LSCM

LOGISTICS SUMMIT 2021
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The Intelligence of Transport IoT Technologies

Dr. CH Cheng

Director, Research and Technology Development,

Logistics and Supply Chain MultiTech R&D Centre

Agenda

- Pedestrian detection using thermal technology
- Monitoring system for the safety of minibus passengers
- Estimated Time of Arrival (ETA) for green minibuses
- Modelling for ETA calculation

Pedestrian Detection using Thermal Technology

Intelligent Pedestrian Light control

- Operated in Broadwood Road/Link Road Since May 2019

Purposes of Pedestrian Detection

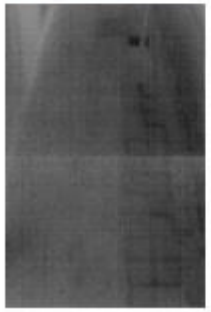
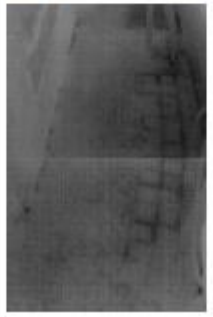
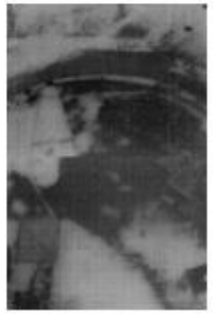
- Reduce the waiting time for pedestrians to cross the road
- Reduce the number of times of unnecessary RED lights for ongoing vehicles
- Improve road safety
- Improve the operational efficiency of signal-controlled junctions
- Assess the necessity of pedestrian detection devices at signal-controlled junctions
- Enhance the traffic efficiency and provide pedestrian friendly junctions

Reply to Legislative Council

(1) At present, the TD has installed video pedestrian detection devices at five junctions under the pilot scheme, namely the intersection of Hoi Bun Road and Lai Yip Street junction in Kwun Tong, the intersection of Link Road and Broadwood Road in Happy Valley, the junction near the transport interchange in Sham Mong Road in Cheung Sha Wan, the pedestrian crossing at Po Ning Road near Tseung Kwan O Hospital in Tseung Kwan O, and the pedestrian crossing facing Ebenezer School & Home for the Visually Impaired in Pok Fu Lam. The expenditure involved in the pilot scheme is about HK$900,000.

LSCM's Work

Locations of Thermal Devices

Location	Link Road		Broadwood Road	
Device No.	101	102	103	104
No. of Thermal Sensors	2	2	2	2
Image of Thermal Sensor				
Coverage of Detection Area				
Sample of Thermal Image				

System Functions

1. Detect the presence of pedestrians
   - Adjust the green-man time for pedestrian crossing
2. Distinguish by-passing / crossing pedestrians in the waiting zone
   - 'Activate' the pushbutton when pedestrians are waiting a green-man
   - 'Cancel' the pushbutton if pedestrians leave the waiting zone before the green-man is shown

LSCM's Contributions

- Confirm the technical and operational feasibility of thermal technology
- Develop a solution that preserves the privacy of road users
- Design an operational mechanism for automatic green-man activation and cancellation
- Integrate the operational mechanism in a conventional traffic signal controller
- **Pedestrians no longer need to touch the pushbutton for road crossing**

Monitoring System for the GMB Safety

South China Morning Post Published: 6:40am, 4 Aug, 2021

Letters | Fatal Hong Kong minibus accident a wake-up call on seat belt requirements

LSCM's Solution

Since September 2020, the Transport Department has installed sensors and corresponding wiring for seat occupancy and seat belt fastening detection in a small number of minibuses to enhance passengers' awareness of wearing seat belts.

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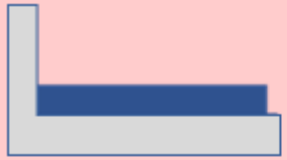
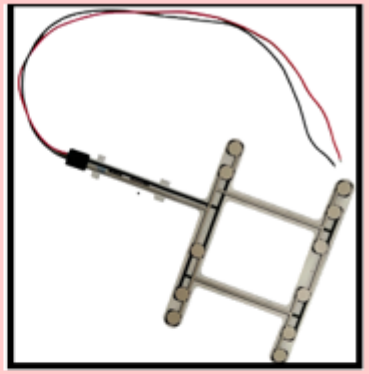
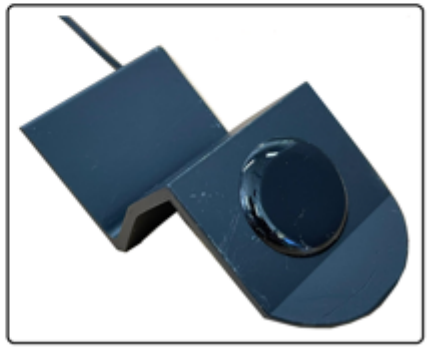
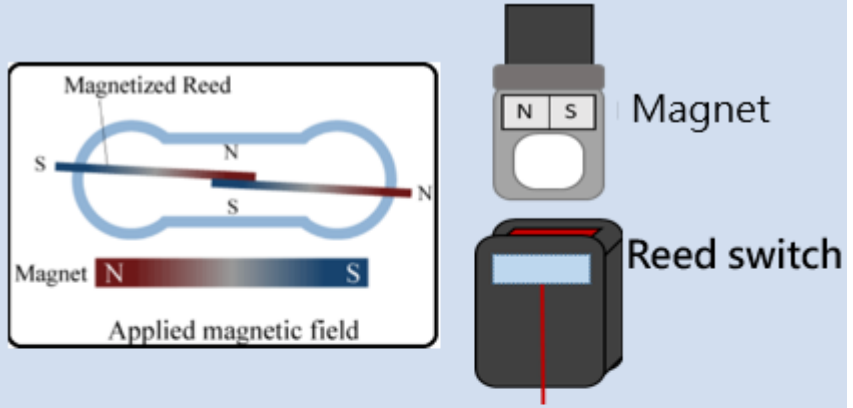
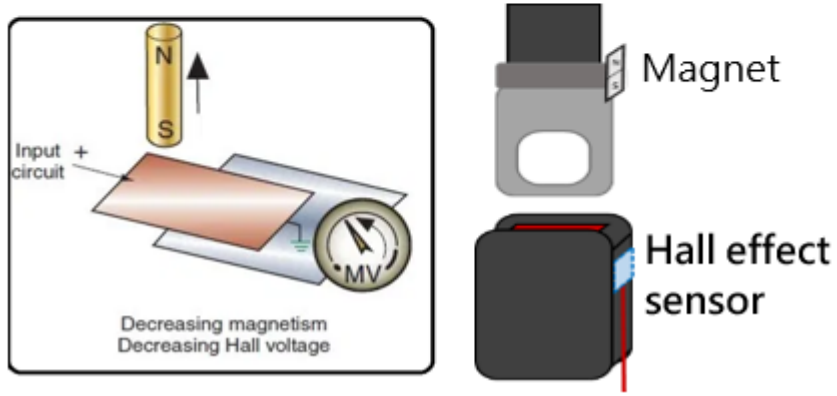
We believe such a seat-belt-fastening detection system should be used in all the minibuses to enforce the seat belt requirements for passengers as soon as possible.

Weizhen Bian, Kowloon Tong, and Qinyi Xue, Pok Fu Lam

Seat Occupancy Detection

1	**Pressure Sensor**		
2	**Infrared Sensor**		

Seat Belt Fastening Detection

1	**Reed Switch**	
2	**Hall Effect Sensor**	

Visual Alert

1	**LCD Panel**	
2	**LED Signal**	

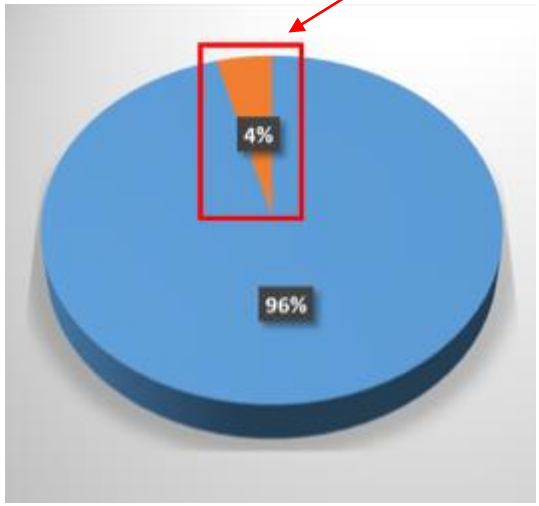
Audible Alert

1	**Speaker** **(Audio announcement with three languages)**	
2	**Buzzer** **(Voice alarm with "Bi" sound)**	Buzzer

Sampling of GMB Passengers

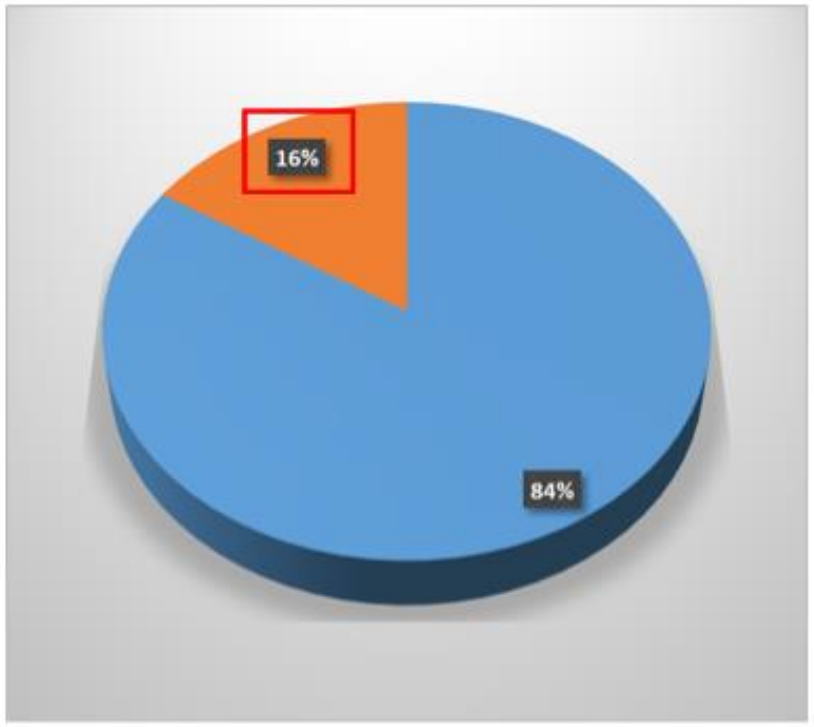
- Number of Passengers Involved: 834
- Number of GMB: 8

Only 4% of passengers used seat belts

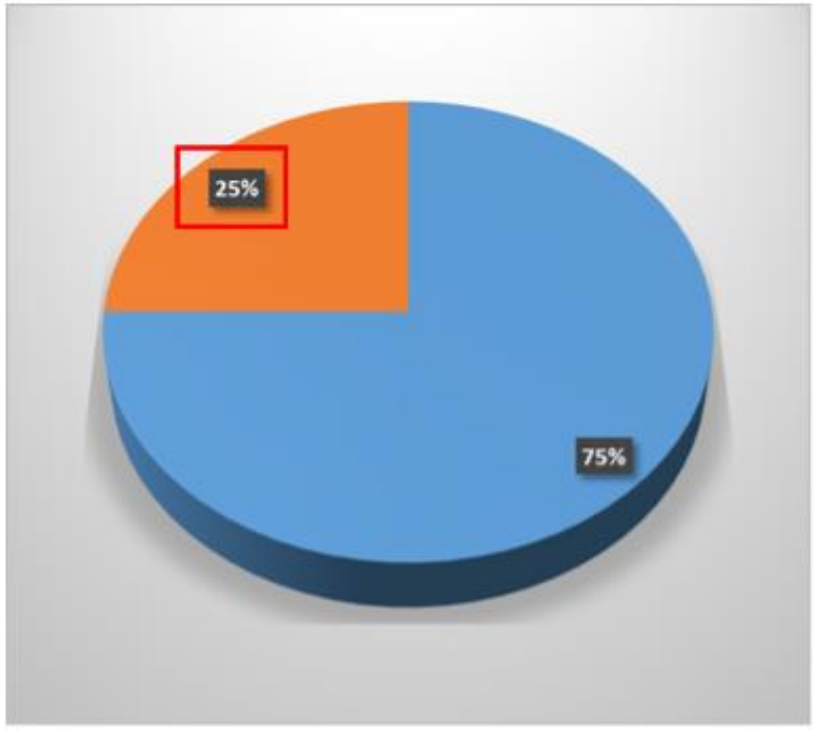


Impact of LCD and LED Alert

With LED

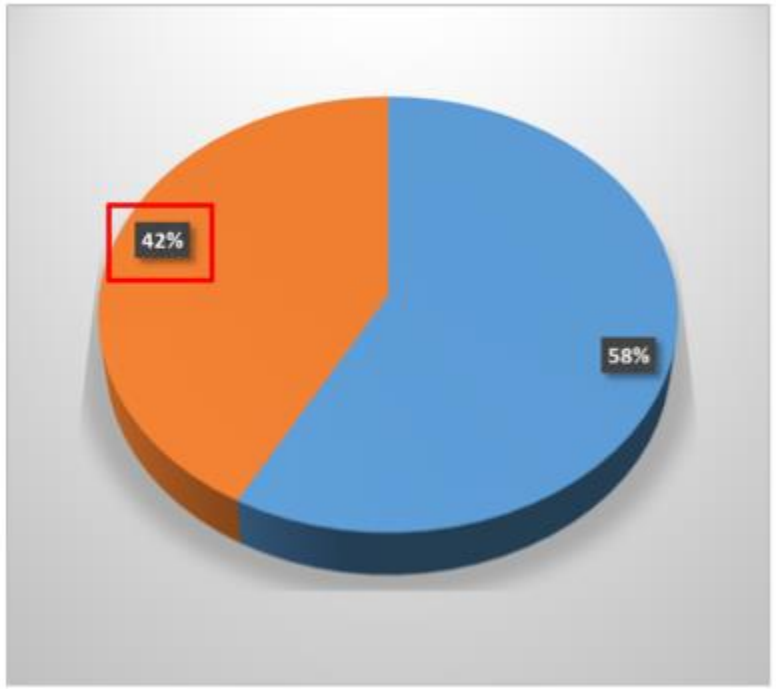


With LCD

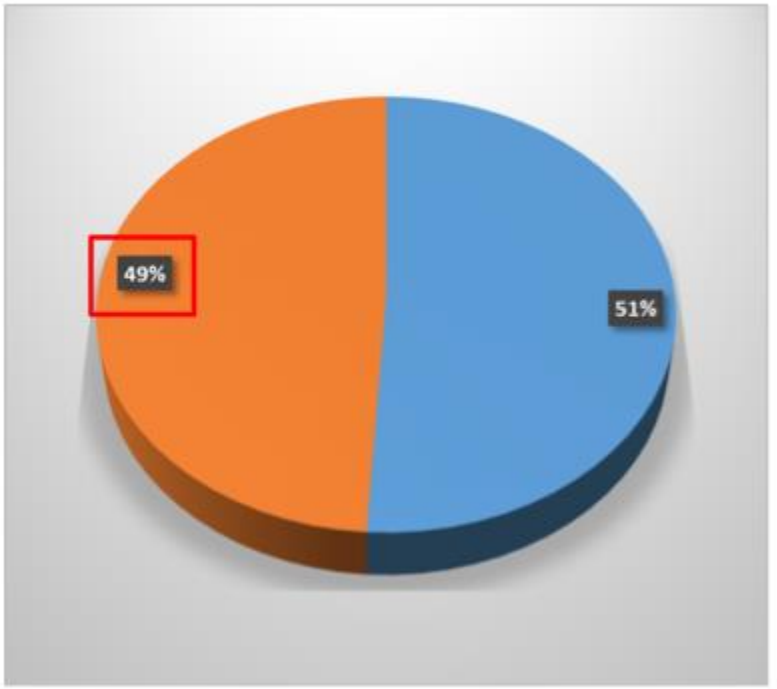


Impact of Buzzer and Speaker

With LCD and Buzzer



With LCD and Speaker



Estimated Time of Arrival for GMB

GMB

+

GPS Tracker

GMB Location data

Backend system

- Passengers — To provide GMB ETA information via "HKeMobility"
- GMB Operators — To support operator's fleet management
- TD — To facilitate traffic management and transport planning
- Public — To provide data to the public via. DATA.GOV.HK

On Site Trial

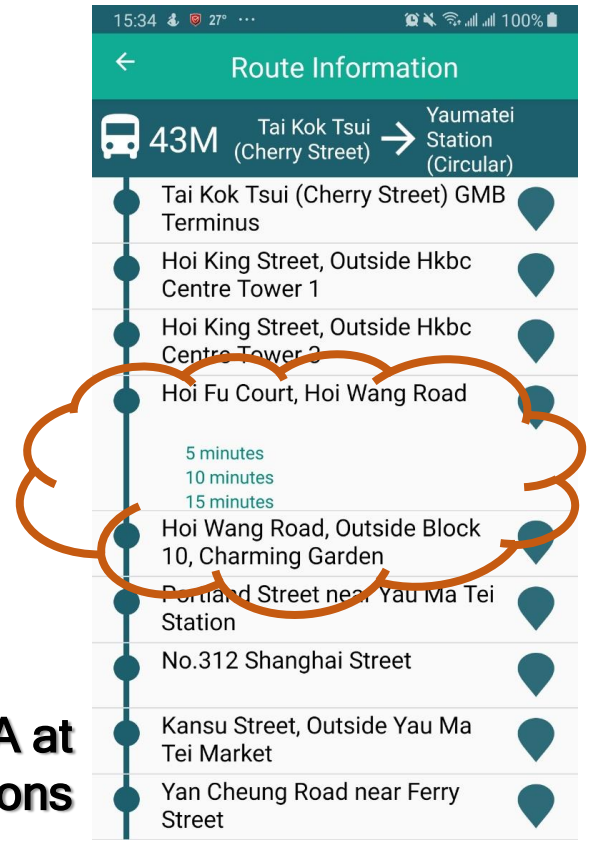
- Covered 38 licensed routes over different parts of Hong Kong
- Involved 142 GMBs
- Detect real-time GMB's location
- Calculate ETAs for the upcoming stops
- Disseminate ETA information
- Develop an online management portal

GPS Location Devices

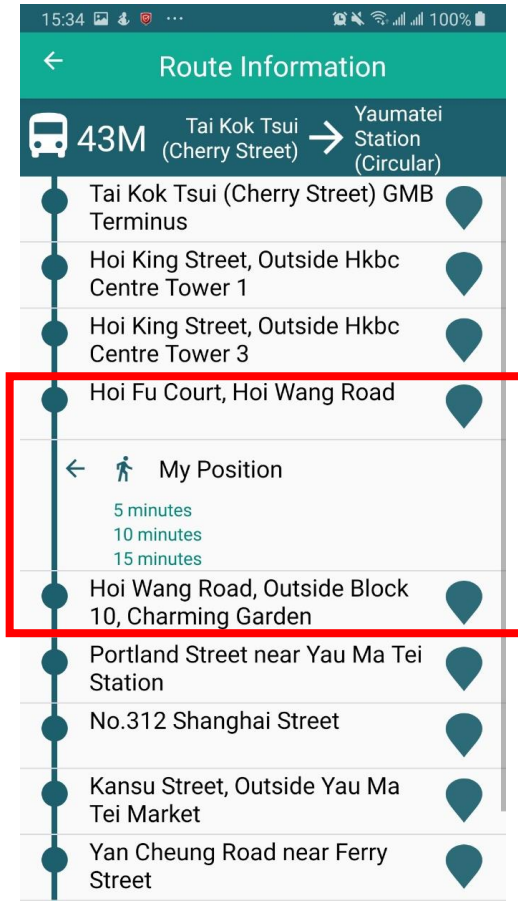
Android devices

Terminal devices

ETA Dissemination on Rider's devices



Sample ETA at GMB stations



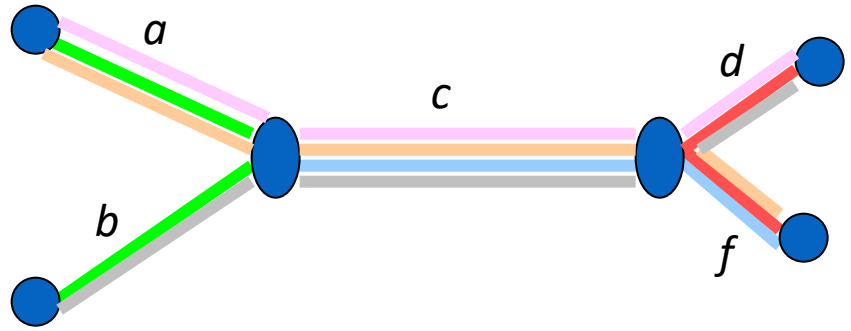
Sample ETA at User's location

ETA Calculation: a straightforward approach

- Use a simple average
  - Easy calculation
  - Finding a value minimizing estimation error is the ACT of GOD
- Adjust it with historical data
  - Not real-time
- Adjust it with posted speed limit
  - Not reflecting the real situation

A Simple Example

	Trip	Duration
	a-c-d	13 (mins)
	a-c-f	12
	a-b	5
	d-f	11
	c-f	10
	b-c-d	14



Solving a system of equations

- Let t_e be the estimated travel time of each edge e
- A unique solution can be obtained by solving a system of equations:

Equations

$$t_a + t_c + t_d = 13$$
$$t_a + t_c + t_d = 12$$
$$t_a + t_b = 5$$
$$t_d + t_f = 11$$
$$t_c + t_f = 10$$
$$t_b + t_c + t_d = 14$$

Solution

$$t_a = 2$$
$$t_b = 3$$
$$t_c = 5$$
$$t_d = 6$$
$$t_f = 5$$

A Realistic Situation

- In a real situation, there is some discrepancies of different GMB drivers traveling on a link and hence the trip duration
- The number of equations is often less than the number of variables in a realistic situation
- Instead of solving the system of equations, we minimize the discrepancies of the *estimated duration* to the *reported duration* of all trips
- We can adopt a Linear Programming framework developed by Dr. Jacky Wong

Notation for Formulation

- Parameters:
  - $G = (V, E)$ is the graph of the road network, where V is the set of vertices and E is the set of the arcs
  - m_e = the minimum travel time (free-flow) of arc e, $e \in E$
  - K = is the set of GMB trips taken into the estimation
  - E_k = the set of arcs traveled by route k, $k \in K$, and $E_k \subseteq E$
  - K_e = the set of GMB trips traveled on arc $e \in E$, $k \in K$, and $K_e \subseteq K$
  - d_k = transit duration of trip k
- Decision Variables:
  - t_e = the estimated travel time of arc e, $e \in E$
  - s_e^+ = the overestimated duration of trip k, $k \in K$
  - s_e^- = the overestimated duration of trip k, $k \in K$

A Basic Model

$$\min \sum_{k \in K} (s_k^+ + s_k^-) \tag{1}$$

$$\sum_{e \in E_k} t_e - s_k^+ + s_k^- = d_k \qquad \forall k \in K \tag{2}$$

$$t_e \geq m_e \qquad \forall e \in E \tag{3}$$

$$s_k^+, s_k^- \geq 0 \qquad \forall k \in K \tag{4}$$

Thank you