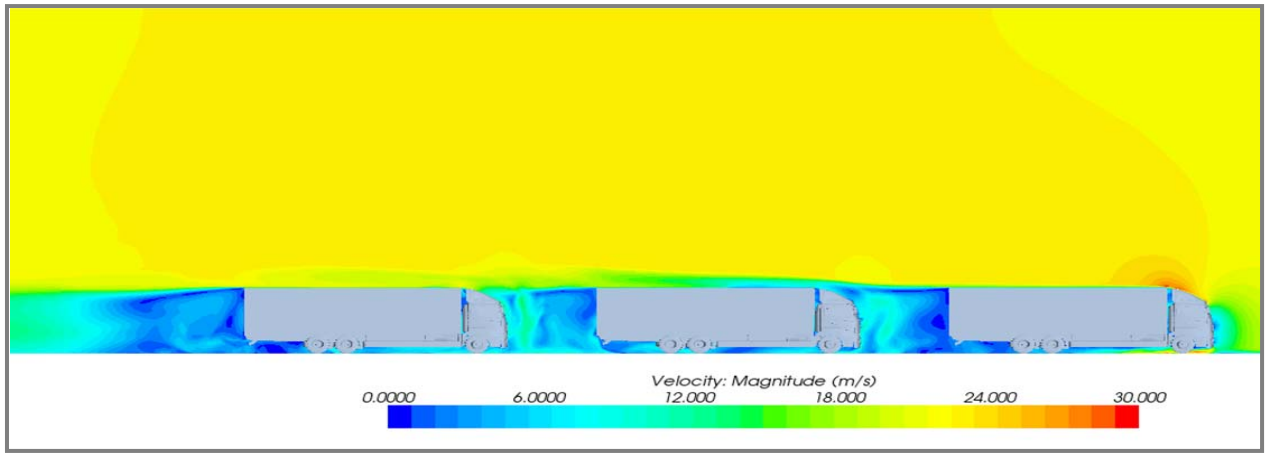
Vision Sensor
For Tracking

Rader and Lidar Sensor for distance measurements

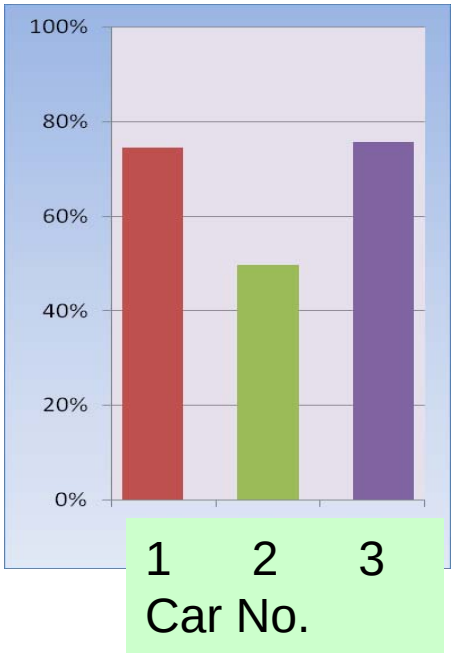


Effects on Eco Ability and Final Goal

Numerical Simulation for aero drag



Reduction of aero drag (single truck : 100%)



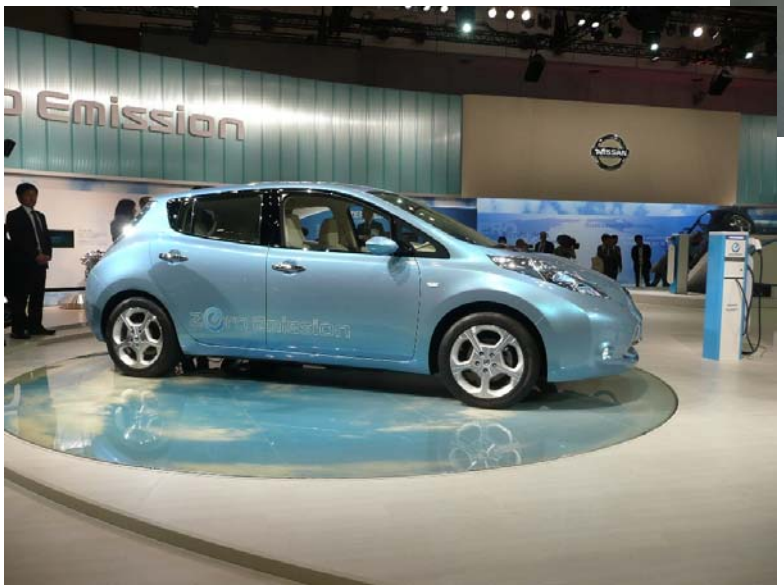
Final Goal:

- Vehicle distance: 4m
- Four trucks with different size
- Speed: 80 km/h
- At least 15% reduction of energy consumption

R&D for Electrical Drive for Automobile

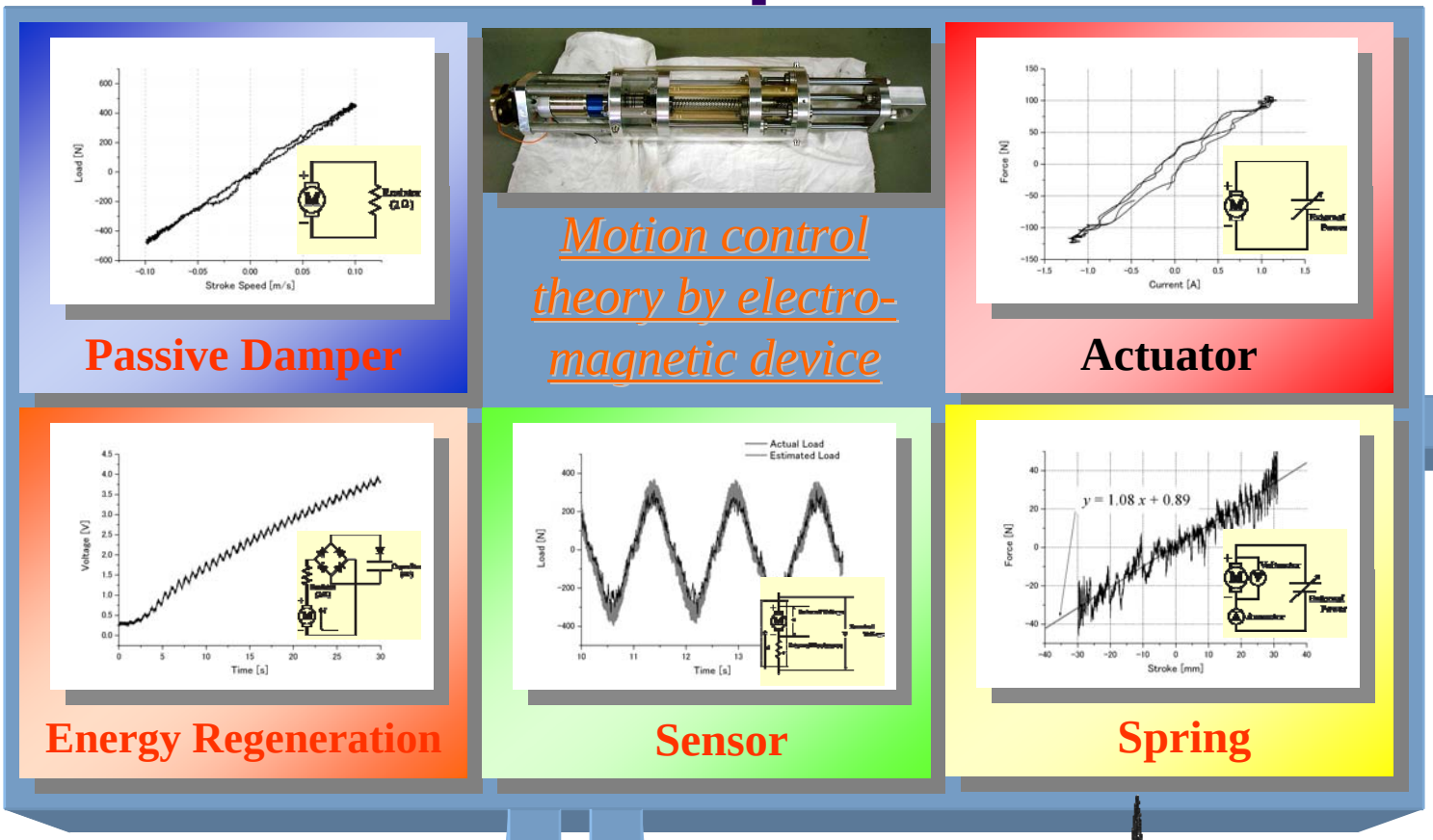
- Plug-in Hybrid Vehicle

- EV



This type of Development is mainly made by Company

R&D for electromagnetic device for suspension



Apply to various systems with adjust for individual feature

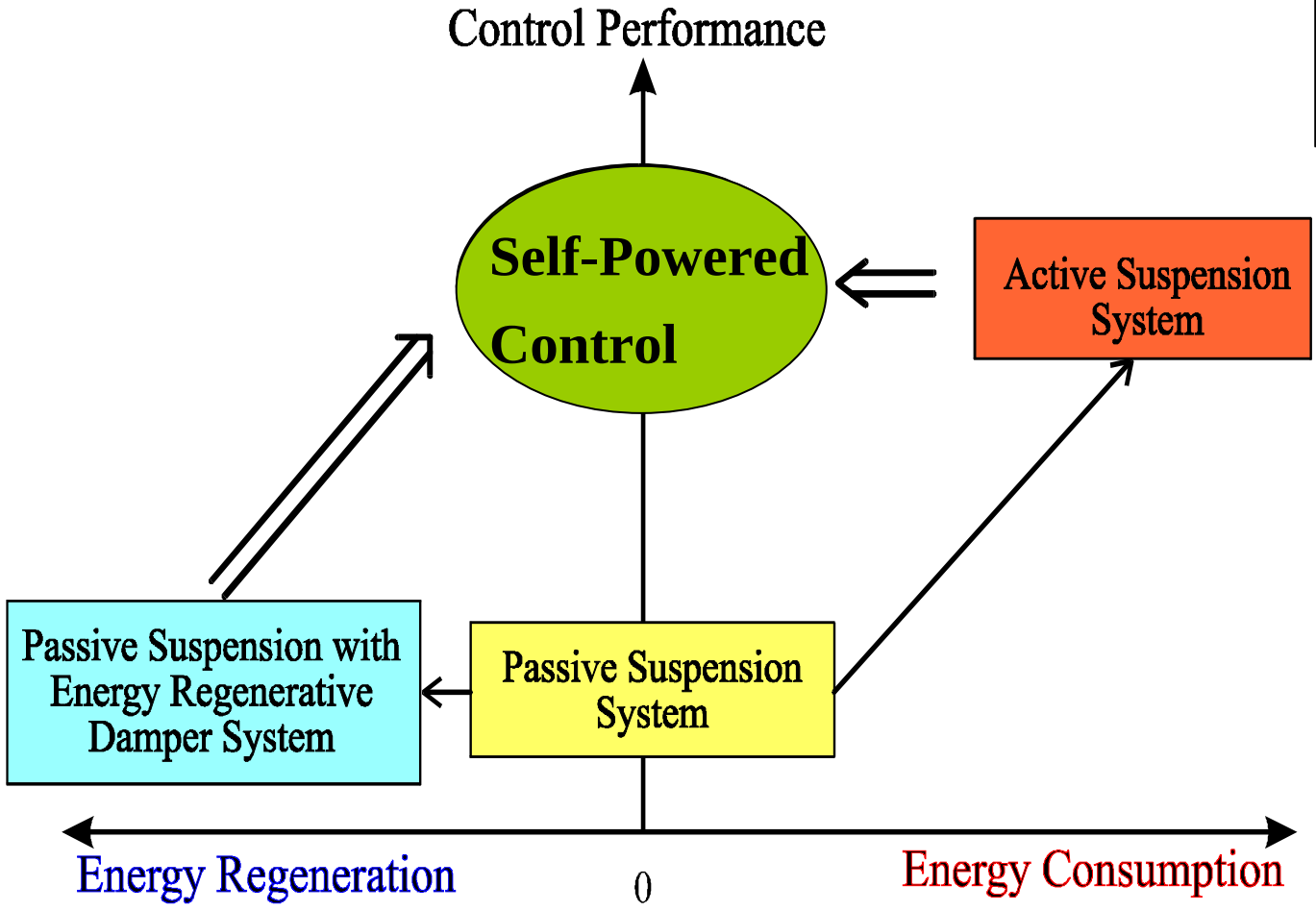
ITS Center THE UNIVERSITY OF TOKYO 先進モビリティ研究センター

Practical Research with Industries

- •Passenger car:
  - •Improvement of ride comfort
  - •Energy regeneration from vibration
  - •Quick response and control of road folding
- •Heavy duty truck:
  - •Vehicle stability and prevent turn over
  - •Improvement of drivability

- Original device developed by laboratory
- Collaborative Study with KAYABA,TOYOTA and HINO

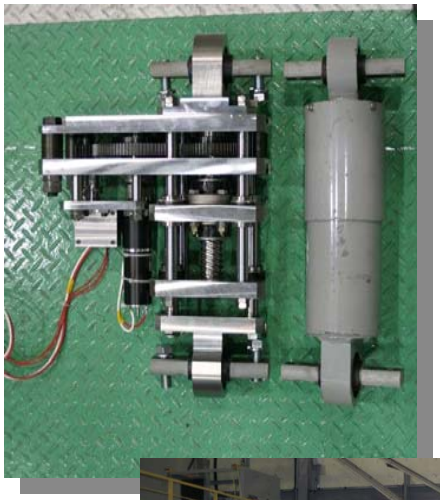
Self-Powered Active Control



No External Energy but High Performance

Application to High Speed Rail Vehicle

Full-active Control



Energy consumption of active control can be reduced significantly by utilizing regenerated energy effectively.

Collaboration with East Japan Railway

Modal shift to high speed rail in Europe and Asia

JR Central, Japan

JR East, Japan

German ICE

French TGV

Taiwan High Speed

Chinese High Speed

Modal Shift to LRT (Light Rail Transit) in Europe

France Paris

Hungary Budapest

Germany
Munich

LRT (Light Rail Transit) for Public Transit in Japan

Kumamoto

Hiroshima

Takaoka

Toyama

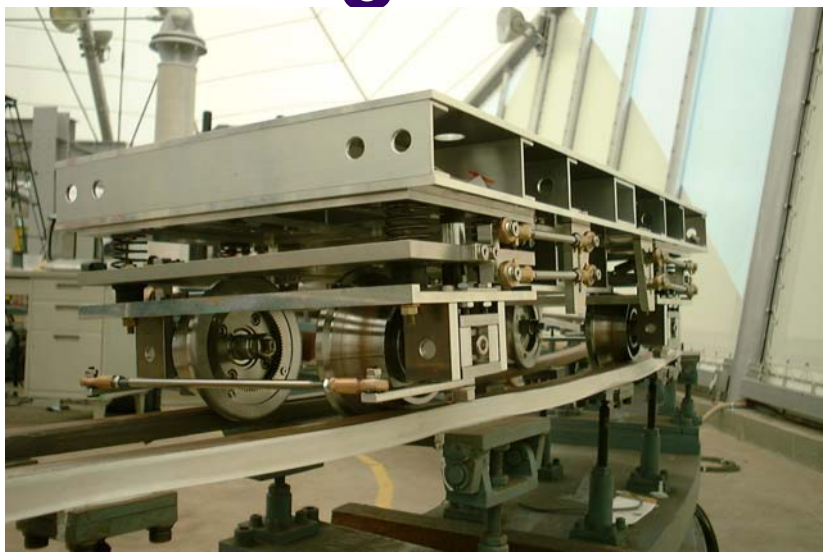
ITS Center THE UNIVERSITY OF TOKYO 先進モビリティ研究センター

Key Words for LRT
Light Rail Transit

Improvement of Performance

- Self-steering
  - Tight curve negotiation ability in urban area
  - Independent rotating wheel for low floor
- Self-power
  - Hybrid system with battery
  - Without trolley for city amenity
  - Energy regeneration

Developed vehicles with Self-steering truck and battery



1/10 Scaled Model Vehicle with proposed self-steering independent rotating wheel in Chiba Experiment Station

Low floor vehicle with battery powered traction by Kawasaki Heavy Industries

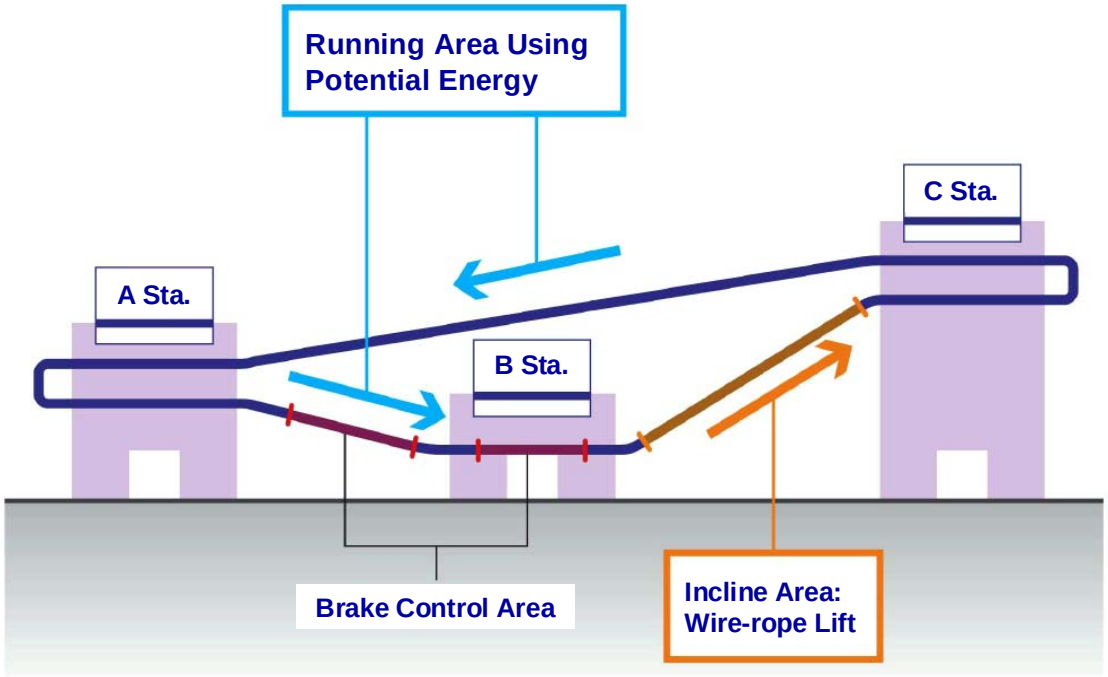
Asymmetric design with independent rotating wheel

Development of Energy Saving Urban Transportation System "Eco-Ride"

- Full scale Experimental vehicle and test track
  at Chiba Experiment Station,
  Institute of Industrial Science, The University of Tokyo
- Collaboration with Senyo Kogyo supported NEDO and METI

Concept and property

- Potential Energy
- Roller Costar Technology

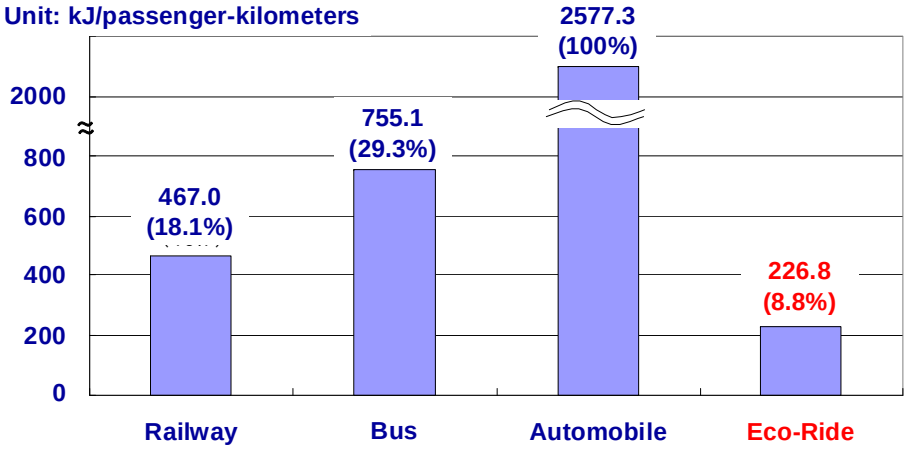


- Short distance less than 10 km
- Transport capacity 2000-2500 persons/hour
- Max Speed 40 km

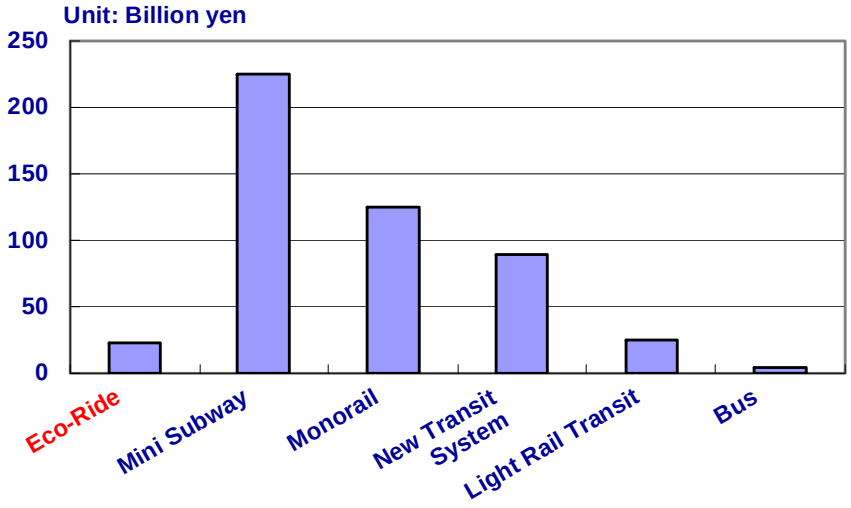
Main Characteristics

- Light weight vehicle without power unit
- Safety by existing roller costar technology
- Low cost for construction

Energy Consumption and Cost for Construction



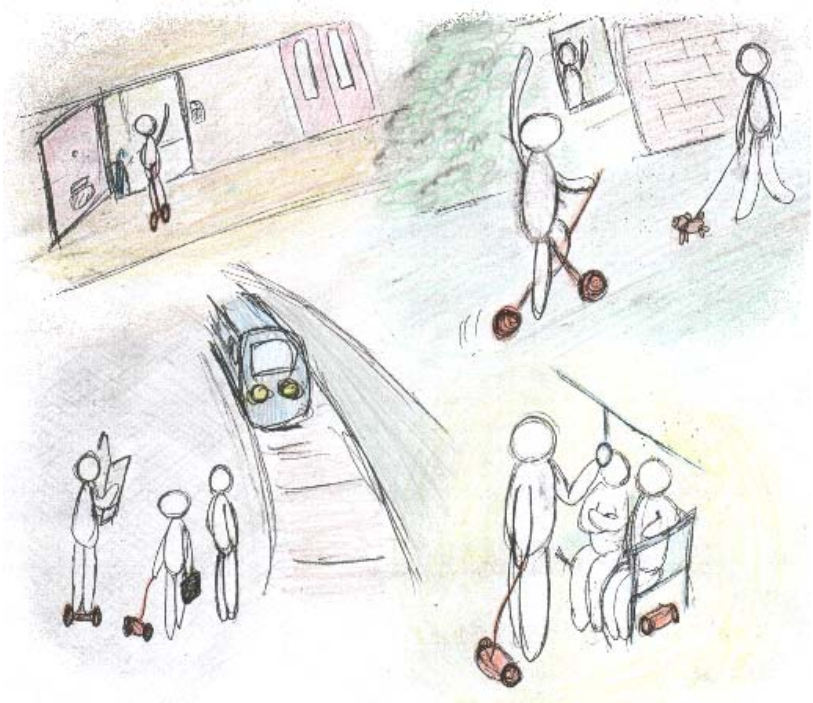
Energy consumption:
1/10 of automobile
Half of railway



Construction Cost:
1/10 of mini subway
Same as LRT

Personal Mobility Vehicle with Robot Technology

- Short distance transport with electric drive and/or human power
- Safety operation in pedestrian area
- Compact and light weight for carry by public transit and car



Present Personal Vehicle

- Bicycle (Series two wheel vehicle)
- Electric Powered Assist Bicycle
- Parallel two wheel vehicle (Segway)

Too large and heavy for Japanese
Out of regulation for public road

Unstable at low speed

Collaboration with TOYOTA for developing Personal Mobility Vehicle

Experiment for safety and comfort for pedestrian area

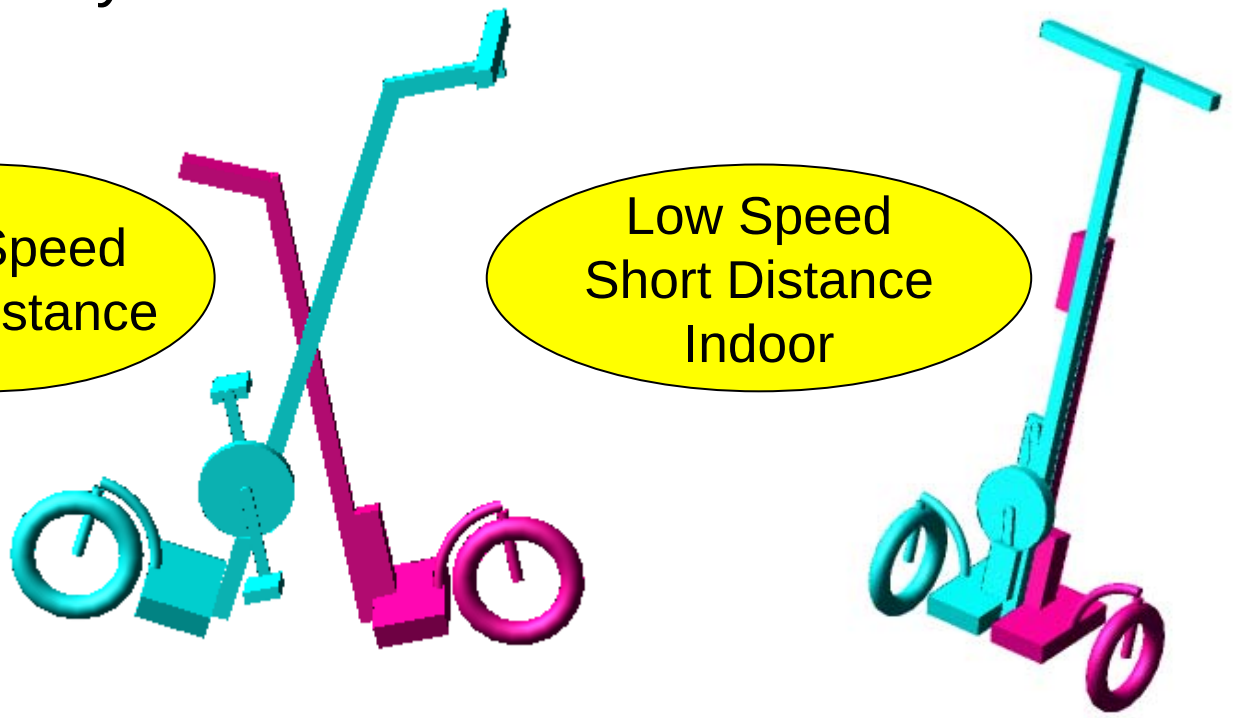
Proposed Hybrid PMV
Personal Mobility Vehicle

Bicycle mode

Reverse Pendulum mode

High Speed
Long Distance

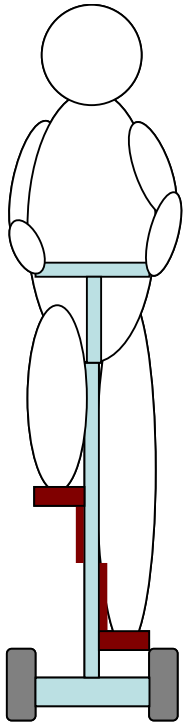
Low Speed
Short Distance
Indoor

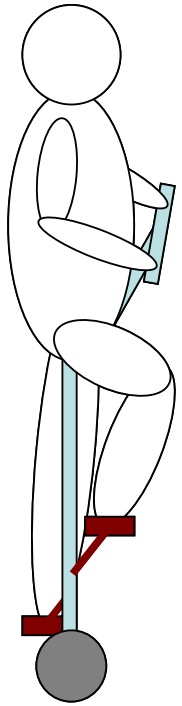


Steer by wire, Light weight, Compact

Proposed New Concept Robotic Vehicle

- Stability control by electric motor
- Human pedaling and electric power assist

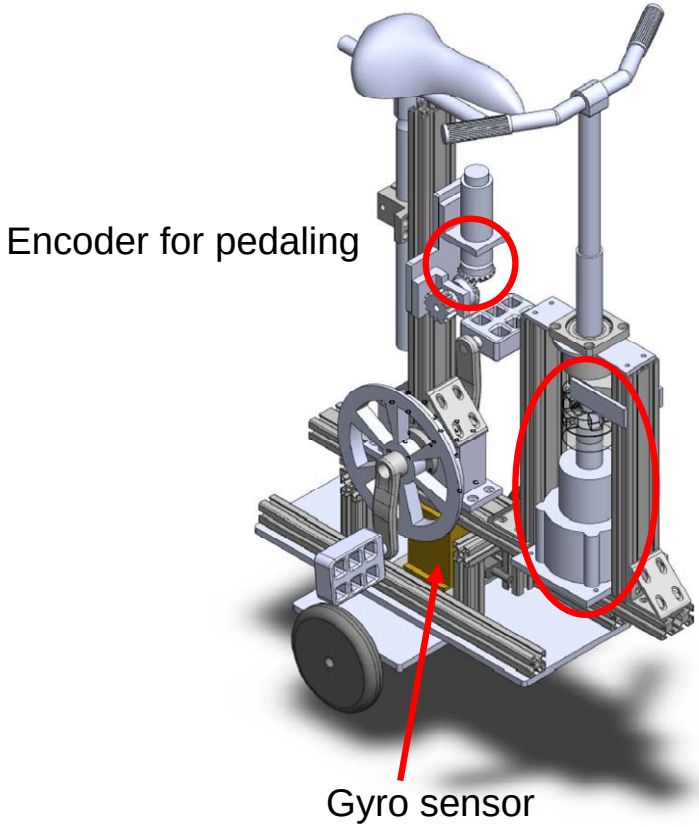




Merits:

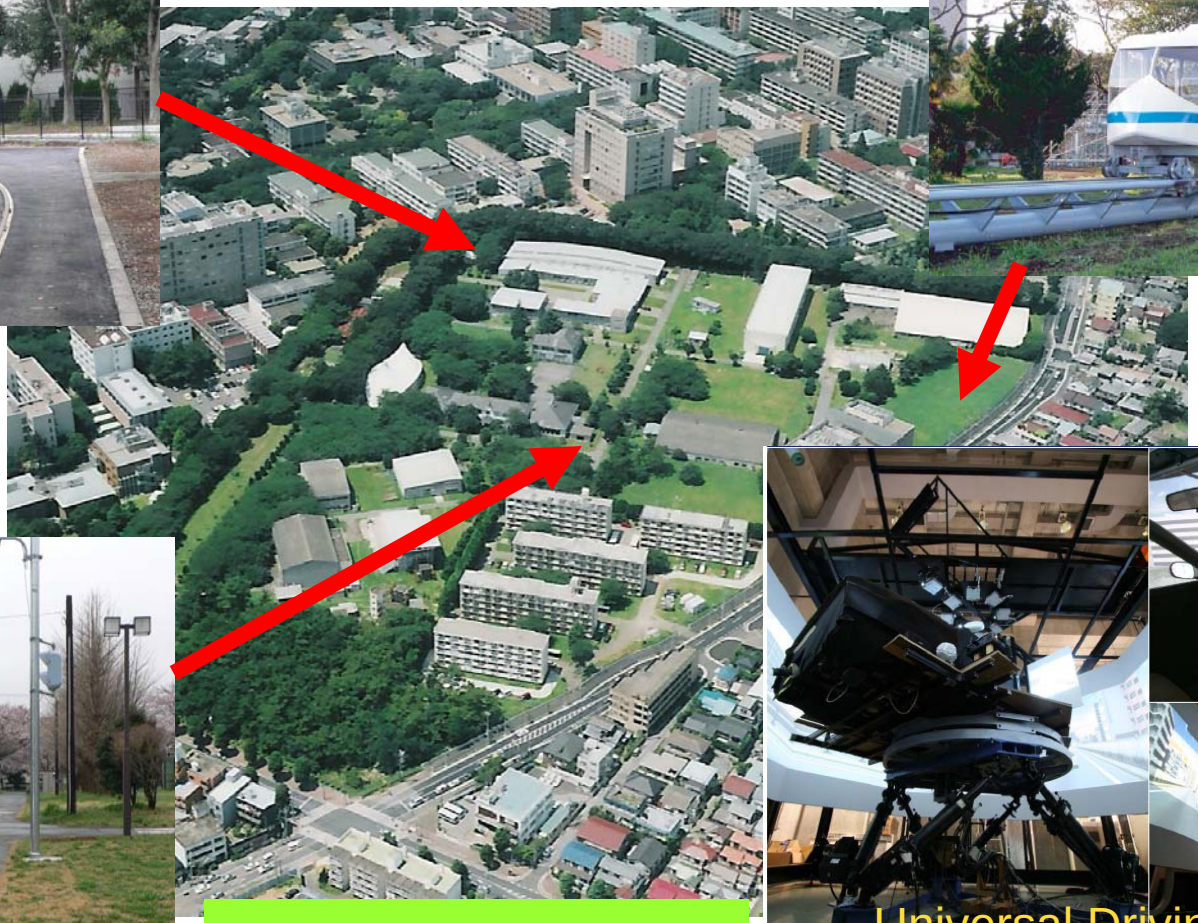
- Low energy consumption
- Healthy
- Long distance operation

Trial Vehicle for Experiments of Steering and Traction



Field Experiments at Chiba Experiment Station, IIS, The University of Tokyo

Full Scale LRT
Test Track



Eco-ride
Test Track

ITS Test Road

Probing Ground

Universal Driving Simulator

Important Integrations

- Research Fields
  - Mechanical and Vehicle
  - Electric and Electronics
  - Civil and Transportation
  - Information Science and Technology
- Sectors
  - Industry
  - Academia
  - Government (Local and Federal)
  - Citizen
- Modal mix
  - Road and Automobile (ITS)
  - Public Transit (LRT, Subway, High Speed Rail)
  - New Concept Personal mobility with robot technology

Key Words for Sustainable Transport

- ITS for road traffic and advanced automobile
  - Improvement of Energy efficiency of automobile
  - Intelligent management of Traffic, Energy flow
- Advanced Guideway System
  - Modal shift from automobile to public transit system
  - LRT and new concept system “Eco-ride” in urban area
  - Energy efficiency High-speed rail and Maglev
- Personal Mobility
  - Promote to small EV and human power
  - Promote from automobile to public transit
  - Robotic two wheel vehicle for stability and safety

Concluding Remarks

- Advanced Mobility Research Center Conducts for Stainable Transportation
- Synthesis and Integration
  - Integration of Technology area
  - University - Industry- Government
  - Automobile + Public Transit + Personal Mobility
- Improvement of Energy efficiency
- Field Experiments and Evaluation