INTELLIGENT TRANSPORTATION SYSTEMS:

LECTURE 1:
INTRODUCTION TO “ITS”

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Our current research focuses on Mobility Modelling and Analytics, Mobility Data mining, Mobile Phone Cellular Network data Analytics, and Intelligent Transportation Systems (ITS).

Research activities cover four main directions:

- Mobility Analytics
- Advanced Travel Information Systems
- Advanced Driver Assistance Systems
- Vehicular Networking
Lecturers:

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• Course webpage: https://courses.cs.ut.ee/2022/ITS/fall

• Lectures:
  
  • Wed. 10h15 -12h00
    
    • Recording
    
    • Hybrid (Classroom) or Online

  • Fri. 10h15-12h00
    
    • Recording
    
    • Hybrid (Classroom) or Online
COURSE SYLLABUS

• Midterm exam (20%)

• Final exam (20%)

• Projects and presentations: (35%) (two choices)
  • Research paper (individual)
    • A critical review of selected ITS literature
    • Analysis of some topics of interest to you related to ITS
  • Creating a small application (individual or group)
    • Possible applications will be discussed during the lab sessions

• Labs: (25%)
  • The first part is related to image processing and computer vision in ITS
  • The second part is about GIS, Mobility modeling, and traffic simulation
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<td>Introduction to ITS: definition, roles and involvement.</td>
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<td>Advanced Traveler Information Systems (ATIS)</td>
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<td>Advanced Transportation Management Systems (ATMS)</td>
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<td>ITS services: Advanced Public Transportation Systems (APTS), Commercial Vehicle Operation (CVO), etc</td>
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<td>ITS and technologies: Automated highway systems (AHS), Autonomous Vehicles, Intelligent Infrastructures, etc</td>
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<td>Critical ITS issues: ITS and security, ITS and safety, human factors, privacy, sustainability, etc</td>
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INTRO

VIDEOCLIP BY FORUM DE COMPETITIVIDADE DE IOT
WHAT IS ITS?

**DEFINITION 1.1:**
ITS is about applying well-established technologies of communication, control, electrons, computers (hardware and software) for increasing the safety and efficiency of the existing transportation system.
INTRO

DATA CAPTURING

SMART SENSORS

DATA PROCESSING

DISSEMINATION OF INFORMATION

STATIC SYSTEM

DATA PROCESSING

DYNAMIC SYSTEM

SYSTEM
INTRO

WHY IS “ITS” IMPORTANT?

SAVE LIVES
- Reduce crashes and fatalities
- Improving security and safety
- Improving emergency response

SAVE TIME
- Improve trip planning
- Improve delivery time
- Increase reliability

SAVE MONEY
- Cost avoidance
- Improve productivity
- On-time delivery
- Customer satisfaction

SAVE THE ENVIRONMENT
- Fuel saving
- Reduce pollution

Source: cvlibs.net
Source: its.cs.ut.ee
**"ITS" MAIN OBJECTIVES**

- Traffic Monitoring
- Energy consumptions
- Safety on roads
- Pollution on roads
- Fluidity of traffic
- Sufficient parking infrastructure
- Reduce travel time
- Ease of public transport

...
"ITS" ELEMENTS

SOFTWARE
- ALGORITHMS
- MOBILE APPS
- SYSTEMS MANAGEMENT
- AND OPERATION
...

HARDWARE
- CARS
- BUSES
- TRAINS
- AIRPLANES
- DRONE
...

INFRASTRUCTURE
- ROAD NETWORK
- MOBILE NETWORK (..4G/5G)
- SENSORS
- WIRELESS INFRASTRUCTURE
...
“ITS” MANIFESTATION
ITS INDUSTRY INVOLVES MANY CATEGORIES, DISCIPLINES AND EXPERTISE

- ADVANCED TRAVELER INFORMATION SYSTEMS
- VEHICULAR NETWORKING
- ADVANCED DRIVER ASSISTANCE SYSTEMS
- AUTONOMOUS VEHICLES
- ADVANCED TRAFFIC MANAGEMENT SYSTEMS
- Collision Avoidance
- Collision Detection
- Active traffic
- Traffic jams
- Incidents
- Traffic flow
- Travel Time
- Navigation
- V2V
- V2I
- V2X
- Travel Assistance
- Trip Planning
- Fleet Management
- Toll Collection
- Vehicle-to-Vehicle
- Safety Systems
- Traffic Signs
- Passenger Information
- WLAN
- Intermodal Communications
- MOBILE
- Mobile Communications
- TERRESTRIAL BROADCAST
- SATELLITE COMMUNICATIONS
- ETSI 2008

"ITS" MANIFESTATION

ITS INDUSTRY INVOLVES MANY CATEGORIES, DISCIPLINES AND EXPERTISE

DEFINITION 1.1: ADAS

Advanced driver assistance system are intelligent systems integrated in the vehicle that assist the drivers to ensure their safety during driving or parking. These systems are based on automated technology or algorithms that uses sensors to detect obstacles, traffic signs, driver errors, and respond accordingly to the situation.
EXAMPLE 1.1: Adaptive Headlights

Designed to make driving during the night safer by increasing visibility in curves and over hills.
EXAMPLE 1.2: Automated Valet Parking

It is the actions of performing an automatic or driverless parking actions.
DEFINITION 1.2: Autonomous Vehicles

Autonomous Vehicles or self-driving car is a vehicle capable of sensing its environment and moving safely with little or no human input.
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DEFINITION I.3: Autonomous Vehicles

- **SENSE**: Data collection and gathering from sensors
- **PERCEIVE**: Interpret and understand the sensors data
- **DECIDE**: Action selection in a safely manner
- **ACTUATE**: Action initiation

Data collection and gathering from sensors
Interpret and understand the sensors data
Action selection in a safely manner
Action initiation
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DEFINITION I.3: Autonomous Vehicles

- **Sense**
  - LIDAR units
    - Creates a 360-degree 3D map of the vehicle's surroundings using laser.
  - Cameras
    - Forward facing cameras array to detect near and far objects, vehicle activity, pedestrians, and traffic signals.
  - Stereo Cameras
    - Paired of cameras are used to capture a 3D picture and can detect objects.
  - Additional LIDAR units
    - Aid in detecting objects close to the vehicle or in blind spots.
  - Computer
    - Built-in computing & storage for live data processing.
  - Radar
    - Uses bursts of sound to determine distance between objects.

Data collection and gathering from sensors


Ontario - Metro

Paris - Metro

Sensible 4 - Shuttle
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DEFINITION I.3: Autonomous Vehicles

PERCEIVE

Interpret and understand the sensors data

Camera

Lidar
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DEFINITION I.3:

DETERMINE

ACTUATE

Action selection in a safely manner

Action initiation
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Deployment reality:

**ADAS**
- Level 1: Driver Assistance
  - ACC (Braking)
  - Lane Keeping Warning
  - Auto Emergency Braking
  - Park Assist

- Level 2: Partial Automation
  - ACC (Steering)
  - Lane Changing
  - Traffic Jam Assist
  - Overtaking Assist

- Level 3: Conditional Automation
  - Highway Driving (~50MPH)
  - Driver Initiate Lane Change
  - Automated Valet Park
  - Traffic Jam Chauffeur

- Level 4: High Automation
  - Highway Driving (~100MPH)
  - Automated Lane Change
  - Cruise Chauffeur
  - Free Drive

- Level 5: Full Automation
  - Robot-Taxi
  - Automated Shuttle
  - All Driving Conditions

**AUTONOMOUS VEHICLES**
- 2000: Everything on
- 2013: Feet off
- 2018: Hands off
- 2024: Eyes off
- 2027-2030: Mind off
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**DEFINITION 1.4: ATMS**
Advanced Traffic Management Systems are responsible for streaming real-time transport data from the entire traffic infrastructures into one Transport Management Centre (TMC). The TMC is where all the data is processed in order to take intelligent measures for handling traffic jams, increasing mobility efficiency, maintaining and improving safety.

**WHY:**
ATMS helps in:
- Monitor
- Control
- Optimize
- Operate

ATMS are the eyes of Transport Management Centres which acts like a control room for mobility in smart cities.
EXAMPLE I.3: Traffic light Control Systems

Adopted network:
Junction of two roads with four lines each. Each line has two sensors that help in having more accuracy in handling the junctions by the controller.
EXAMPLE I.4: Traffic Counting

Counting traffic in Junction using Camera and Machine Learning (ML) methods.

Source: Bachelor Thesis by Jorgen Juurik Vehicle Tracking and Speed Estimation in Aerial Footage
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**DEFINITION I.5: ATIS**

Advanced Traveler Information Systems are considered to be the core service of intelligent transportation systems and their main role is to support travellers in planning their journey efficiently in order to define their route, estimate travel time and avoid traffic congestions. Therefore, ATIS provides two types of information such as:

- **Static information**
  - Geographic data of stopped vehicles
  - Transport schedules
  - Etc,

- **Dynamic information**
  - Schedules
  - Weather conditions
  - Closed roads
  - ETAs
  - Etc,
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FUNCTIONS 1.1: ATIS operational roles:

• Static and real-time traffic information
• Weather information
• Real-time information about public transport
• Parking information
VANETs

Vehicular networks has emerged due to the advancement and development of wireless technologies, ad-hoc networking, and automobile industry. These networks are constructed among moving vehicles, infrastructure (road side units), and pedestrian (mobile devices).
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**EXAMPLE 1.4: Simulating IoT System for public transport**

Step-one is a set of tools developed for the purpose of simulating IoT systems in a smart city scenario.


Git: https://github.com/jakskd/step-one
THANK YOU FOR YOUR ATTENTION

— Intelligent Transportation Systems - MTAT.08.040 - Lecture 1