Smart and sustainable urban transportation for ASEAN region

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Contribute to ASEAN and India by developing smart and sustainable urban transportation.
2-1. Research Focus and Key Technologies

1. **Visualize:** Intuitive visualization of bus operations through IoT analytics combining traffic congestion, people mobility and spatio-temporal demand variations.

2. **Analyze:** Analytics on heterogenous information sources such as in-vehicle video, roadside camera, Automatic Fare Collection System (AFCS), road quality information, GPS and trip schedules to generate Key Performance Indicators (KPI)

3. **Optimize:** Impact assessment of traffic events, modeling and simulation of route networks to generate optimal schedules.

### IoT Data Sources
- **a** GPS devices
- **b** Smartphone App
- **c** CDR
- **d** Video data

### Analysis
- **Vehicle type classification**
- **In-bus crowd analysis**
- **Person trip analysis**
- **Bus Operation analysis**
- **Bus Schedule Simulation**

### Sensing
- Traffic congestion info.
3-1. Public Transport Optimization - Visualize

Analysis & Visualization of Bus Operation

1. Map based On-road/In-bus congestion visualization
2. Grouping & picking-up inefficient bus operation
3. Analyzing what causes the inefficiency
4. Visualizing the congestion data of each time slot & day of the week
5. Visualizing load pattern & boarding/alighting across stops a route
6. Analyzing bus bunching, delays due to traffic and bus frequency

Optimize operation plan of bus companies in order to solve congestion both on roads and in buses and increase occupancy.

**Benefit**

**Bus company**
- **Identify problem area** from operation data analysis, **Identify missed opportunity** with areas of high demand, **cost reduction** by reducing low occupancy services bus operation,

**Citizen**
- **Better usability** of public transportation with less in-bus congestion, and improved service.
3-2. Public Transport Optimization - Analyze

Machine learning based automatic classification of trips and modes of travel to extract city Origin-Destination (OD) patterns.

![Data collection](image)

**Smartphone Probe**
- BUS + GPS receiver
- Roadside camera, sensors
- Smartphone of citizens

**Analysis & Visualization**
- Speed / Acceleration Log
  - Speed
  - Acceleration
  - Auto, Rickshaw, Train, Walking, Bus

**Speed / Acceleration Log**

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3-3. Public Transport Optimization - Crowd Analysis

Passenger density analysis with deep learning to analyze spatio-temporal ridership

Solution:
- Train an Image Classification CNN to classify input image to one of 5 levels
- Resultant density level is useful for planning, optimization of routes

Evaluation:
- **Accuracy** - We achieved on an average **80% and above** on real world city bus services videos

CNN: Convolutional Neural Network
3-4. Public Transport Optimization - Passenger counting

To detect and count passenger in-flow and out-flow i.e., boarding, alighting at each stop.

- **Solution**: To detect and count passenger in-flow and out-flow i.e., boarding and alighting at each bus stop. Portion of image focused at door will be analysed.

- **Input image**

- **Computer Vision based passenger count measurement**
  - Motion Detection & Blob Extraction
  - Motion Tracking & Counting Decision
  - Passenger In-flow & Out-flow count value

- **Fixed analog CCTV**
- **Resolution**: 352x288
- **12 fps framerate**
- **CCD image sensor**
- **PAL video format**
- **Day/Night colour camera**

- **Accuracy range**: 75~90% tested over 90+ videos

- **Typical test scenarios considered are:**
  - Day & night time cases
  - Single/multiple boarding alighting
  - Includes reflection, shadow, occlusion ...

- **Idea**: Light weight algorithm
- **Deploy on OBU (i.e., on-board unit in bus)**
3-5. Public Transport Optimization - Bus Scheduling

Simulation driven schedule optimization for interim validation of timetables

Step 1: Frequency setting

Step 2: Timetable Development

Service Frequency by Route, Day and Time Periods

Departure/Arrival times for individual trips on each route

Re-optimize

Monitoring Phase

ITS data collection of trips, ridership and fare collection

Field Validation

Vehicle-crew allocation

Proposed Multi-agent simulation driven optimization

Interim-Validation

Implementation Phase
Enable to measure traffic volume with multiple vehicle types and to detect traffic violation/accident accurately. Contribute to understand traffic events.

Measurement & Collection

① Multiple vehicle type classification
- Four Wheelers
- Three Wheelers
- Two Wheelers
- Light Motor Vehicles
- Trucks/Buses

Collect data with multiple types of vehicles

② Traffic violation/accident detection
- Collision
- Wrong way
- Dangerous driving

Solution

- Real-time operation
  - Prompt response for traffic event
  - Efficient regulation

- Data analysis
  - Find areas violation/accident frequently happen
  - Traffic simulation

Legend
- 5:00 – 10:00
- 10:00 – 18:00
- 18:00 – 24:00
- 24:00 – 5:00
4-2. Video Analytics for City Traffic Control - Use case

**Observation with stereo cameras**

Stereo camera

**Statistical Analysis on GIS**

- **Incident type**: Wrong way driving 58%
- **Vehicle type**: Bike 48%

**Current situation found from data**: Motorbike drivers are likely to drive wrong way.

**Current Situation in roads**

- **Traffic accidents happen**
- **Wrong way driving**
- **Congestion**

**Improvement Plan Study**

- Alert in real-time VMS or roadside speaker

**Situation in roads after improvement**

- **Safe driving**
- **Smooth**

**Reduction of traffic accidents**

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• Automatic recognition of different types of cracks such as linear cracks, longitudinal cracks, alligator cracks, blur white lines, etc.
• Images are frame grabs taken from inside of vehicle, with on-board camera unit.
• Deep Learning algorithms for identifying different types of cracks, from dataset from different cities of Japan.

IEEE BIG DATA CUP CHALLENGE    Hitachi India team has an accuracy of 60%
5. Conclusion

- Hitachi’s technologies for smart, sustainable urban transportation including visualization and optimization are introduced.
- City traffic and road video analytics to monitor passenger flow in vehicles and on-road incident analysis.
- Through collaboration and proof of concept (PoC) opportunities we hope to expand research and development activities in urban transport for ASEAN region.