「Strategic Innovation Promotion Program (SIP) Phase Two / Automated Driving (Expansion of Systems and Services) Visual Field Defects

~FY2018-FY2020_FY2020 Annual Report~

Summary

RIKEN
Nagoya university
University of tsukuba

【Agenda】

1. Project overview
2. Progress list for each task
3. Task a
    - 3-1. Summary
    - 3-2. Subject data (Background & Driving data)
    - 3-3. DS calibration accuracy verification
    - 3-4. Result
4. Task b
    - 4-1. Summary
    - 4-2. High-precision DS setup and optimization
    - 4-3. Result (Visual behavior analysis)
    - 4-4. Result (Simulation)
5. Task c
    - 5-1. Summary
    - 5-2. Driving outpatient
    - 5-3. Draft of design guideline

▷Research agenda of FY2020(□) in overview

		FY2018	FY2019	FY2020
a.	Construction of driving database for visually impaired and normal persons, clarification of accident factors specific to visually impaired persons			
	i. Construction of driving database for visually impaired and normal persons	→	Data acquisition using DS →	
	ii. Clarification of accident factors specific to visually impaired persons		Data analysis →	→
b.	Verification of accident reduction effect specific to people with visual impairment for driving support system using DS			
	i. DS repair for presentation of driving support function specialized for visual field disorder	DS repair →	Reviewing the scenario →	
	ii. Clarification of support conditions for obstacle recognition function and avoidance function to avoid accidents as well as healthy people	Preliminary Exam. →	Clarification of support conditions →	
	iii. Verification of accident reduction effect by using driving support system		→	Verification of accident reduction effect →
c.	Development of driving support design guidelines using automated driving technology for visually impaired persons			
	i. Establishment of methodology to prove safety by using driving support system		Organize requirement items → Methodology of safety assurance	→
	ii. Development of design guidelines utilizing automated driving technology			Design guidelines →

FY2020

2. Progress list for each task

▶☒Task a.

Construction of driving database for visually impaired and normal persons, clarification of accident factors specific to visually impaired persons

【Fin】 Collection of DS data at medical institutions
【Fin】 Re-analysis of DS data
【Fin】 Clarification of accident factors specific to visually impaired persons
【Fin】 Construction of driving database

▶☒Task b.

Verification of accident reduction effect specific to people with visual impairment for driving support system using DS

【Fin】 High precision DS scenario modification
【Fin】 Visual behavior analysis using high-precision DS data
【Fin】 Accident frequency analysis about visual impairment
【Fin】 Accident analysis simulation that reflects visual behavior analysis

▶☒Task c.

Development of driving support design guidelines using automated driving technology for visually impaired persons

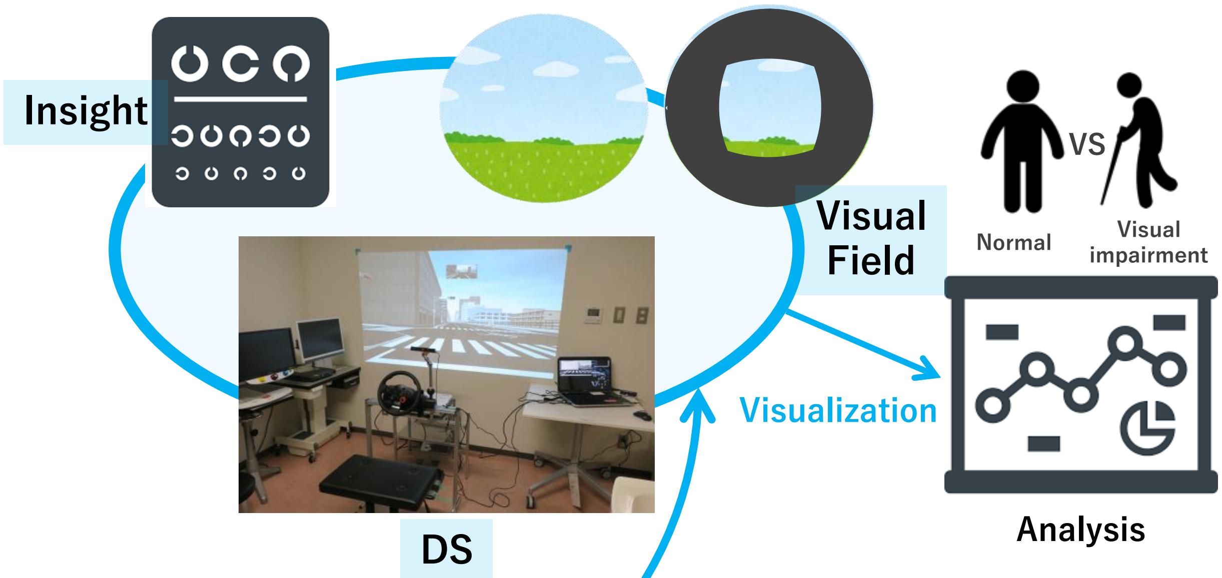
【Fin】 Driving outpatient
【o/g】 Enlightenment for society

*Cooperation with other projects

▷Clarification of accident factors specific to visually impaired persons
Visualized driving risk

◆Collection

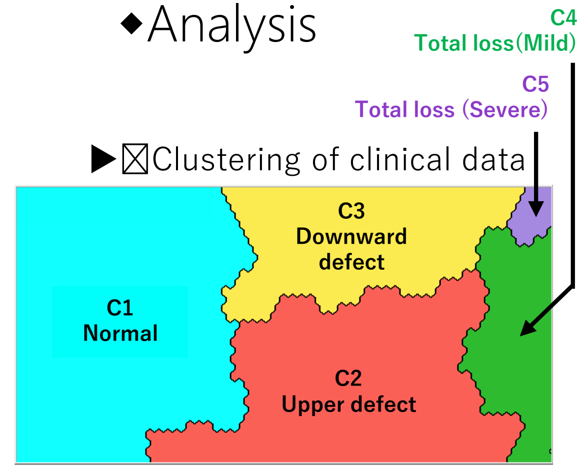
Data Collection ⇨ Analysis Clustering ⇨ Database



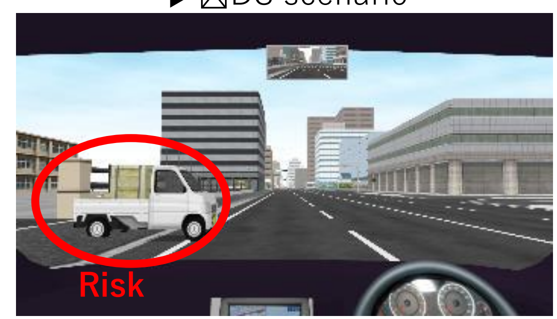
-[Fin] Principle verification
-[Fin] Setting
-[Fin] Pre-operation
-[Fin] Pre-operation at driving outpatient
-[o/g] Data analysis

◆Analysis

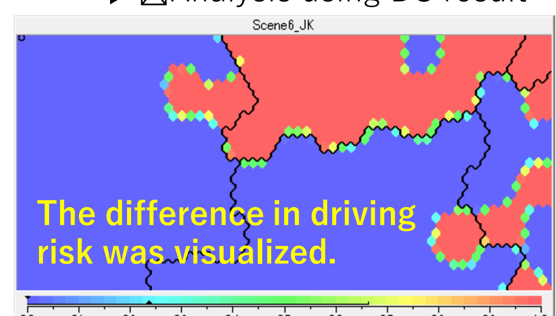
▶☒Clustering of clinical data



▶☒DS scenario

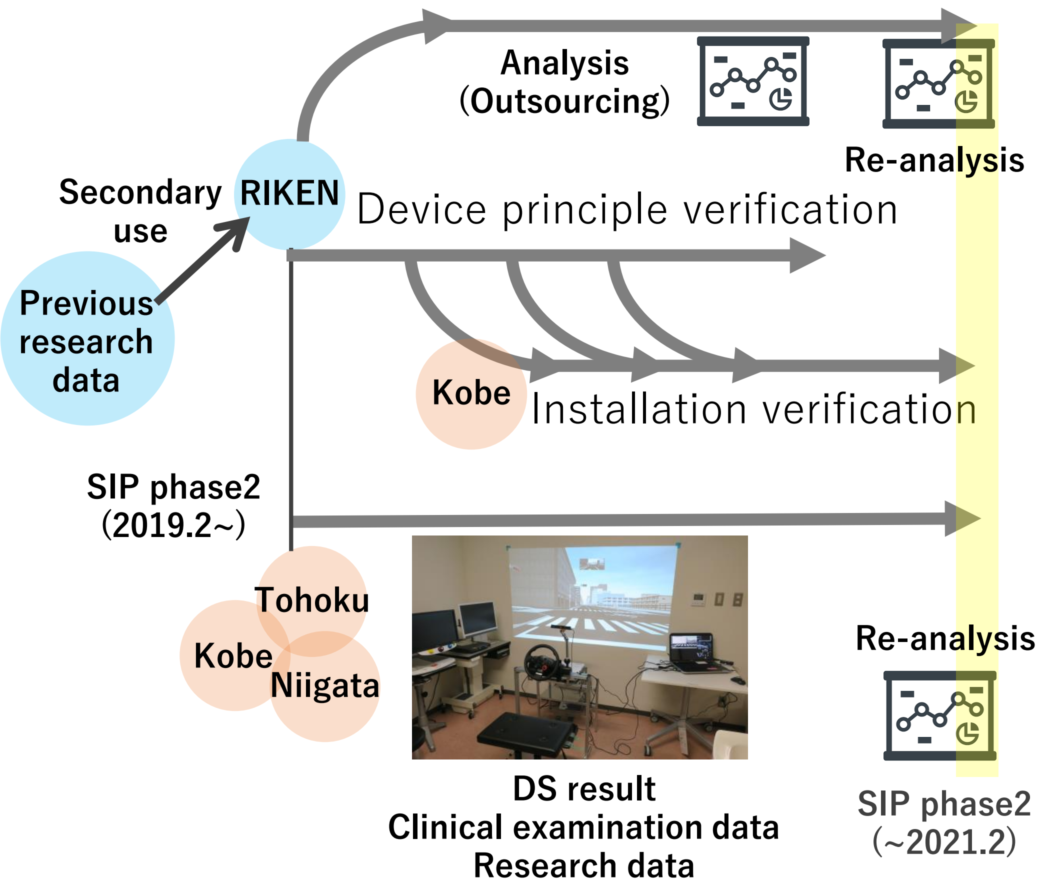


▶☒Analysis using DS result



3-2. Task a, Subject data and background

▷Schematic image of task a: Data collection environment and analysis
【Fin】At each medical institution, DS is performed for subjects with visual impairment(320 cases). The collected driving data was analyzed.



↑
HMD-DS(VR)

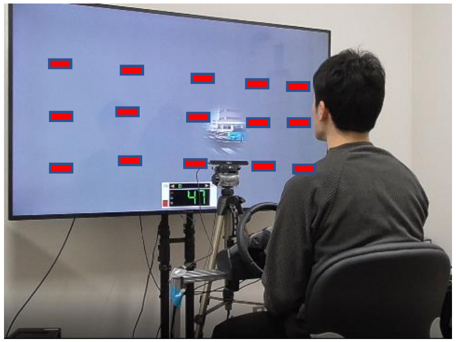
Gaze behavior→

RIKEN Principle verification

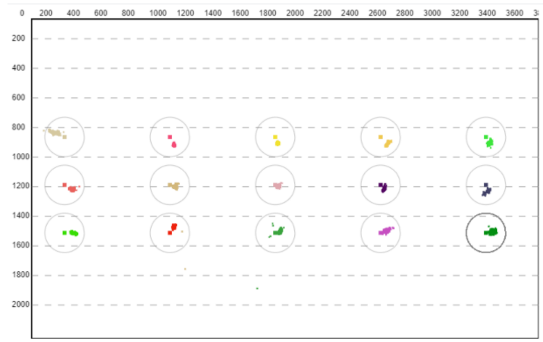
Kobe Tohoku Niigata Nishi kasai

Result of data collection (Total)	
Medical institute	Total (RP)
Kobe Eye Center Hos	108(64)
Tohoku Unv	44(21)
Niigata Univ	113
Nishi-kasai Inoue clinic	55(1)

▷We established a process to assure the accuracy of the eye tracking data before conducting driving simulation tasks.



After completing calibration of the eye tracker, the participate is asked to look at each of the red points again in order to obtain the data for accuracy check.

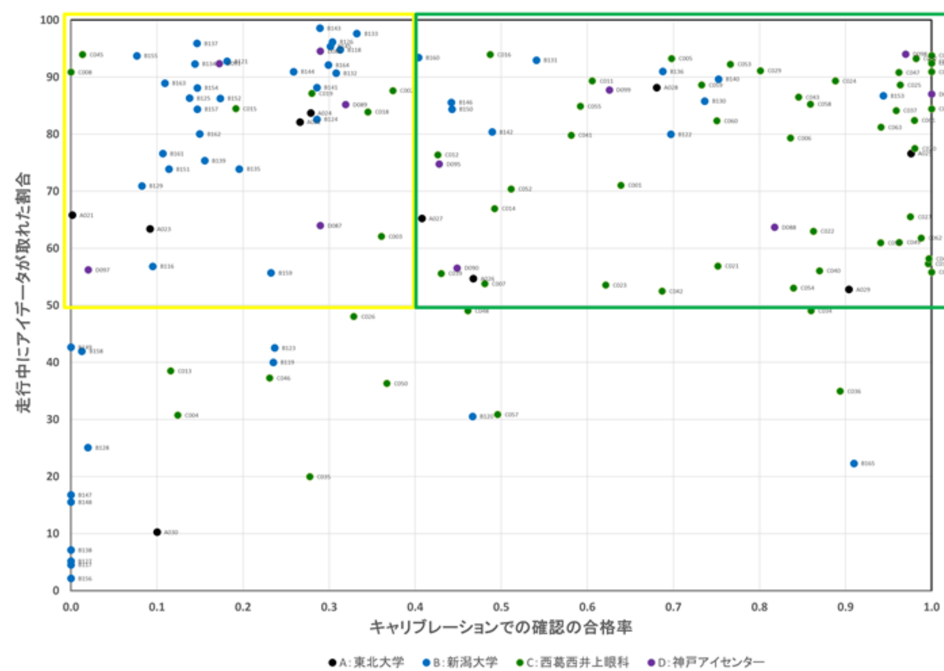


The experimenter checks the results whether the data for each red point are within the tolerable circle.

If the results are acceptable, the driving simulation tasks are done.

Due to the limitation of available time, it is possible to do the driving simulation even if the accuracy is not so high. Then we check the accuracy later in order to clarify to what extent the obtained gaze points are reliable.

In the right figure, each data point represents the grade of the data for a participant. The data within the green square is adequate enough to analyze the participants' gaze behavior. The horizontal axis is the accuracy confirmed before the driving simulation, and the vertical axis is the amount of data obtained in the driving simulation.



3-4. Task a, Result

▶☒Data analysys, previous research*(●) and collected data(●)

▶☒ Analysis target(219)
Niigata(53), Tohoku(48), Kobe(18), Nishi-kasai(29), Tajimi(71)
▶☒対象変数
Age, Sex, Field of viw(24-2), Insight, MD, DS data, Visual impairment

	全体 N=219	中心視野欠損 N=24	その他 N=195
Scene01	28.3%	50.0%	25.6%
Scene02	62.1%	79.2%	60.0%
Scene03	30.1%	62.5%	26.2%
Scene04	13.2%	25.0%	11.8%
Scene05	13.2%	20.8%	12.3%
Scene06	28.3%	33.3%	27.7%
Scene07	14.2%	45.8%	10.3%
Scene08	8.7%	12.5%	8.2%
Scene09	11.0%	20.8%	9.7%
Scene10	8.7%	8.3%	8.7%
Scene12	7.3%	8.3%	7.2%
Scene13	5.5%	16.7%	4.1%
Scene15	16.4%	16.7%	16.4%

1)Central visual field defect is defined as having a sensitivity of 10 or less, which is more than half of central field of view (Section 33,34,43,44)

2)Risk assessment of central visual field defect

①Turn right on the oncoming vehicle (Scene3,7)
【 Calling attention to oncoming vehicles】

②Jumping out from the left and right (Scene4,13)
【Calling attention to the left and right】

③Ignore signal(Scene5,9)
【Calling attention to signals】


Scene 3, Turn right(Blue)


Scene 7, Turn right(White)


Scene 4, From right

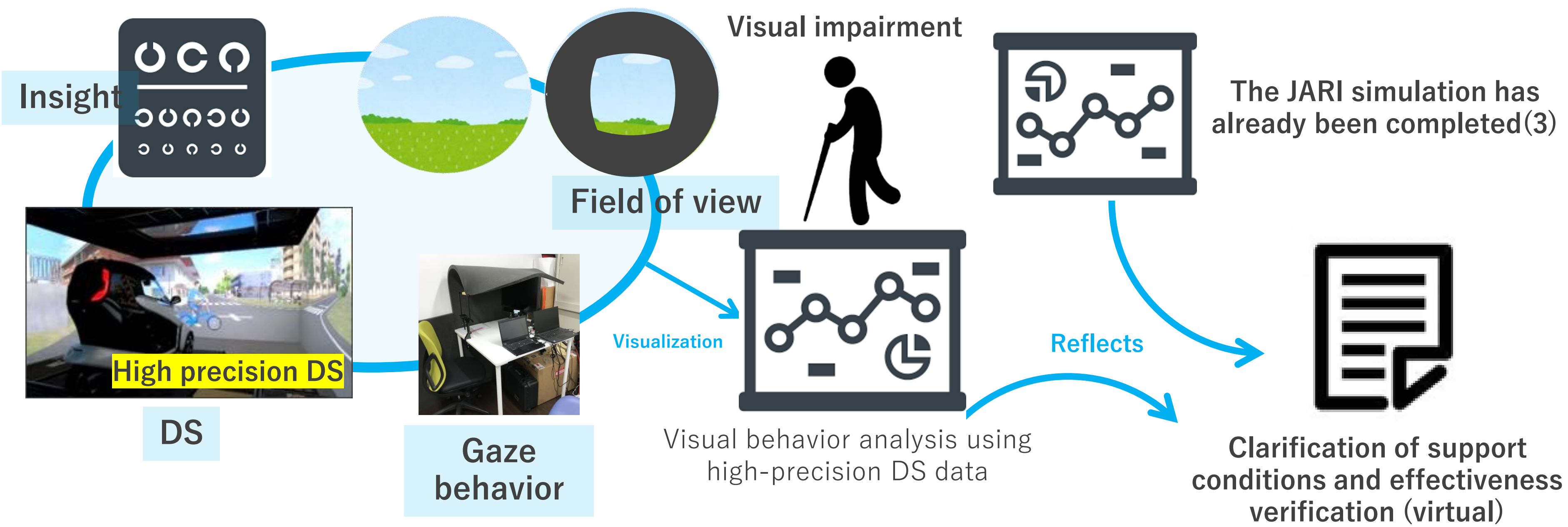

Scene 13, From left

*Research data was provided by Dr. Iwase at Tajimi iwase eye clinic

▷Task b, overview

▷Verification of accident reduction effect specific to people with visual impairment for driving support system using DS

- ◆Summary of previous results
- ◆Visual behavior analysis using high-precision DS data
- ◆Accident analysis simulation that reflects visual behavior analysis



4-2. High-precision DS setup and optimization

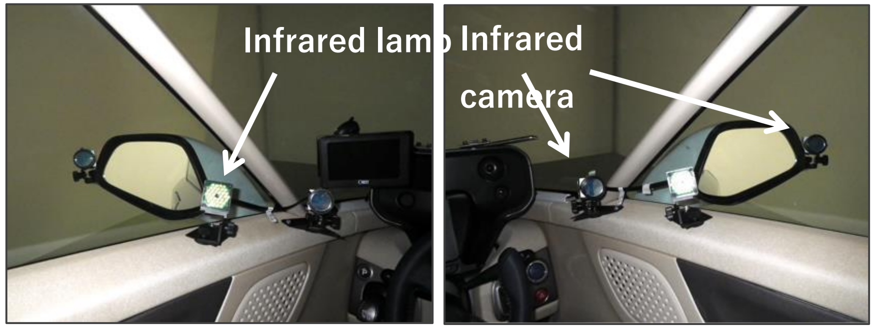
▷Modification of driving simulator

*Supported by Tajimi Iwase Eye Clinic

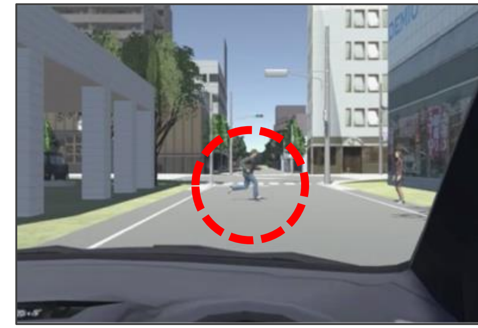
-We set up an eye-tracking system and created 5 driving scenarios.

-Data were collected from 15 drivers with visual field loss* and 10 drivers with normal eyes.

High-fidelity DS



Eye-tracking system

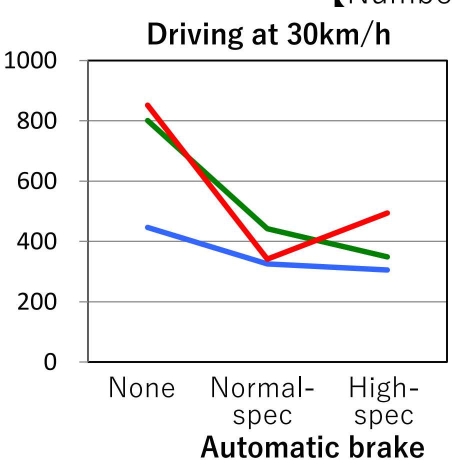


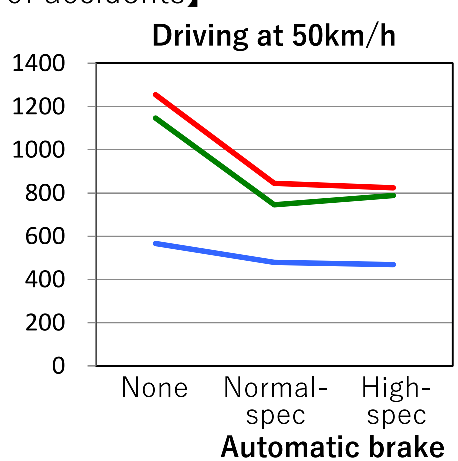
Example of scenario

▷Preliminary simulation of the effect of driving assistance

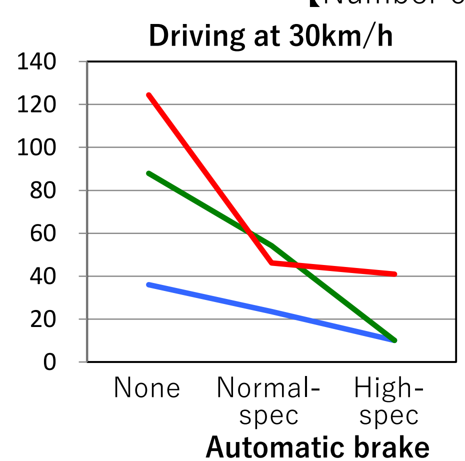
-Automatic brake systems may reduce fatal accidents of drivers with visual field loss to the level equal to or less than drivers with normal eyes.

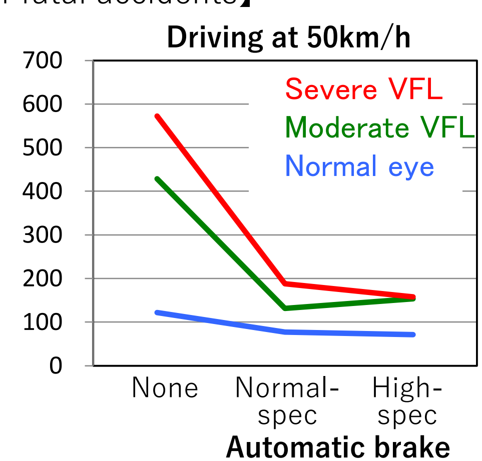
【Number of accidents】





【Number of fatal accidents】



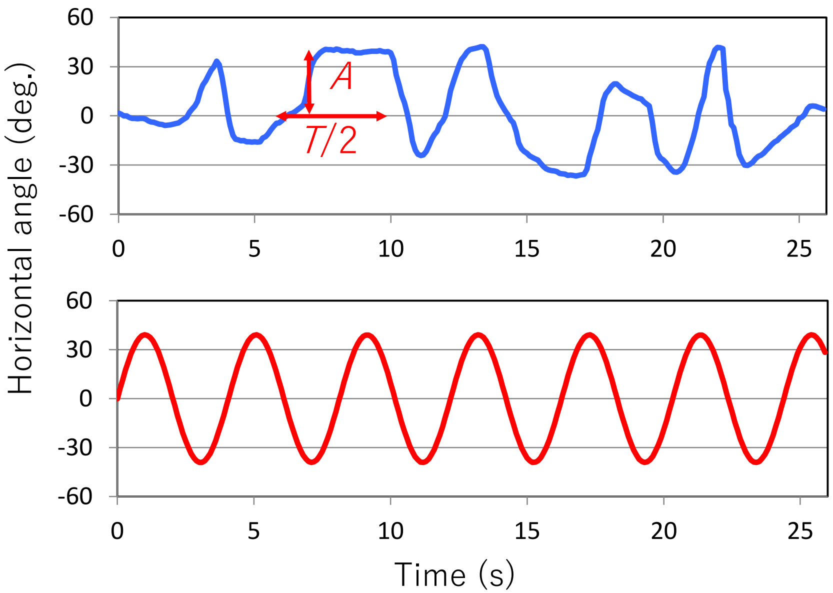


4-3. Result (Visual behavior analysis)

▷Models of drivers' behavior

- Head movement (stop-sign intersection: sine curve, the other: Cauchy distribution)
- Braking response time to alarm (log-normal distribution)
- Duration of fixation to pedestrians (normal distribution)
- Probability of missing signals (1.67 times by severe loss)

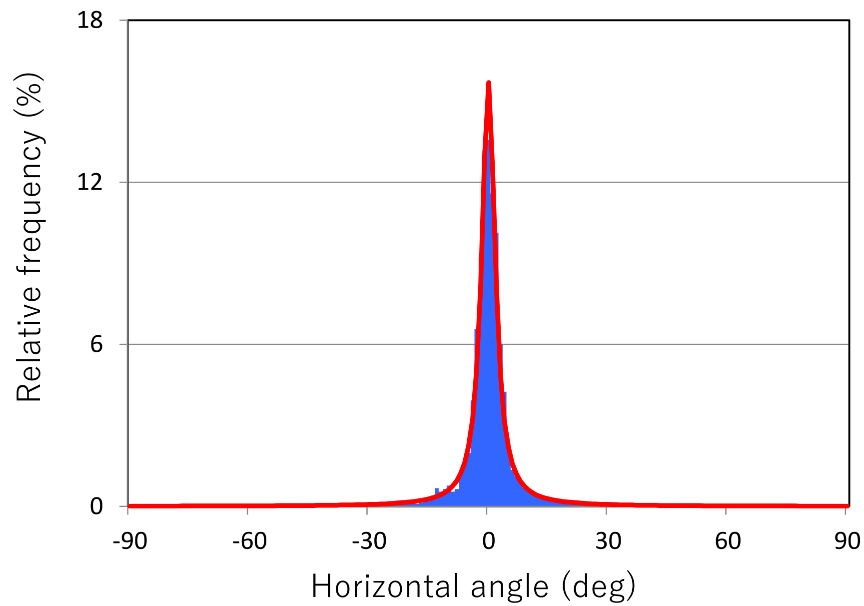
} Data obtained with virtual reality using a head-mounted display



Sine curve: $f(t) = A \sin \frac{2\pi}{T} t$

Normal eye: $A = 37.63$, $T = 4.22$ Visual field loss: $A = 39.13$, $T = 4.06$

Head movement at a stop-sign intersection



Cauchy distribution: $f(x) = \frac{1}{\pi} \frac{\gamma}{(x - x_0)^2 + \gamma^2}$

Normal eye: $x_0 = 0.14$, $\gamma = 1.97$ Visual field loss: $x_0 = -0.04$, $\gamma = 1.99$

Head movement at the other locations

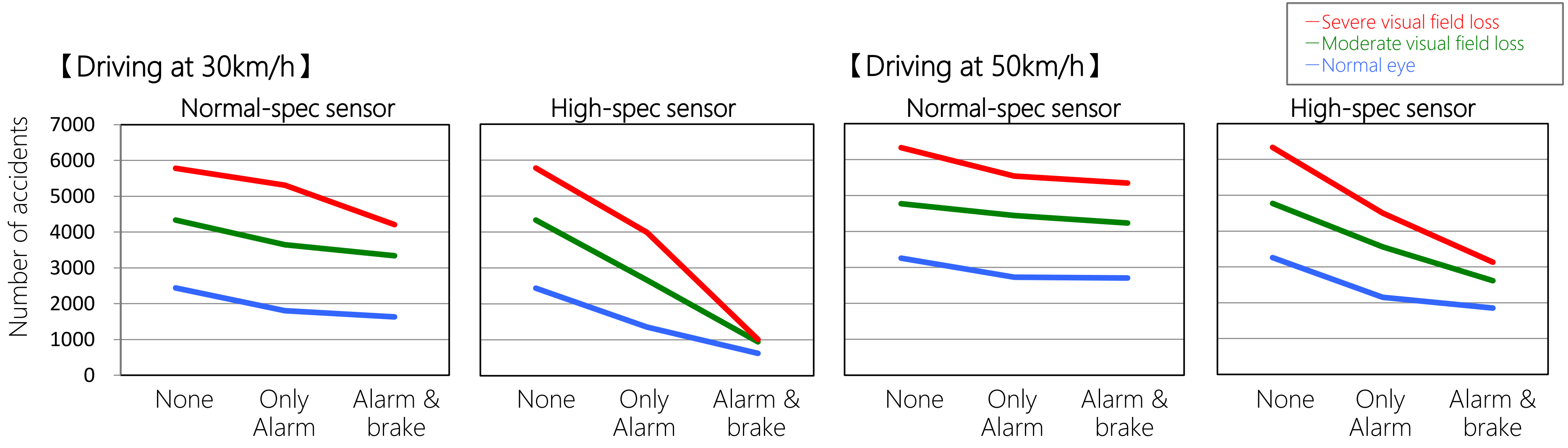
▷Simulation to test the reduction of accidents

-We created a traffic environment including intersections with and without signals

-3 widths of visual field - - - normal eye: 140°, moderate loss: 40°, severe loss: 20°

-4 assistance systems - - - (only alarm / alarm and automatic brake) × (normal-spec sensor (40°) / high-spec sensor (140°))

-By combining the automatic brake and high-spec sensor, the accidents of drivers with visual field loss were reduced to the level equal to or less than drivers with normal eye.

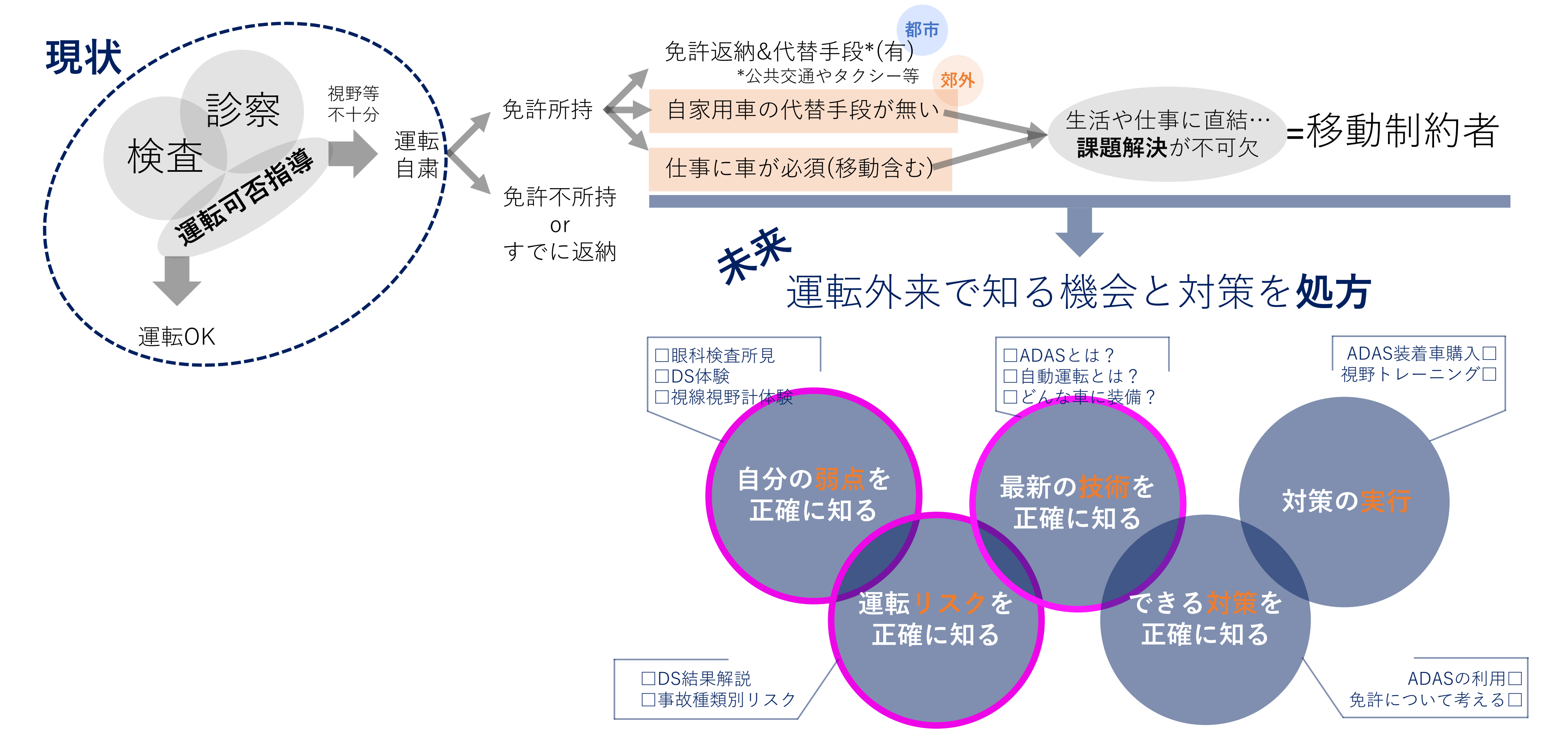


5-1. 課題c_概要

全体計画より抜粋

c. 視野障害者を対象とした、自動運転技術を活用した運転支援デザインガイドラインの開発	2018年度下期	2019年度	2020年度
i. 運転支援システム利用による安全性を証明する方法論の確立		必要な運転支援技術の検討 → 安全性を保証する方法論の確立	安全性を保証する方法論の確立
ii. 自動運転技術を活用したデザインガイドライン開発			デザインガイドラインの開発

▶運転外来の設置



5-2. 課題c_運転外来の経過(神戸)

▶☒神戸の運転外来(全6回)



▶☒医師によるカウンセリング(3件)
-被験者は医師の言葉に真摯に耳を傾ける様子であった(家族も_説き伏せるには有効かもしれない)
-多少の緊張感がある雰囲気

▶☒医師+研究者によるカウンセリング(1件)
-医師以外のコミュニケーターの介入で緊張感が緩和→ヒアリングの精度が高まった
>ヒヤリハット事例や車の使い方等の詳細な聞き取りが達成できた
>今後の選択肢に関する具体的かつ納得感のあるアドバイスができた
>丁寧な対応は時間の課題を検討する必要がある
>一方的な指導ではない寄り添い(カウンセリング)が重要であることが示唆された

被験者ごとに生活環境や置かれた状況が異なるため、何を求めているかを探ることが納得感に直結する。一方的なインプットでは効果が限定的になることが示唆された。

5-3. 課題c_デザインガイドライン案

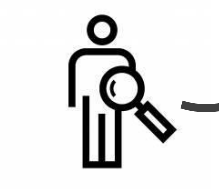
▷課題c-ii：デザインガイドラインの開発(他課題との連携_普及・啓発の仕掛け)

①運転外来前(医療機関へのフック)

②運転外来そのもの(医療機関)

③運転外来後(医療機関外)

【個人/一般向け】
- 健康診断
- セルフメディケーション
- 無自覚群の掬い上げ



【企業/団体向け】
- 職業ドライバーの安全推進
- 企業健診などと連携
- 受けて得する受け皿準備

運送業、バス、タクシー等

別課題/研究と連携
(名古屋大学)

医療機関(眼科)
運転外来

視力

視野

DS/視線

【利用：支援システム】
- 後付け警報装置
- ADAS車購入支援

【学習：トレーニング】
- 教習所との連携
- 視線トレーニング

【制度設計】
- 行政との連携(医療特区)
- 保険業界との連携

【医療連携】
- 認知症
- 服薬・持病等

眼科医会/医師会
との連携

□眼科検査所見
□DS体験
□視線視野計体験

□ADASとは？
□自動運転とは？
□どんな車に装備？

ADAS装着車購入□
視野トレーニング□

自分の弱点を正確に知る

最新の技術を正確に知る

対策の実行

運転リスクを正確に知る

できる対策を正確に知る

□DS結果解説
□事故種類別リスク

ADASの利用□
免許について考える□

2020年度

▷コンテンツの充実
▷他事業の連携模索