Artificial Intelligence and the Urban Transport
The *Arguments* for Precision, Sustainability, and Environment

Sheikh Muzamil Hussain
CEPT Ahmedabad
Arguments

What role is AI going to play in the fourth age and what impact does it have on systems, transport including:

- Human vs Artificial intelligence
- Conventional technology and Machine learning technology
- The debate of precision, sustainability, and environment in relation to AI incursion into urban transport.
Why AI?

What is AI

- Everything is interconnected (Deleuze and Guattari, 2009). Concept of Urban Planning as ‘rhizome’
- World Economic Forum (WEF) defines AI by its ability to “do things traditionally done by people”,
- Brain of smart cities.

AI can help us better understand our cities and delivers an informed urban planning, and together with citizens' input, it helps us better determine the needs of the public, what means making more sustainable decisions.

Global Footprint

- 11% of the surveyed organisations are AI adopters
- 62% of the surveyed public transport organisations are involved in AI technologies projects and solutions

Why Artificial Intelligence

- Real time operations management
- Customer Analytics
- Predictive manner
- Network planning and road design

“connectivity and cartography are bridges to the unconsciousness and transparent connections between urban fabrics and movement”
Why AI?

SUSTAINABILITY AND ENVIRONMENT

Al applications in transport is connected and autonomous vehicles, which aims to enhance productivity by reducing the number of accidents on highways.

*Sustainability is arbitrary term*

*Less the utilization of resources, more the sustainable*

It is estimated that around 30-40% of the emissions come from transport related services. In some studies that figure is more than 50% which means transportation services around the world are dealing a major blow to the idea of a sustainable future.

According to the Department of Energy (DoE), automated vehicles could reduce energy consumption in transportation by as much as 90%. This stark contrast matters, considering that more than a quarter of greenhouse gas emissions come from the transport sector, as per the Environmental Protection Agency (EPA).

SOURCE: Delhi Air Pollution Modelling Using Remote Sensing Technique
Handbook of Environmental Materials Management, Shivangi Saxena, Springer
EFFICIENT AND SUSTAINABLE

AUTONOMOUS VEHICLES
Autonomous Driving

1961
Stanford car was inspired from lunar rover developed in US in the preceding decade and could navigate using a solid white line on the ground.

1977
the Japanese Tsukuba Mechanical Engineering produced an autonomous vehicle that could recognize street signs and markings.

2009
The Google car uses Light Detection and Ranging, abbreviated as LIDAR, to measure the distance between the objects, which in case of road traffic are visualizing the vehicles.

2016
Autopilot 8.0, which processes radar signals to create a coarse point cloud similar to LIDAR to help navigate in low visibility, and even to 'see' in front of the car ahead.

2018
Uber Advanced technologies group (ATG) in support from Volvo has produced their own self-driving vehicle which are capable of roaming the cities without manual assistance.

Pros
- GPS Synchronization
- Real time monitoring
- Holistic Navigation

Challenges
- Congestion
- Recognition capability
LIDAR Technology

- The Google Waymo uses **Light Detection and Ranging**, abbreviated as **LIDAR** to measure the distance between the objects, which in case of road traffic are visualizing the vehicles. The LIDAR is equipped with a camera atop the vehicle that uses array of 32 or 64 laser lights to measure span of distance within the moving objects.
- Google’s Waymo is equipped with eight sensors.
- Additionally, the car has surface mounted cameras to receive **geographic information from satellites**. The GPS enables the car to be more precise and more importantly generates a real-time flow of activities.

**COMPONENTS**
- COMPUTING
- SENSORS
- DRIVE SYSTEM
- POWER SUPPLY
- COMMUNICATION

**LIDAR COMPONENTS ON WAYMO**
SOURCE: 9TO10GOOGLE.COM

**LIDAR NAVIGATION SYSTEM**
SOURCE: DANIELA MOYA

**LIDAR SENSOR MODULE**
SOURCE: MONSH GMBH
Ahmedabad has 89 km network of BRTS and the capital cost was Rs. 1200 Crores, averaging at around cost of 13 Crores per Km.

Trips = 130000 per day
Bus fleet = 254
Maintenance cost = 20.2 Cr.
Operation cost = 110.22 Cr.
Other costs = 20 Cr.

All cost figures are for year 2018

Cost Benefit

- Vehicle operation cost savings (VOC savings)
- Fuel savings
- Environmental pollution maintenance cost
- Passenger time savings
- Speed optimization
- Acceleration and Deacceleration
- Whole system sync with real time data

20 – 30%

Automation has a more effective grip over acceleration and deacceleration which significantly increases the efficiency of transportation systems.

ICT ENABLED TRANSIT SYSTEM EXAMPLE

The maintenance and operation cost are around 20% less than conventional bus transport network given the fact the BRTS uses real time data from GIS and additionally uses Intelligent system (ITS).

Ahmedabad BRTS

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SOURCE: M. Chaudhary, Shodhganga.inflibnet.ac.in
Technology

REAL TIME DATA COLLECTION
Data Assessment- Practices, Challenges and Possibilities

Traffic Data is fundamental to all Transportation Infrastructure planning and improvements. Inaccurate Traffic data can affect the entire Infrastructure project very badly. Inaccurate Data can be either an undercount or an Over count. Both have terrible impacts on the entire project.

- Route number
- Trip number
- Number of passengers
- Origin (Stage or stop)
- Destination (Stage or stop)
- Time stamp of ticket sold

Transportation studies are backed by number of surveys to access the ground situation. In most of the developing countries the data is manually collected and sampled in proportion of the population. Many field surveys, for instance trip data collection which is a mutual discussion between the surveyor and the respondent may lack the rigorous stats by which the modelling is performed to generate desire lines or the busiest corridors of the city in terms of traffic flow.

GPS BASED DATA ASSESSMENT

- PICK UP POINT + CLUSTER GROUPS = POI/DESTINATION
- PICK UP POINT + TRAJECTORY = ROUTE

AUTOMATIC FARE COLLECTION SYSTEM (AFC)
- DATA GENERATION ON TRANSIT SYSTEMS
- DIGITAL COLLECTION OF DATA
- REAL TIME ANALYSIS

ELECTRONIC TICKETING MACHINES (ETM)
- PORTABLE FOR BUSES
- RECORDS VITAL DETAILS LIKE TIME OF TRAVEL, ORIGIN AND DESTINATION
The pixel quality of the camera is high-resolution and thus can detect minutest of detail. The standard pixels are:

- 6.08 million Pixels (2752x2208)
- 6.8 million pixels (3382x2008)
- 8.30 million pixels (3840x2160)

The algorithms digitised using Convolutional Neural Network (CNN) by the control apparatus using the hi-res camera can detect:

- Vehicle recognition
- Logo recognition
- License recognition
- Face capture
- Adherence to traffic rule
- Pedestrian yield
- Seat belt compliance
Advances in Traffic Data Assessment

NEURAL NETWORK RECOGNITION TECHNOLOGY

Demand Analysis

- Flow of traffic
- Waiting time, length of Queue
- Average travel speed
- Modal statistics for analysis
- Security and safety

Surveys

- Road Inventory survey
- Traffic volume counts (peak and non-peak)
- Origin and destination
- Pedestrian survey
- Cordon line survey
- Speed and delay analysis

SOURCE: IntelligentTransport.com
Accuracy to detect the movement on roads and how the AI data can be synched for other operations like traffic management

- 95% Recognition accuracy for vehicle license plate
- 95% Recognition of running red lights
- 95% Recognition of crossing forbidden lines
- 98% Recognition of converse driving
- 98% Recognition of occupying non-motor vehicle lanes
- 98% Recognition of occupying dedicated bus lanes
- 95% Recognition of spotting trucks on roads
- 80% Recognition of non yielding to pedestrians

SOURCE: Hai Tao, AITPM Conference 2017, China
Ant Colony Optimization Algorithm

ALGORITHM IN TRANSPORTATION
A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.
A heuristic algorithm is one that is designed to solve a problem in a faster and more efficient fashion than traditional methods by sacrificing optimality, accuracy, precision, or completeness for speed.

Optimization
Continuous Iterations
Dynamic Networks

Travel time optimization using ACO

Ant Colony Optimisation algorithm (ACO) is a similar manifestation of natural phenomenon of ants which they use for searching food. Ants can’t see but possess a highly developed sense to trail paths using a chemical they transpire- pheromone.

Combining ant colony optimisation (ACO) with the current reinforcement (CR) model

SOURCE: Chao Gao, Chen Liu

SOURCE: Uloom Computers Isfahan
Ant Colony Optimization - Concept

\[ p_{ij} = \frac{[\tau_{ij}]^\alpha [\eta_{ij}]^\beta}{\sum_{h \in E} [\tau_{ih}]^\alpha [\eta_{ih}]^\beta} \]

- \( p_{ij} \) = Travel from node \( i \) to node \( j \)
- \( \tau \) = represents an \( n \) by \( n \) pheromone matrix
- \( \eta \) = Attractive co-efficient
- \( \sum = h \) is summation of all possible locations to reach by a particular ant

Probability is also subject to vaporization of pheromone (demand in our case).
Algorithm Design Principle
Time complexity is one of the main factors considered in this algorithm. Time complexity refers to the time function required for the program to run to the end of the solution. When the number of vehicles and road nodes is large enough, the time complexity of the lower power can be ignored.

1. Measuring the distance from the vehicle to the end point, and then we can judge whether the vehicle has reached the end point or not according to the measured distance. If it arrives, return the pheromone. If not, continue to execute the cycle.

2. Determine whether the information of the next node is different from the original plan. If there is a difference, continue to proceed according to the original plan.

3. According to the information concentration and the heuristic function, the next function is measured.

4. Select the road that the vehicle will travel to determine whether it has reached the end point.

The principle and flow of ACO used by the Isaack Kamanga in his study of city public transport design in Tanzania.

Source – Viktor Danchuk et al, (Danchuk, Bakulich, & Svatko, 2007)
Conclusion

AI imitates human thinking and behaviour and thus makes for an viable alternative

Intrusion of AI into Urban Transport system is inevitable

Significant reduction in operation costs

AI makes Urban Transport more sustainable, alike for governments, policy makers and environment
Thank You