岩手県立大学
Iwate Prefectural University

Proposal of Guidance Method in Car Navigation System

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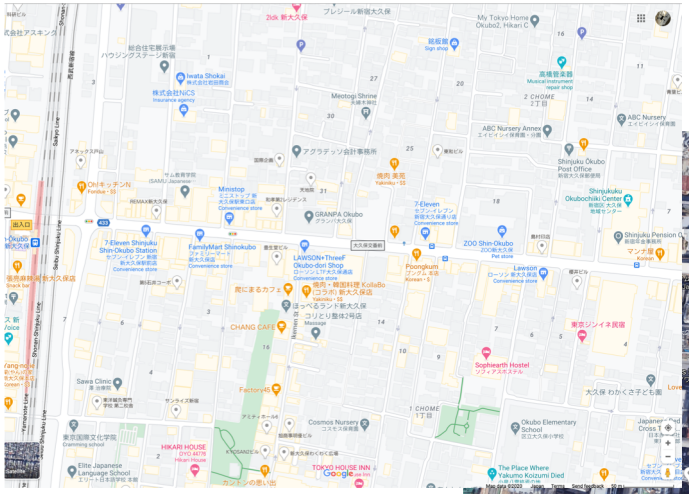
Profile

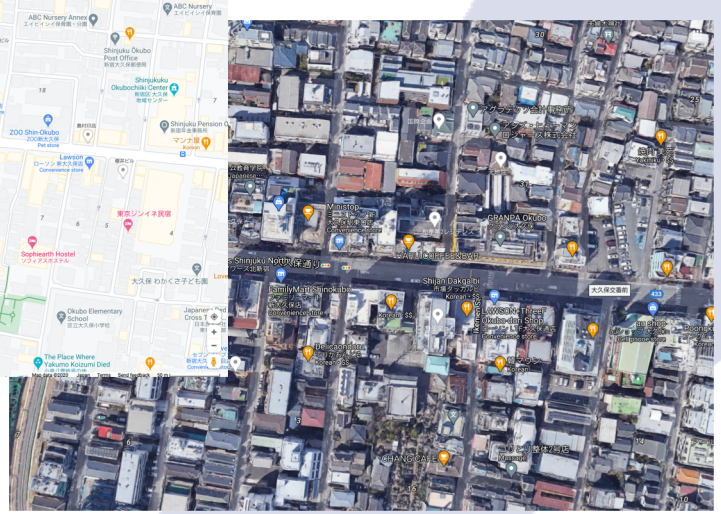
- Akimasa Suzuki obtained his Ph.D. degree in engineering in 2011, and engineering degree (MSc) in information system science in 2008, all of them from the Soka University of Tokyo, Japan.
- He has been Assistant Professor at Soka University, Tokyo, Japan, until 2013.
- He is now Associate Professor at Iwate Prefectural University, Iwate, Japan.
- Research areas: sensing, robotics, and digital signal processing.
- Interests: positioning sensor, especially with spread spectrum ultrasonic waves for indoor positioning systems applied to mobile robots and people.

Introduction

- The car navigation system and map applications such as Google Map have been popularly used.
- However, drivers sometimes cannot drive a car correctly to obey their instruction.
- Because of mis-judging the indicated distance, they would turn an intersection former than the indicated one or pass over it.

- We invented the new instruction method in which “turning on the right/left blinker,” and evaluated it experimentally.





Especially urban Asian street intervals are dense

Related Works

- Car navigation systems have three main tasks, positioning; routing; and navigation (guidance).
- It is difficult and dangerous for drivers to drive a car watching a display of car navigation system [1].
- Drivers sometimes select a road that is different from an instructed one.
- Kinds of guidance information are roughly classified to the distance direction and landmark [2].
- Some manufactures adopt the 3D map to improve identifiability between a road map and real roads (Figure 1)[3].
- The augmented reality (AR) technologies are introduced to improve identifiability guidance instruction such as a turning intersection and direction on real roads [4–6].
  →Unfortunately, the 3D map or AR technology do not solve the problem that a driver must watch a display to understand an instruction.
- The 2nd guidance method, Pioneer corp. has already provided the AR-navigation system and windshield projection unit. (Figure 2)
- David R. Large studied the effect of different voice navigation [4].

→We could not find research papers to improve the guidance accuracy in voice navigation method.

Figure 1. Car navigation system, Strada CN-F1XVD, Panasonic [1]

Figure 2. Pioneer, Cyber Navi [3]

Experiment for for perceptual distance

Test course in the university

- Participants are instructed the distance or the number of seconds to stop, while driving a car.
- They will stop a car at a point they think to travel an instructed distance or the number of seconds.
- In this experiment, 100, 300, and 500 m are instructed for the perception of distance.
- Each participant drove and stopped a car 3 times for each distance. The other hand, 10, 20, and 30 seconds are instructed for the elapsed time.
- The participant drove and stopped a car for each elapsed time.
- The number of participants is 20.
- They are a student who have a driver’s license.
- Before measuring perceptual values, participants drove a few laps of the test course to obey instructions of an examiner, and confirmed the distance and elapsed time.
- And, they had a test experience one time before measuring data.

Results of experiment for perceptual distance

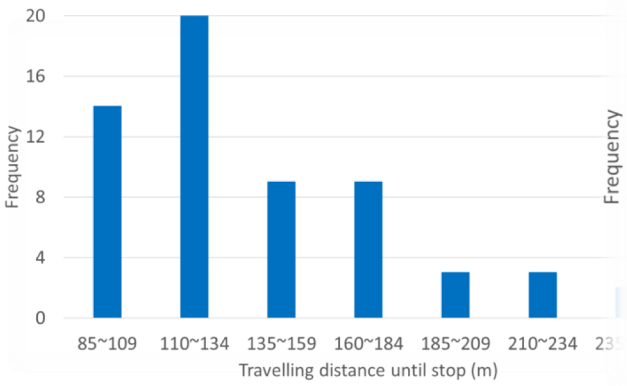
- The average distance, average difference from an instruction, and standard deviation are shown.
- The instructed distance is longer, the average difference is increased longer. Difference between participants are very big that is a few ten percent of the instructed distance.
- This result shows that the instruction such as ″turn right/left at XX meters ahead″ is not useful for the road that distance between instructions is longer than 100 m, and additional information are needed within 100 m.

Measurment results for perceptual distance

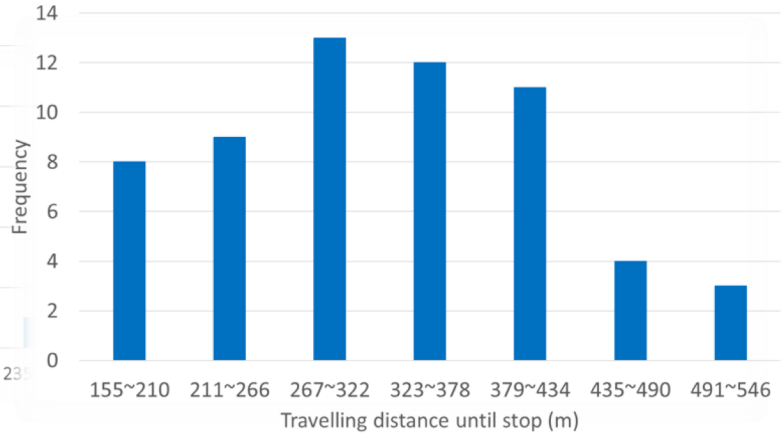
	100 (m)	300 (m)	500 (m)
Average (m)	138	327	527
Av. Difference (m)	41	82	120
Standard dev. (m)	38.7	91.3	121.6

Results of experiment for perceptual distance

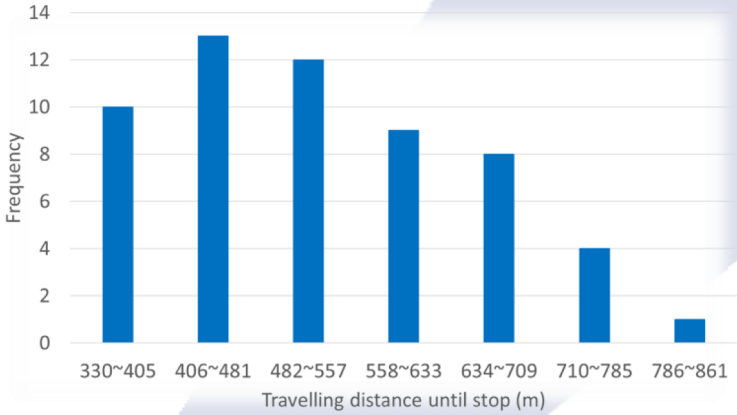
- A frequency distribution for each instructed distance are shown.
- The frequency distribution is calculated from 60 measured data for each instructed distance. Measured data are widely distributed.
- The curve is not the Gaussian distribution.
- Some participants travelled extremely longer than an instructed distance.
- The other hand, not participants travelled extremely shorter than an instructed distance.
- These results indicate that re-instruction less than 100 m is useful to decrease taking wrong road.



(a) Instruction distance = 100 m



(b) Instruction distance = 300 m



(c) Instruction distance = 300 m

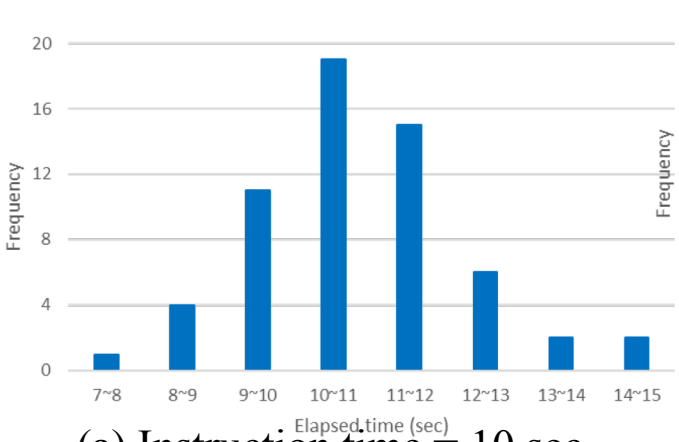
Results of experiment for perceptual elapsed time

- The average distance, average difference from an instruction, and standard deviation are shown.

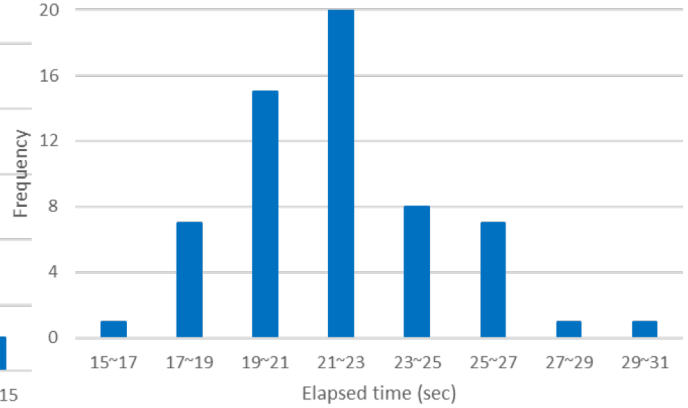
MEASURMENT RESULTS FOR PERCEPTUAL ELAPSED TIME

	10 (sec.)	20 (sec.)	30 (sec.)
Average (m)	10.8	21.9	32.5
Av. Difference (m)	1.25	2.6	3.29
Standard dev. (m)	1.44	2.56	3.17

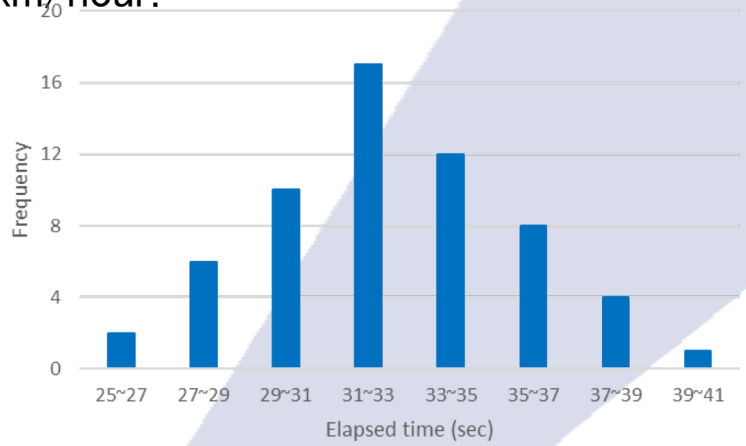
- A frequency distribution for each instructed elapsed time are shown.
- The frequency distribution is calculated from 60 measured data for each instructed elapsed time.
- Errors are very small, that is less than 15 % of an instructed time. In case of the instructed time being 10 sec., an error distance is roughly 20 m in travelling speed being 60 km/hour.



(a) Instruction time = 10 sec.



(b) Instruction time = 20 sec.



(c) Instruction time = 30 sec.

NOVEL GUIDANCE METHOD

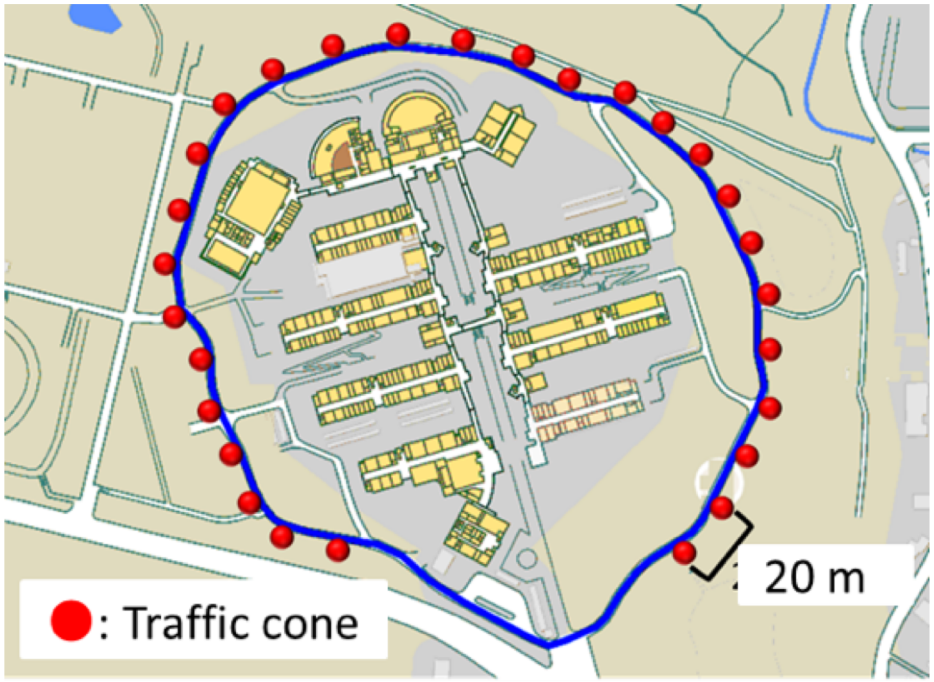


Figure 6. Test course of instruction methods in the university

- As a result of the previous section, we believed that re-instruction less than 100 m was useful to decrease taking wrong road.
- Following two methods were proposed as alternatives;
  - Countdown method: giving voice instruction, such as “50 m, 40 m, 30 m, 20 m, 10 m, and 0 m.”
  - Blinker method: instructing to turn the blinker such as, “Blinker left” at 30 m to the target intersection. In Japan, a driver must turn on the blinker at 30 m to the target intersection in a law.
- We examined to compare above two methods. At first, we examined using a test course.
- We also examined the existing method in which “Turn left 100 m ahead” was instructed.
- The test course was a circuit road of Iwate Prefectural University, and intersections were established with traffic cone.
- As a result of exploring a road map, most distances between intersections were less than 20 m.

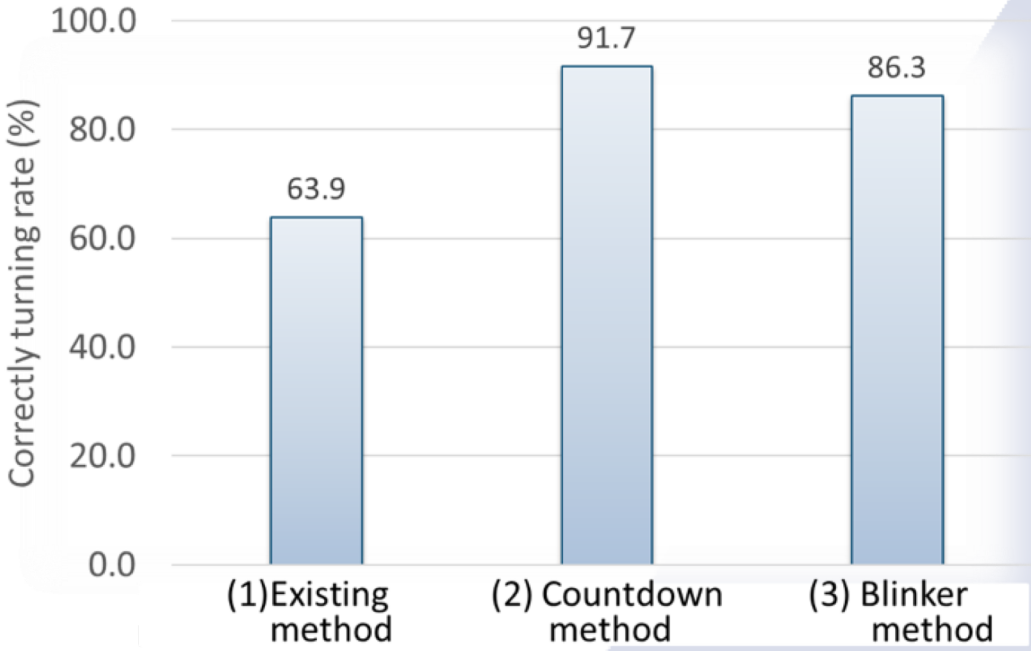
Experiment setting

- We examined to compare above two methods.
- At first, we examined using a test course.
- We also examined the existing method in which “Turn left 100 m ahead” was instructed.
- As a result of exploring a road map, most distances between intersections were less than 20 m.
- Therefore, traffic cones were put at intervals of 20 m.
- An emergency brake was established at the assistant driver’s side to keep safety driving.
- The number of participants was twelve. They were a university student who had a driving license and usually drove a car.
- In fact, participants stopped a car at a point they thought an instructed intersection instead of turning. They examined three times for each method.

Test car

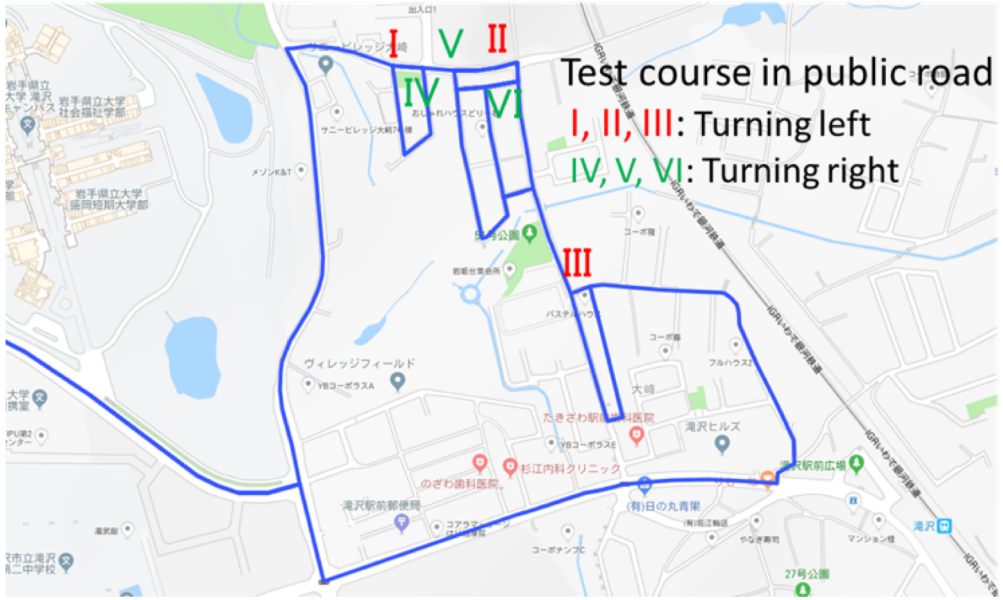
Experimental Result

- https://youtu.be/4b2gUsMwfaU
- Rates that participants correctly turned (stopped).
- The countdown method is the best of which correctly turning rate is 91.7 %.
- However, some participants evaluated that the countdown method has too many instructions, and such instructions cause lowering attentions.
- The correctly turning rate of blinker method was a little less than that of countdown method, that was 86.3 %.
- An instruction of the blinker method was very simpler than that of the countdown method.
- And, we believe the blinker is superior for safety driving, since a blinker is surely switched on before turning; subsequent drivers must notice the blinker.



Correctly turning rate

Experiment for blinker method



Test course for the blinker method in public roads

- We evaluate the blinker method would be one of the best voice instruction method for roads in which distance between intersections is very short less than 100 m.
- We examined the blinker method in public roads.
- Distance between intersections for evaluation were less than 20 m.
- The number of participants was ten.

Experimental result on the blinker method

Detail map around the intersection V

- As a result of examination, one participant selected a wrong intersection one time.
- We think the reason is that since the distance between the intersection V and former one is very short such as 10 m
- it is a little difficult to recognize such difference.

Accuracy of turning intersections

- The way of examination was same as that of evaluating the blinker method.
- The number of participants was ten, some of them were same as the evaluation of blinker method.
- The proposed method, blinker method is superior than the navigation function of Google Map for roads in which distance between intersections is very short less than 20 m.

Accuracy of turning intersections

Intersection #	Turn L/R	Blinker method (%)	Google Map (%)
I	L	100	100
II	L	100	20
III	L	100	40
IV	R	100	80
V	R	80	40
VI	R	100	100

CONCLUSION

- We estimate that this wrong-driving is caused by the difference between a perceptual distance and true one.
- We experimentally evaluated the difference between perceptional values and true ones for the distance and elapsed time.
- Experimental data indicate that re-instruction less than 100 m would be useful to decrease taking wrong road; and the method instructing an elapsed time would be useful for the high way.
- We also proposed a new guidance method that is “turning on the right/left blinker.”
- As a result of evaluation experiments, this method effectively decreases mis-driving; and is superior in terms of safety driving.
- In future works, we will realize the guidance method without sound or visual notification.