Nagoya University Center of Innovation (COI)
-Empowering an aging society through advanced mobility-

August 22, 2017
Vice Research Leader, Nagoya University COI
Professor Hirofumi Aoki, Ph.D.
What is “Center of Innovation”?

“We want to create a new future!”

How should we change society and people by the end of the next decade?
The COI Program promotes challenging and high-risk R&D to realize our visions for our ideal society.

Key points of the COI Program

- **Backcasting Approach**: Employ the “backcasting approach”, visualizing an ideal society at the starting point and subsequently setting R&D plans towards realization of the society, rather than the “forecasting approach” which relies on existing researches or technologies aiming at their commercialization.

- **Under One Roof**: Establish an innovation platform (COI Site) where universities and companies can work on R&D together under one roof.

- **Period & Budgets**: Support each COI Site up to 9 fiscal year with expenses from 100 million to 1 billion yen per year, including overhead expenses.

Research funding by the Ministry of Education (MEXT) through Japan Science and Technology Agency (JST), (from Nov., 2013 to Mar. 2022)
What is “Center of Innovation”?

Management of a COI Site

Three Visions of COI STREAM

Vision 1
Secure sustainability as a country advanced in its aging population and declining birth rate
: Smart Life, Ageless Society
Key concepts: Innovation, Media, Reality, Mental Health, Meditation, Sports, Food, Tiles ⇒ Realization of happiness

Vision 2
Create a living environment with a high quality of life as a prosperous and reputable country
: Smart Japan
Key concepts (function): (Intuition) ing thinking, Active thinking, Serendipity, Six senses ⇒ Innovative thinking method

Vision 3
Establish a sustainable society with vitality: Active Sustainability
Key concepts (function): Personalization, Resilience, Sustainability, Functionalization, Flexibility, Waste ⇒ Development of a durable town for centuries

Backcasting
Identify multi and/or interdisciplinary R&D challenges

Research Promotion Institution
Act as a research headquarters, create a strategic management plan

Project Leader (from industry)
: Supervise the overall management of COI sites and their R&D activities.
Research Leader (from academia)
: Responsible for the day-to-day operation of the headquarters of COI sites and support of R&D strategy planning.

ICITI 2017
The Objective of Nagoya COI activities

-Empowering an aging society through advanced mobility-
Participating Organizations in Nagoya COI

- TOYOTA MOTOR CORPORATION
- DENSO CORPORATION
- TOYOTA CENTRAL R&D LABS., INC.
- Aichi Prefecture
- National Institute of Advanced Industrial Science and Technology
- Tokyo University of Agriculture and Technology
- Aichi Prefectural University

- Mobility Research
- Cooperative Research
- The University of Tokyo
- Toyota City
- Nagoya City

- FUJITSU LIMITED
- Information Infrastructure Research

- AGC ASAHI GLASS
- Daily Healthcare Infrastructure Research

- Panasonic Corporation
- Sustainable Infrastructure Research

ICITI 2017
Three Pillars to Realize the Objective

Driving Assistance System and Autonomous Cars for safe and reliable mobility

Vitalizing the aging society by mobility advances

Physical Conditions and Mental Inspiration to stimulate going outside

Participatory Society to foster mutual aid and self-respect
Three Pillars and R&D Items

1. **Driving Assistance System and Autonomous Cars for safe and reliable mobility**
   - Provide an enjoyable mobility experience even for those who cannot or do not like to drive
   - Proactive driving assistance, Slocal (slow and local) autonomous driving®,
   - Driver agent, Dynamic map, Stress-free traffic management

2. **Physical Conditions and Mental Inspiration to stimulate going outside**
   - Use the personal information gathered through casual sensing to maintain physical and mental health
   - Activity recommendation, Walking assistance robot, Casual sensing device

3. **Participatory Society to foster mutual aid and self-respect**
   - Create a social system that inspires self-efficacy among seniors through social participation
   - Model community building, Social science assessments
Three Pillars and R&D Items

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Advanced Driving Assistance System

- System works like a driving instructor offering safety tips to senior drivers -

Environment recognition
Situation assessment

Low potential risk region

Assistance with proactive driving

Path planning based on a driving AI

Senior drivers' database

Cooperative assistance

Driver Agent support system

Mobility Research
High performance environment recognition

**Pedestrian Detection**

Traffic accident risk prediction:
- High accuracy detection
- Target attribute recognition

Direction: Left
Adult/child

Pedestrian detection and target attribute recognition (orientation, adult/child, walking while looking at the smart phone)

**World top level performance in pedestrian detection using Deep Learning**

- Recognition rate (Caltech Benchmark) (1/10 frames error rate)
  - Conventional (HOG+SVM): 32%
  - Past (Dn’MI): 63%
  - Cutting-edge (Checkerboard, 2015: speed ×): 82%
  - Proposed (EIN Dn’MI): 73%

**High performance Traffic accident risk prediction:**
- High accuracy detection
- Target attribute recognition

90% pedestrian detection rate with faster algorithm
Artificial Intelligence (AI) learns from good driving data and generates a path according to the environment. Achieve the planned path performance in various traffic environments.

Supervisory Driver Assistance System

Position Error: 14cm
Velocity error: 3.7km/h
Driving skills are improved after the experience of the driver assistance system.

Supervisory Driver Assistance System

- Steering wheel with LED
  - Gas pedal vibration
  - Steering control intervention

Risk factor; Hazard with direct view (e.g., walking pedestrian)

Risk factor; Hazard without direct view (e.g., cross traffic)

Low potential risk region

Deceleration support based on predicted possible danger

Education effect of the system

The effectiveness of the system was tested with 80 senior drivers, comparing their driving behaviors before and after they experience the driver assistance system.

![Graph showing improvements in driving skills](image-url)
## Research on Features of Senior Drivers

### Database for the assistance of senior drivers

<table>
<thead>
<tr>
<th>Database</th>
<th>Institution</th>
<th>cognitive</th>
<th>visual</th>
<th>physical</th>
<th>driving</th>
<th>behavior</th>
<th>follow-up</th>
<th>sample &amp; notes</th>
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<tbody>
<tr>
<td>Data repository for human life-driving anatomy (Dahlia)</td>
<td>Nagoya COI</td>
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<td>50-95 years, 300 drivers</td>
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<td>Research on elderly drivers (III)</td>
<td>JSDC (Japan)</td>
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<td>×</td>
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<td>68-90 years, 191 drivers (report in March 2014)</td>
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<td>Driving behavior database</td>
<td>HQL (Japan)</td>
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<td>×</td>
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<td>67-87 years, 1155 drivers, 5days Driver Monitoring System (Round2)</td>
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<td>The salisbury eye evaluation and driving study</td>
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<td>Maryland pilot older drivers study</td>
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<td>Factors associated with driving performance of elderly drivers</td>
<td>University of Nebraska</td>
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<td>Candrive II Research Team (Canada)</td>
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<tr>
<td>Driving of cognitively impaired elderly people</td>
<td>NCGG (Japan)</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td></td>
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<td>65 years and more, 10,000 drivers, Cognitive function test of questions, 2011-2013</td>
</tr>
</tbody>
</table>

**Building an effective basis to develop assistance systems for senior drivers.**
Driving Assistance with the Dynamic Map for Senior Drivers

Simulation-based Evaluation Environment

Driving Simulator (DS) connected with traffic simulator

Lane-based Navigation

Lane-change request to the driver

POV

Dynamic Map (Our prototype system)

Dynamic Map View

Collision Detection

Query

Predicted Info.

Dynamic Info.

Static Info.

Map Info.

Use Case

Dynamic Map (DM) shares vehicles’ (the senior’s own vehicle and principal other vehicle (POV’s)) information (i.e., position, direction, velocity) on a virtual map via network.

The POV that receives the lane-change request moves to the next lane for smooth merging.

Traffic safety, driver’s stress mitigation

Effectiveness of DM can be evaluated with the simulation system in virtual environments.
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Watch over everyday life

Collecting continuous daily activity database
Inspires seniors to go outside using real-time activity recognition.

Signals from multiple sensors embedded in the smartphone (e.g., acceleration and sound) -> 91% recognition accuracy for nine kinds of daily activities.

Twitter Bot can encourage seniors based on the recognized daily activities.
"Casual sensing” of health condition in living space

Grasp our own physical and mental conditions from ordinary living environments to support daily life according to the conditions.

Casual sensing

Smart chair

Field demonstration has started by prototype of biosignal sensing system with non-contact sensors.

High-sensitive micro magnetic sensor

Noncontact brain waves measurement

Noncontact pulse wave measurement

Photoplethysmographic near infra-red sensor

Pulse wave measurement with miniaturized all-crystal load sensor

Wide-range QCR load sensor
Casual Health Sensing in Daily Life

Bioaerosol
- 10,000 particles in a cough
- 0.01 ~ 100 μm in size
- Biological components
- Bacteria and viruses
- Fatigue and stress markers

Bioaerosol measurement

Intellectual Glass
- 10 μm separation structure
- Single-cell Isolation!

Microfiltration glass

Car

Outside

Home
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Through Mobility Enhancement, Outing Promotion, and Health Maintenance, we are to upgrade the well-being in aging communities.

Started a pilot project in Asuke Region of Toyota City

Building a Role-Model of Exploiting Mobility for Semi-Mountainous Communities

Asuke Mobility Project is supported by TOYOTA Mobility Foundation (2016～)
Community Support System (CSS)

CSS works as a bonding agent and fillers to the existing community system.
Mobility Blend

- Promote outings
- Facilitate transfers among various transport modes including inter-district one
- Enhance mobility utilizing various transport modes
- Monitor health conditions
- Provide tablets for CSS

Mobility Center

- DR Bus

Mobility Spot

- Slow PM
- Micro EV
- Ride-share
- Taxi-share

Home

- Trunk Route Bus

Slocal Autonomous Cars

Autonomous Cars

Taxi-share

Slocal
Toward an Open Innovation Platform using COI Program
NU MIRAI2020  
Nagoya University Matsuo Initiatives for Reform, Autonomy and Innovation 2020

**Education**
- By promoting a world-class education, we aim to foster courageous intellectual leaders that can contribute to human well-being. We are changing the relationship between Nagoya University and secondary schools.
  - Admitting excellent students: Improving admission system and establishing admission center
  - Reforming three policies: Degree conformity, curriculum design & student admissions
  - Improving international compatibility of educational system: Introducing quarter system and international joint degree programs

**Research**
- Inspired by our Nobel laureates, we are committed to the creation & discovery of knowledge through research.
  - Supporting frontier research led by:
    - “Institute for Advanced Research” for basic research
    - “Institute of Innovation for Future Society” for practical research
    - “ITbM” for WPI program
  - Establishing new research centers: i.e. WPI-Next
  - Recruiting, retaining & supporting most talented faculty & fostering world-class researchers: Greater support for women, non-Japanese & early-career

**International**
- We are developing a university that attracts the best students, faculty & staff from around the world & contributes to creating a more sustainable society. In particular, we seek to work closely with countries in Asia.
  - By 2020:
    - Increasing number of international students to 3000
    - Increasing internationally experienced faculty members to 650
    - Increasing domestic students studying abroad to 1000
  - Increasing international students enrolled in English-taught curriculum & number of English-taught courses: i.e. G30 NEXT
  - Implementing strategies with focus on Asian countries: i.e. Asian Satellite Campus & ASEAN Net PLUS

**University-Industry Collaboration**
- As a core university located in one of the world's most dynamic industrial clusters, we conduct research & pursue innovation that contributes to value creation for betterment of society.
  - Establishing a new “industry-academia-government collaboration” to implement open innovation: Establishing new research center on gallium nitride (GaN) & “Future Integrated Electronics Research Center”
  - Fostering people who contribute to society: Increasing entrepreneurial education & industry-academia collaboration
  - Increasing regional resilience for safety & disaster relief: Establishing Disaster Mitigation Research Center & new model for industry-academia-government-civil society collaboration

**Organizational Management**
- Reforming structures of Schools/Graduate Schools: Strengthening education and research activities through comprehensive evaluation of the fields of engineering, informatics, humanities & social sciences
- Strengthening financial base: Raising 10 billion yen fund by 2021, increasing competitive funding, promoting joint research projects through industry-academia collaboration & strengthening hospital activities
- Improving university-wide communication to more effectively & flexibly assign resources
- Collaborating with Asia and wider world to promote gender equality on campus: Establishing Gender Equality Promotion Center, increasing female faculty members to 20% & promoting women in leadership positions
Nagoya COI is one of the projects of the Institutes of Innovation for Future Society (Est. 2014)

Academic Research & Industry-Academia-Government Collaboration Division (Est. 2013)
Collaborative and educational activities in Nagoya COI

Industry/academia collaborations

R&D testbeds

- Establish R&D testbeds for Industry/Academia collaborations
- "Last mile" autonomous vehicle

Human resources development/education

Young researchers’ appointment

- Challenging exploratory/collaborative research by young researchers
- Outreach activities (Tactics committee by young researchers and university research administrators)

Senior’s house

Bus stop