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# EYE MOVEMENT-BASED ANALYSIS ON METHODOLOGIES AND EFFICIENCY IN THE PROCESS OF IMAGE NOISE EVALUATION

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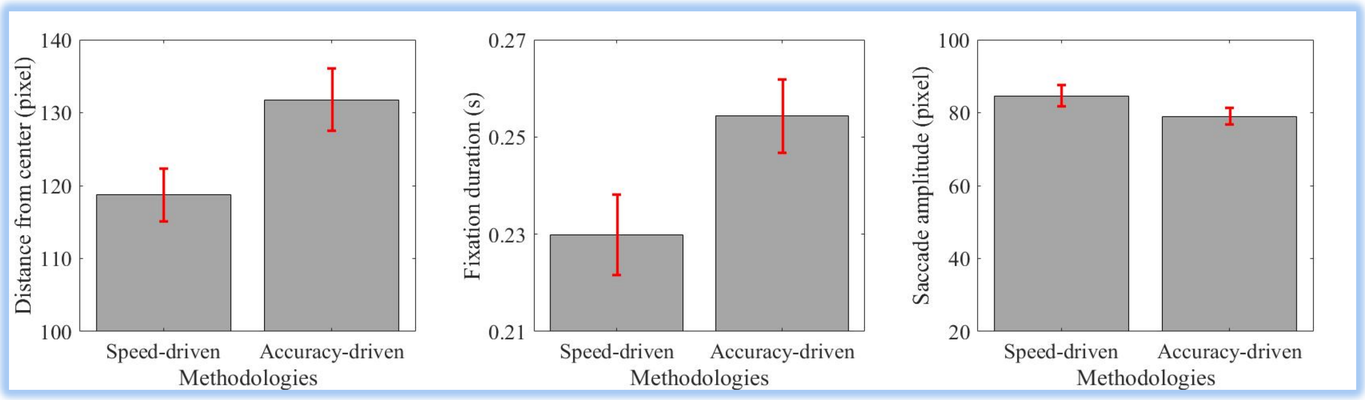
## Introduction

Noise level (image quality) evaluation is an important and popular topic in many applications. However, the knowledge of how people visually explore distorted images for making decision on noise evaluation is rather limited. Recently, more and more studies begin to analyze the relationship between top-down impacts and eye movement data in the decision-making process. Meanwhile, few works have analyzed the differences between eye movement patterns corresponding to different evaluation methodologies. Moreover, the decision-making efficiency, which is characterized by evaluation time and decision error, have rarely been discussed in the process of image noise evaluation. The knowledge of the correlation between the decision-making efficiency and eye movement data is few touched.

## Objectives

- Identify two different types of methodologies in the evaluation processing
- Find the differences in eye movement patterns of different methodologies
- Identify the decision-making efficiency of evaluation processing
- Find a new measure as a proxy definition for this decision-making efficiency

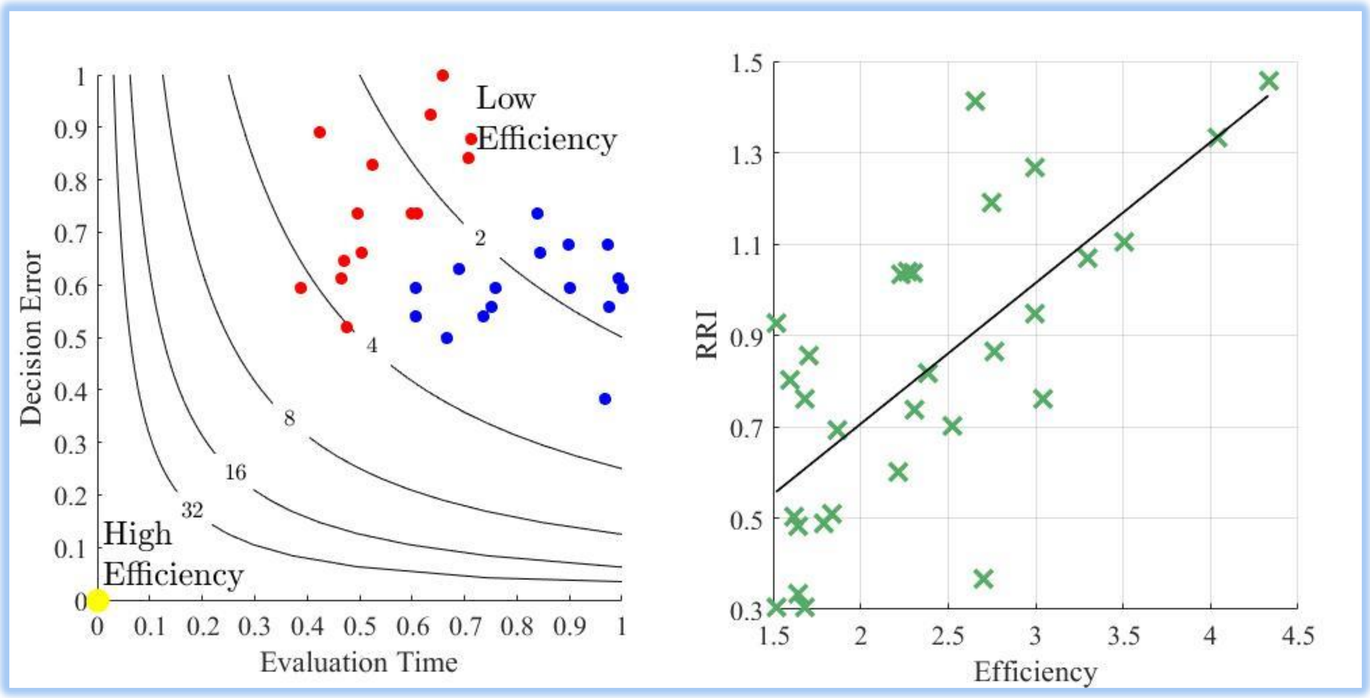
## Result1




Depending on whether time or accuracy the participants focus on, participants data can be divided into two groups, which indicate two evaluation methodologies, speed-driven and accuracy-driven, respectively.

The speed-driven methodology, compared with the accuracy-driven one, uses less time to give evaluation results, with shorter fixation duration and stronger central bias.

## Result2




| | Correlation Coefficient | p-value |
|---|---|---|
| PLCC | 0.71 | < 0.0005 |
| SROCC | 0.67 | < 0.0005 |
| KROCC | 0.49 | < 0.0005 |

$$Efficiency = \frac{1}{Error \cdot Time}$$

The decision-making efficiency for the evaluation, inspired by the efficiency definition of Monte Carlo estimation.

$$H = \sum_{x \epsilon \chi} p(x) log_2 p(x)$$

The Aggregation Entropy (AE) of each participant was defined by calculating an arithmetic average for 24 gaze allocation map entropies. This AE indicates the effective information a participant consumes for using informative noise feature to obtain evaluation results.

$$H(t) = \sum_{x \epsilon \chi} p_t(x) log_2 p_t(x)$$

The temporal-spatial entropy plot (TSEP) describes the evolution of gaze allocation over time. An arithmetic average for the mean entropy values of the 24 TSEPs was obtained, called Evaluation Entropy (EE) . This EE represents the amount of information of fixation distribution during the processing of noise evaluation.

$$RRI = EE - AE$$

RRI can be described as how much ineffective information a participant reduces in the process of noise evaluation. The results demonstrate the significant correlation between decision-making efficiency and RRI.

## Conclusion

In this study, we conducted psychophysical eye-tracking experiments and utilized temporal-spatial entropy analysis on eye movement data to deeply understand how and how efficient people do evaluations for impulse noise of image. We obtained two evaluation methodologies, speed-driven and accuracy-driven, based on evaluation time and decision error. Moreover, we proposed Reduced Redundant Information (RRI) to describe how much redundant information a human being reduces in the process of noise evaluation. Importantly, We found that the decision-making efficiency shows significant correlation with RRI in evaluation processing.

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