# BinoVFAR: An Efficient Binocular Visual Field Assessment Method using Augmented Reality Glasses

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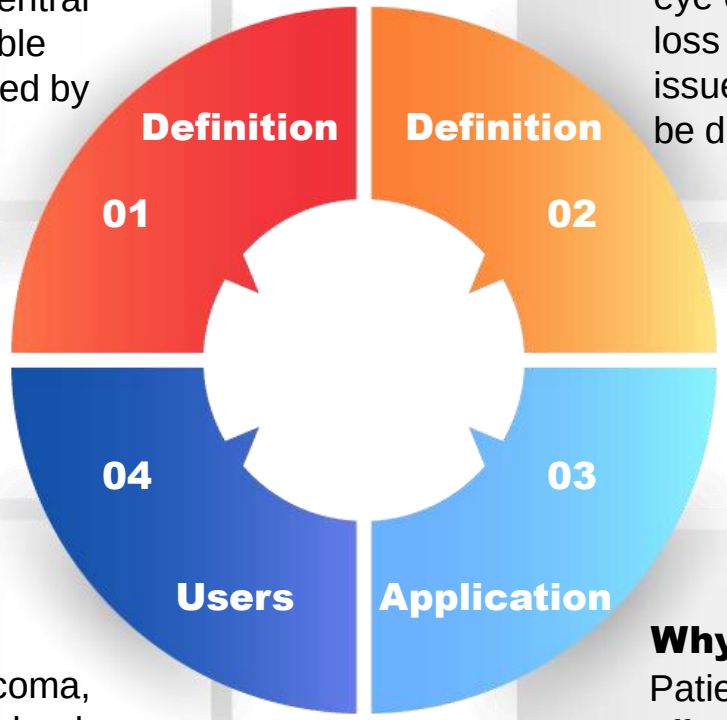
# Introduction

**What is Visual Field (VF)?**
VF is an area that human eyes can see by focusing on a central fixation point and the possible vision loss can be discovered by VF measurement tools.

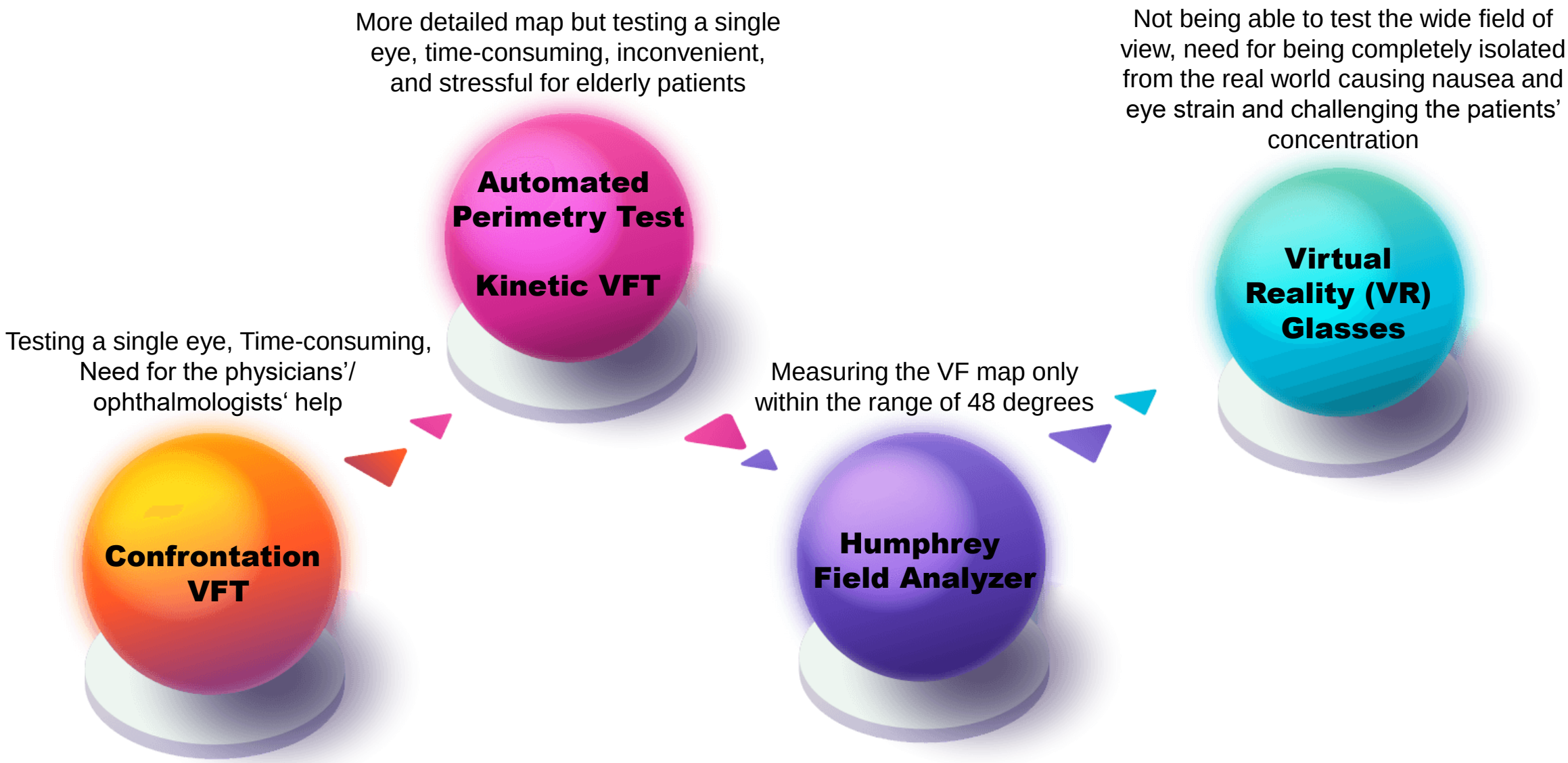
**What is VF Testing (VFT)?**
VFT is a significant part of regular eye care for people at risk of vision loss from diseases and related issues. The possible vision loss can be discovered by it.




**Who needs VFT?**
People suffering from glaucoma, stroke, diabetes, and high blood pressure.

**Why VFT?**
Patients need it to monitor the effects of the diseases on their vision as subjects with the limited VF may not continue their daily activities, e.g. driving in busy roads.

# Current Studies Challenges



# The Proposed System

## Main Goal and Features

Proposing a binocular VF assessment method using novel AR-glasses, namely BinoVFAR for a wide visual field map of 60◦×100◦ in which the whole test takes 3-4 minutes.

To monitor the fixation and calibrate the AR-glasses on eyes, our system uses a color point (red) in the center and eight light-green static points on the border of the visual field.

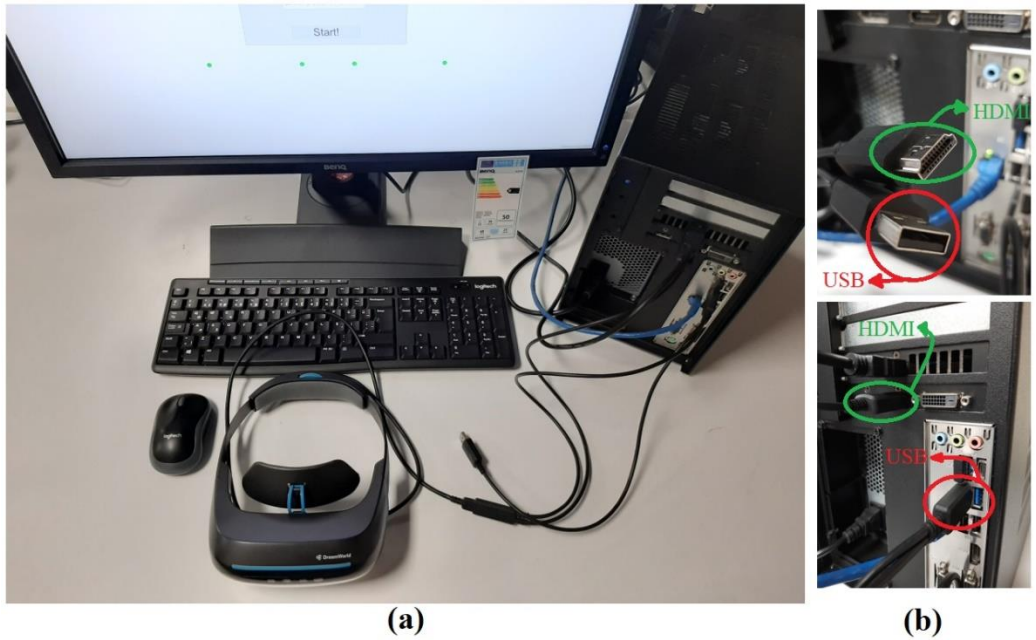
The false negative is minimized by randomly displaying the missing stimulus again.

The variable stimuli presentation rate is adjusted to the subject's response time during the demonstration.

Users are allowed to wear their prescribed glasses along with the AR glasses during the test.

# The Proposed System

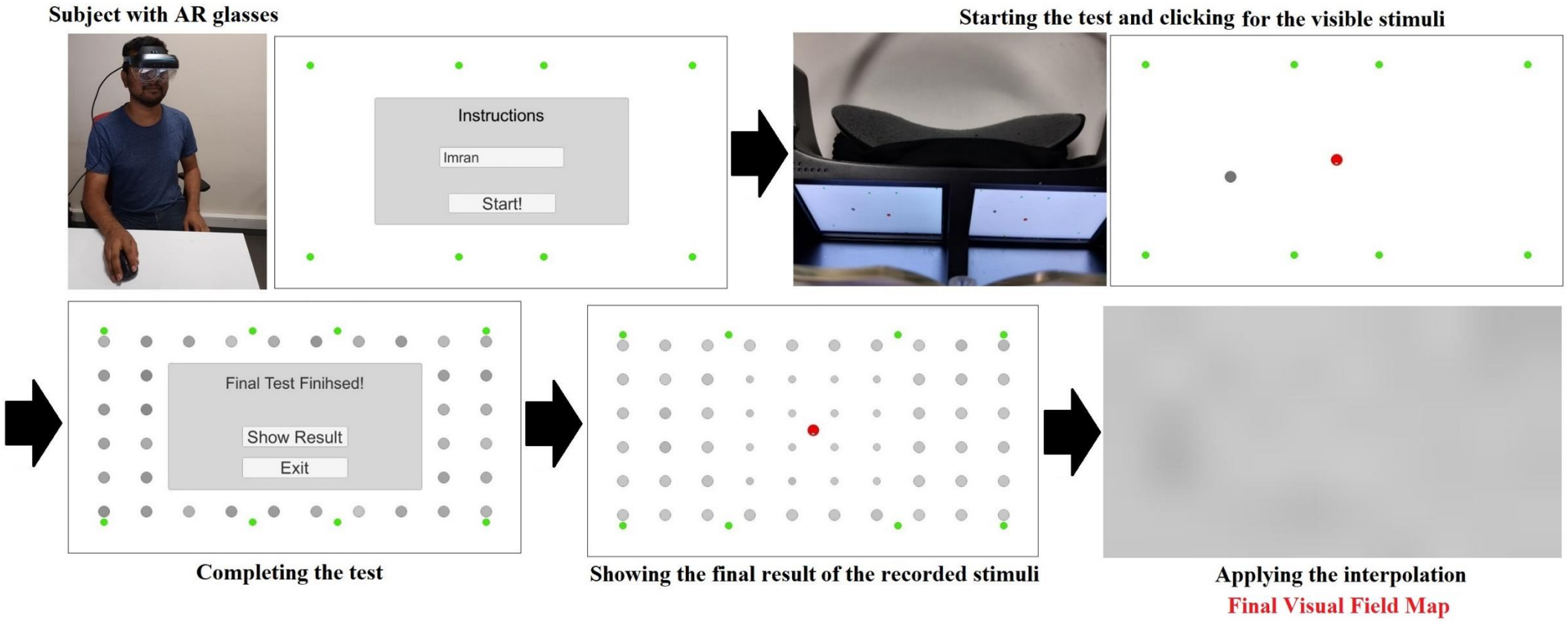
## Materials and Experimental Setup




**Experimental materials of the proposed binocular VF testing, a) computer setup, b) connection between the AR glasses and the computer.**

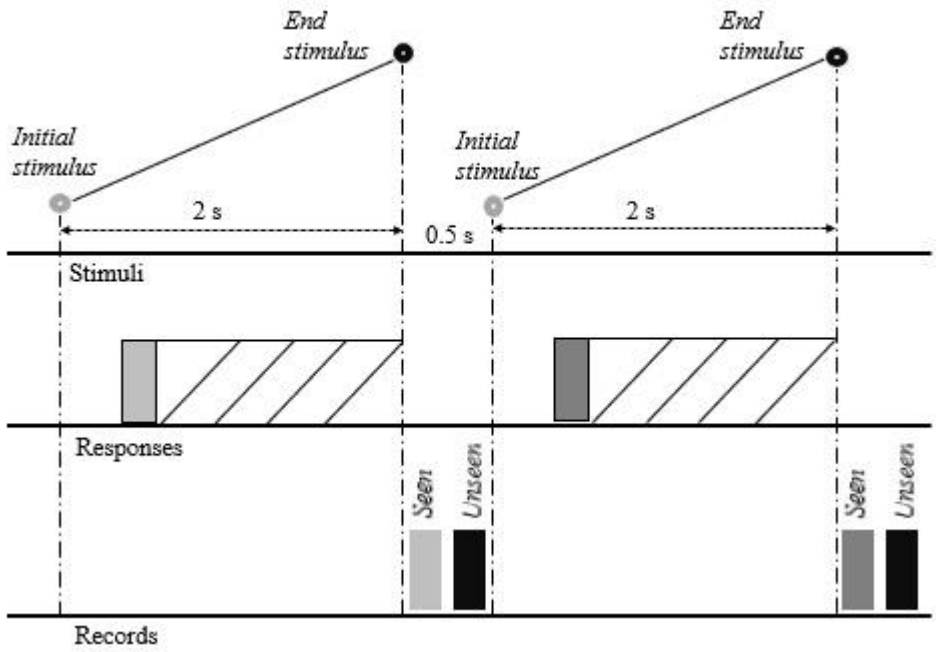

**Dreamworld AR glasses and their characteristics.**

# The Proposed System




**The overall flowchart of VF testing system on a subject using AR glasses.**

# The Proposed System




**Timing of VF testing process for two consecutive stimuli that continuously repeated until the end of the test.**

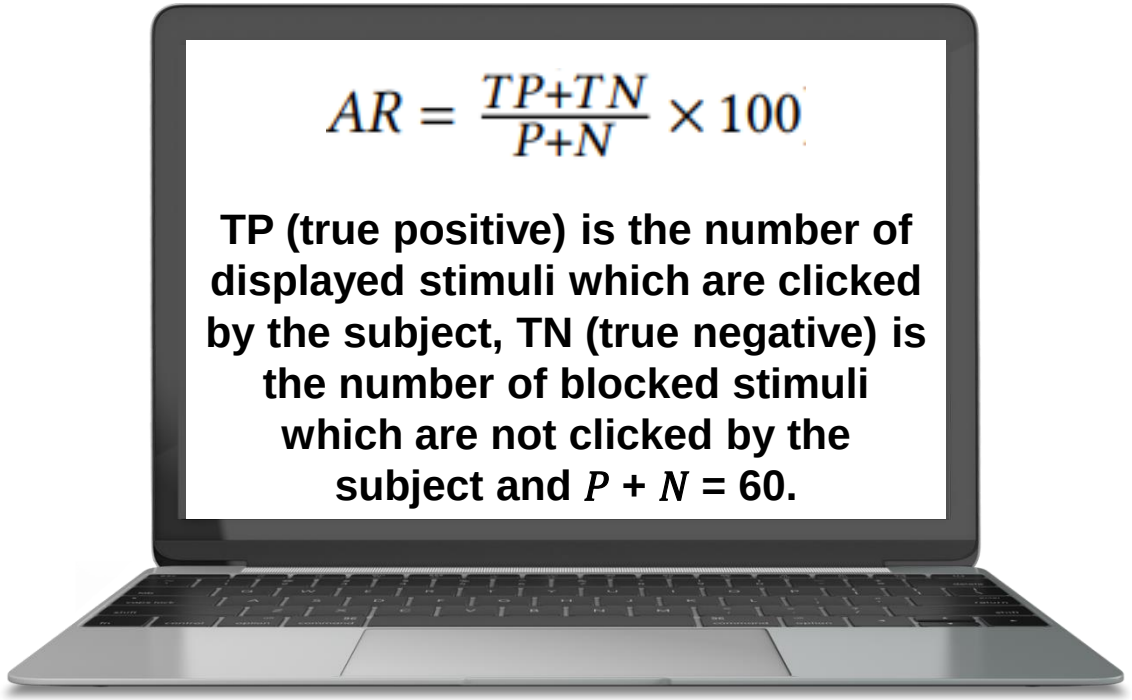
# The Proposed System


**16 different combinations of binocular VF testing a) artificial blocking of the AR glasses, b) the results of the recorded clicked stimuli, c) visual field maps.**

# Experimental Results

| Category | Sub. 1 | Sub. 2 | Sub. 3 | Sub. 4 | Sub. 5 |
|---|---|---|---|---|---|
| H | 100 | 100 | 100 | 100 | 98.33 |
| 2S | 100 | 100 | 100 | 100 | 100 |
| 2T | 100 | 100 | 100 | 100 | 100 |
| 2B | 100 | 100 | 100 | 100 | 100 |
| 3S | 100 | 100 | 100 | 100 | 100 |
| 3T | 100 | 100 | 100 | 100 | 100 |
| 3B | 100 | 100 | 100 | 100 | 100 |
| 2T2B | 100 | 100 | 100 | 100 | 100 |
| 2S2T | 100 | 100 | 100 | 100 | 100 |
| 2S3T | 100 | 100 | 100 | 100 | 100 |
| 2S2B | 100 | 100 | 100 | 100 | 100 |
| 2S3B | 100 | 100 | 100 | 100 | 100 |
| 3S2T | 100 | 100 | 100 | 100 | 100 |
| 3S3T | 100 | 100 | 100 | 100 | 100 |
| 3S2B | 100 | 98.33 | 100 | 98.33 | 100 |
| 3S3B | 100 | 100 | 100 | 100 | 100 |
| **Average** | **100** | **99.89** | **100** | **99.89** | **99.89** |

**The accuracy rates (AR in percentage) of binocular VF test for five different subjects in 16 combinations. The average AR of the results for five subjects is 99.93%, which shows the high performance of the proposed system.**



# Experimental Results

| Subjects | TPR | TNR | FPR | FNR |
|---|---|---|---|---|
| Subject 1 | 1 | 1 | 0 | 0 |
| Subject 2 | 0.9976 | 1 | 0 | 0.0023 |
| Subject 3 | 1 | 1 | 0 | 0 |
| Subject 4 | 1 | 0.9981 | 0.0018 | 0 |
| Subject 5 | 0.9976 | 1 | 0 | 0.0023 |
| **Average** | **0.9990** | **0.9996** | **0.0003** | **0.0009** |

**The confusion matrix of VF test for five subjects in all 16 combinations.**

01 $(TPR = \frac{TP}{P_t})$

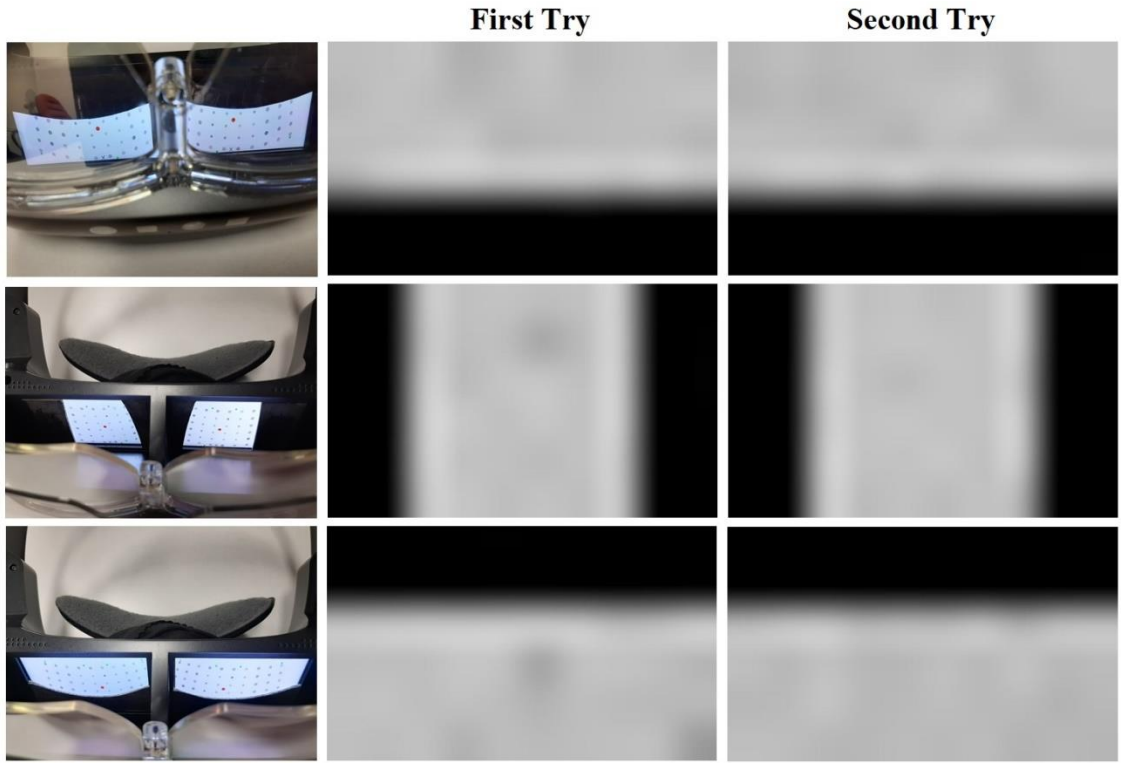
02 $(TNR = \frac{TN}{N_t})$

03 $(FPR = \frac{FP}{N_t})$

04 $(FNR = \frac{FN}{P_t})$

# Experimental Results

## Reproducibility



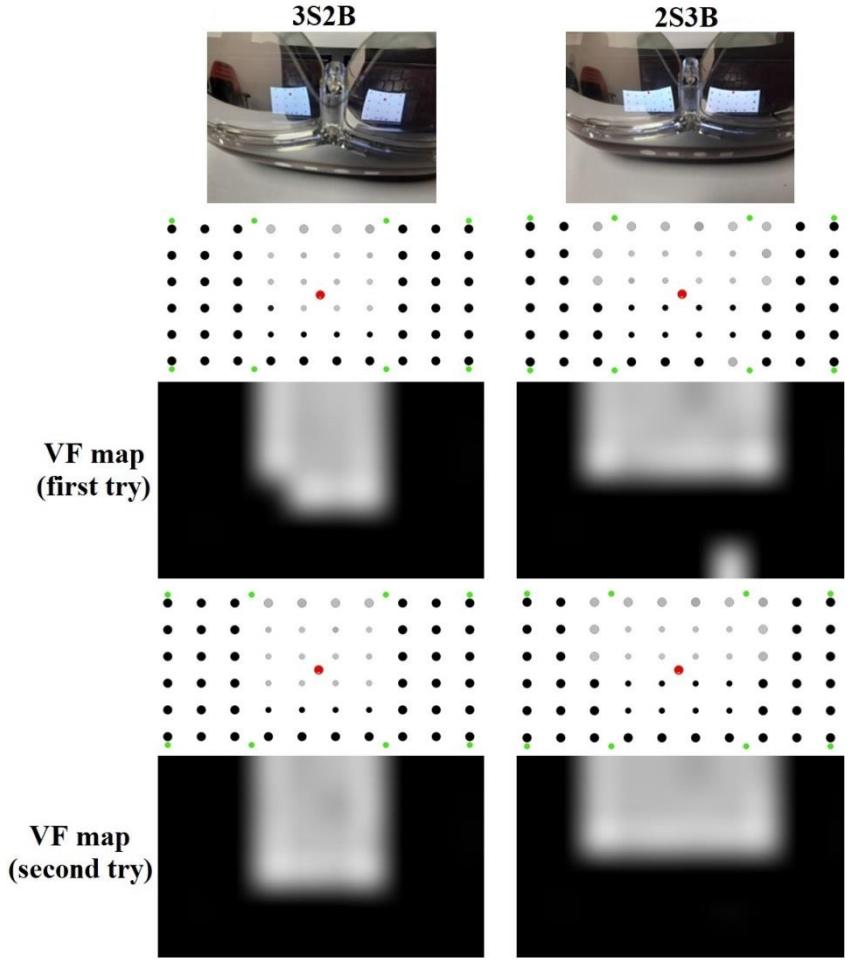

Qualitative results of the reproducibility assessment for three combinations.

| Subjects | 2S | 2T | 2B | 3S |
|---|---|---|---|---|
| Subject 1 | 99.91% | 99.57% | 99.87% | 99.87% |
| Subject 2 | 99.88% | 99.89% | 99.86% | 99.42% |
| Subject 3 | 99.76% | 99.75% | 99.18% | 99.79% |
| **Average** | **99.72%** | | | |

Quantitative results of the reproducibility assessment based on the calculated Intra-class Correlation Coefficient (ICC) for all 12 pairs of VF maps achieved from four combinations tested on 3 subjects.

# Experimental Results

## Repeatability




**Two samples of the repeatability a ssessment for two combinations.**

# Conclusion


\+ A robust binocular visual field assessment method based on novel Augmented Reality (AR) glasses is presented, namely, BinoVFAR that can simultaneously find the VF of both eyes.

\+ It achieved a high performance with an average accuracy of 99.93% with repeatability and reproducibility capabilities tests (average ICC of 99.72%) operating in a wide field of view (60◦×100◦).

\- This system relies on the subjects to focus on the fixation point during the VF testing.
Final visual field map is created based on the recorded data from the test on a different platform (MATLAB).

Applying iris/gaze detection and tracking system.
The whole system will be performed on one platform to increase the test speed and the system applicability.
After Covid-19 restrictions, the proposed method will be tested on actual patients through clinics.


Thank you for
your attention!