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PAVIP: Practical Applications of Visual Information Processing

Do Digital Human Facial Expressions Represent Real Human's?

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About Me

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- **Research of interest**
  - Face Image Processing
  - Digital Human
  - Facial Expression Recognition by AI

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Agenda

- Background
- Research Aim
- Our System
  - Tools Used in This Study
  - Creating Facial Expression Data
  - Evaluation of Quality of Facial Expression
- Result
- Conclusion

■ Background:: Facial Expressions of Digital Humans

To promote communication in virtual space, it is necessary to reproduce facial expressions equivalent to those of humans with digital humans. However, the quality of facial expressions has not been fully verified.

MetaHuman Facial Animation with Face Control Rig in Unreal Engine 5 [1]

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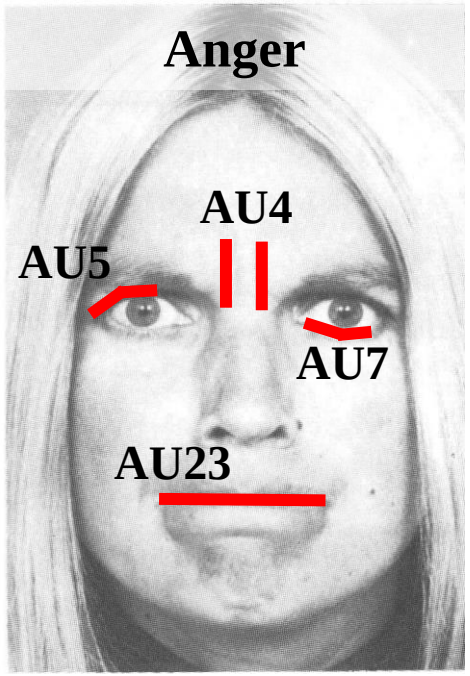
■ Background:: Facial Expressions in Communication

Action Units (AUs) are the movement of an individual muscle or group of muscles [2], and the combination of AUs can recognize facial expressions [3]. Recently, not only AUs but also **deep learning** is used in **facial expression recognition** [4].

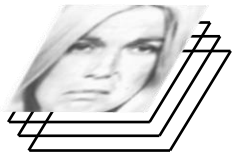
AUs



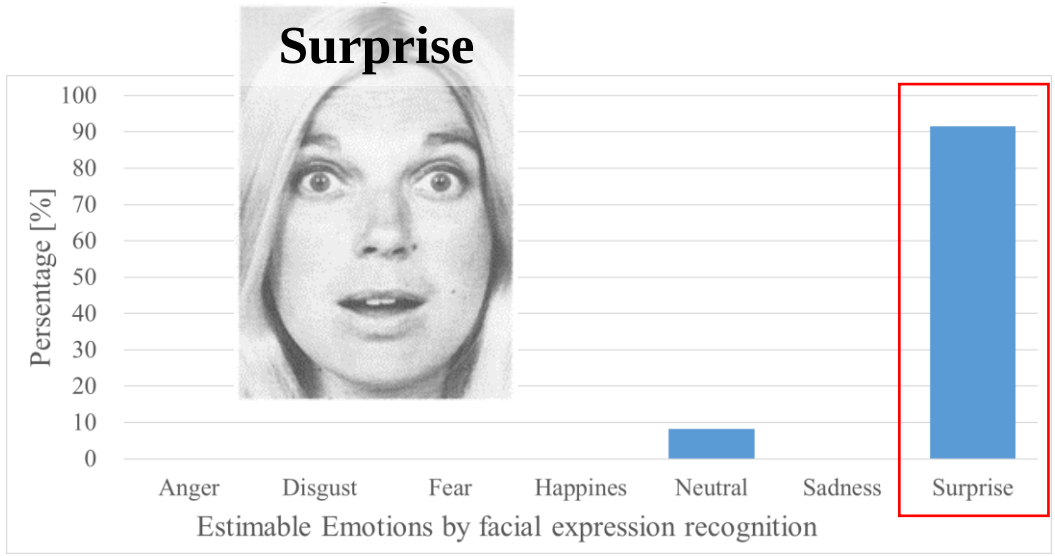
Expression of Anger [5]

Angry

Sadness



AI



Result of Surprise expression image

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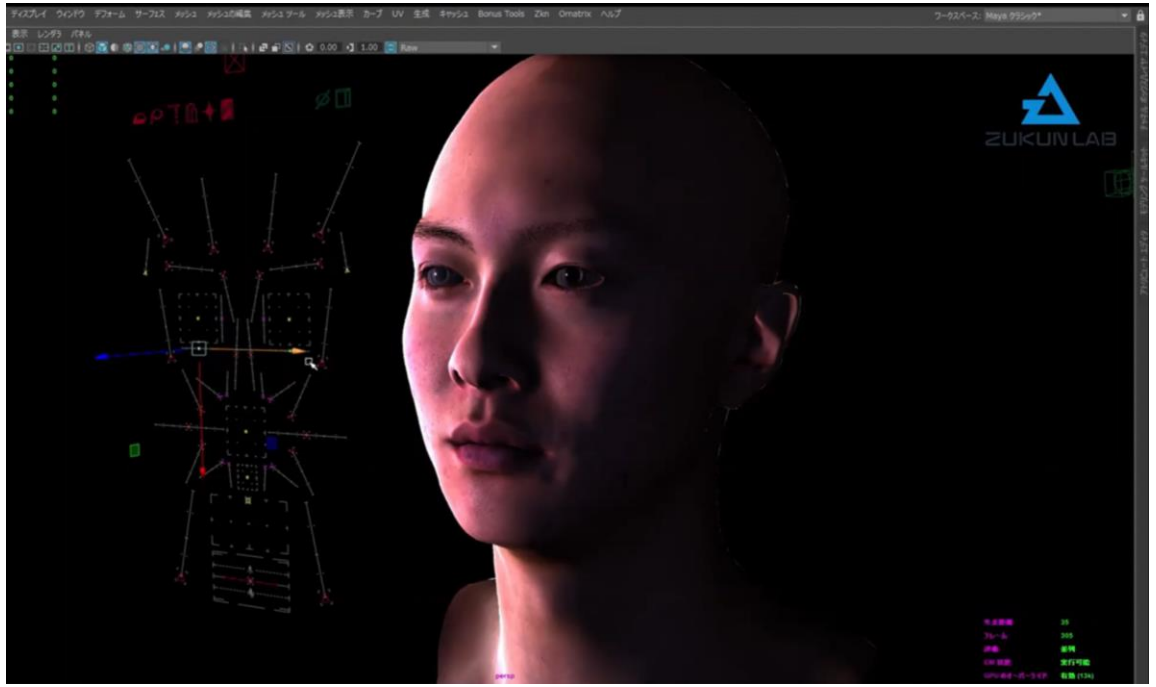
Background:: Reality of the Digital Human

Visual realism [6]

Visual realism is higher as the digital human looks more like a person.



Behavioral realism [7]

Behavioral realism is higher as the digital human performs natural movements.

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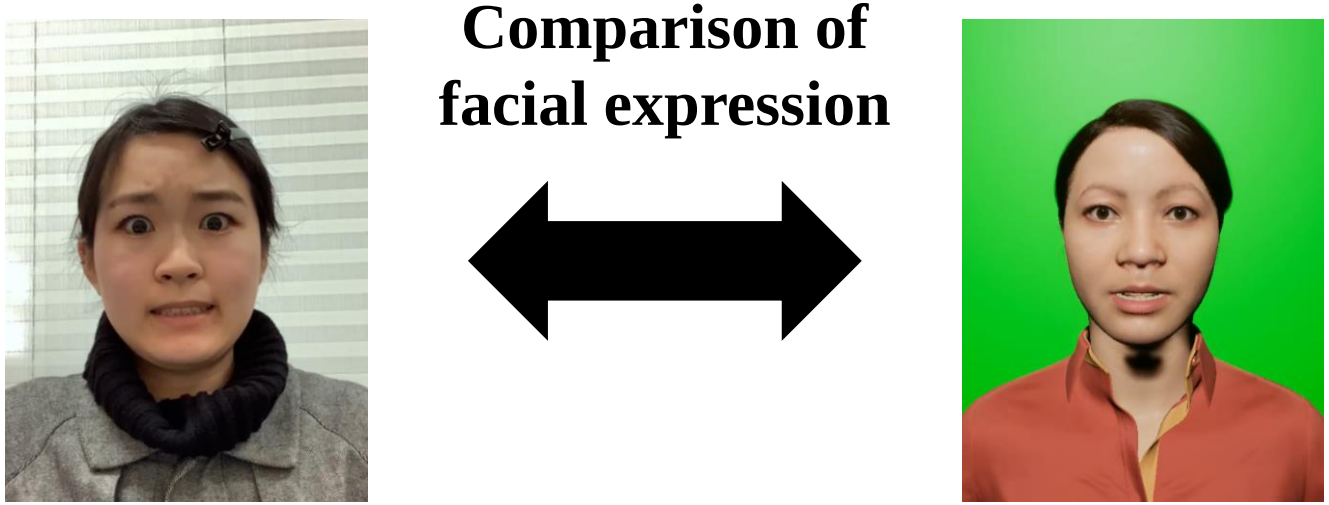
Research Aim

This study compares actor and digital human facial expressions and examines the quality of digital human facial expressions. For this purpose, we create a system that reflects the actor's facial expressions to the digital human in real-time and automatically recognizes the six basic emotions based on their facial expressions.



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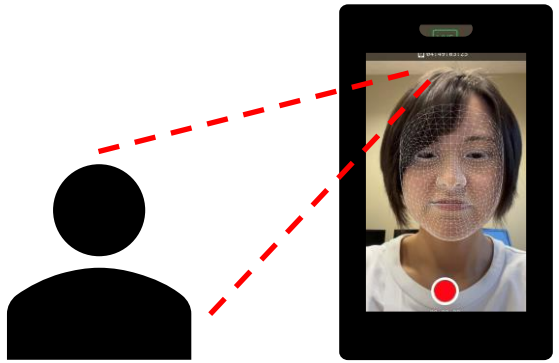
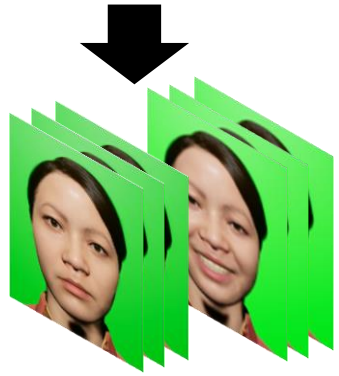
Our System

Creating Facial Expression Data

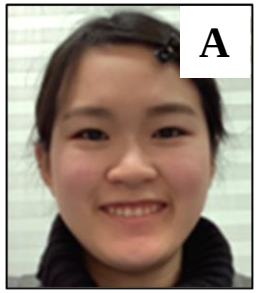


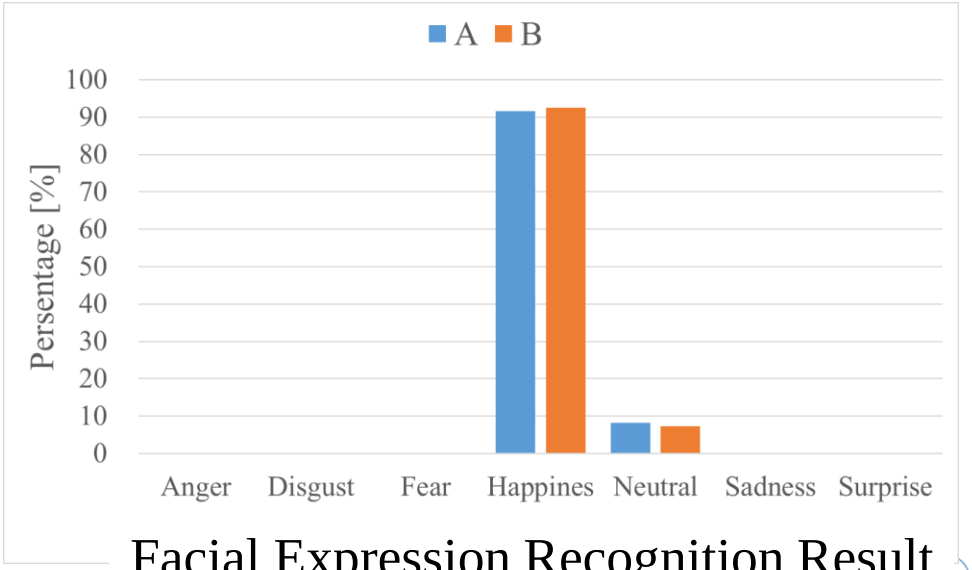
Acquisition of the facial features

Reflect the actor's facial expressions to digital human



Quality Evaluation of Facial Expression





Facial Expression Recognition Result

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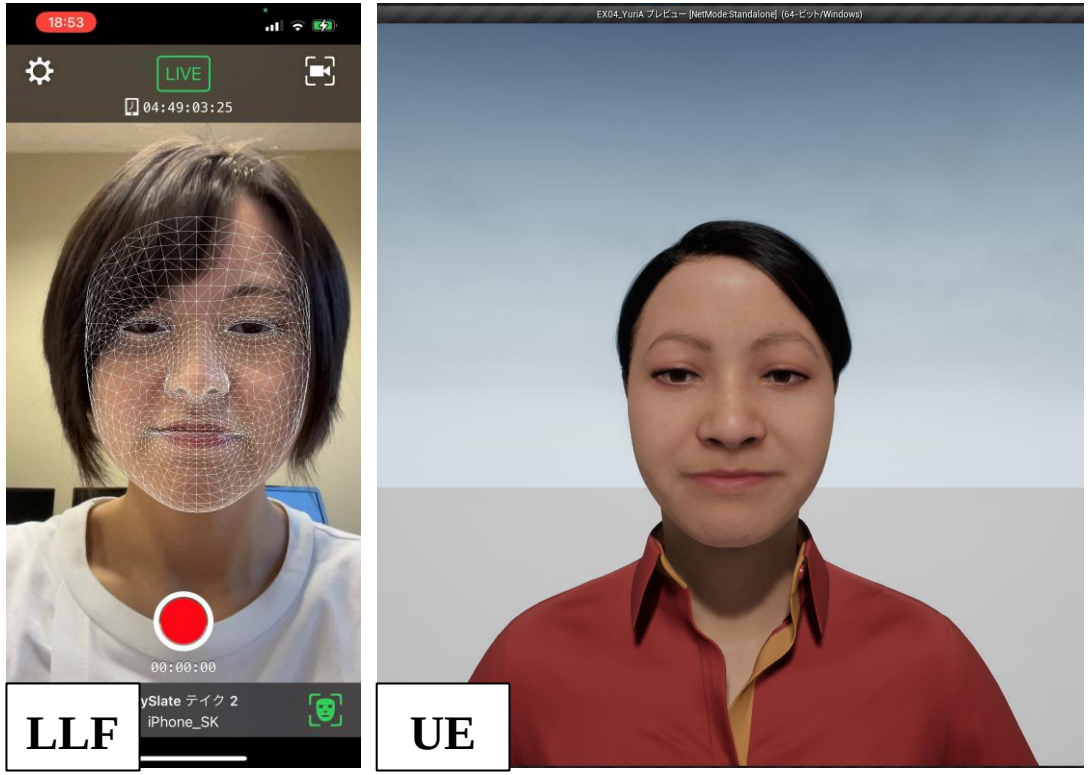
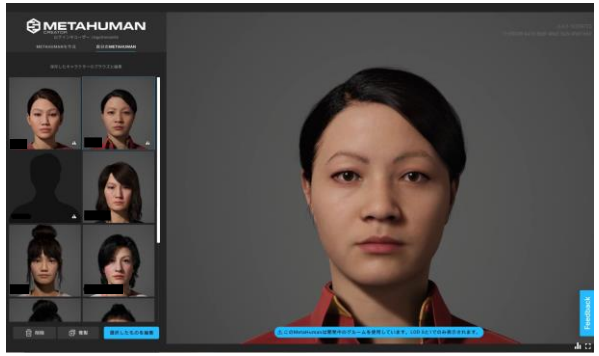
Our System:: Tools Used in This Study

Live Link Face (LLF) [10] and Unreal Engine (UE) [8]



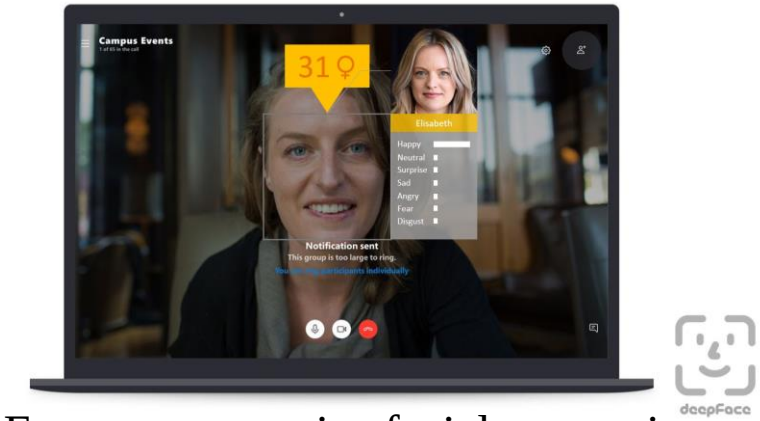
UE is the 3D object rendering engine. LLF can acquire the facial features of an actor.

MetaHuman Creator [9]



MetaHuman Creator can create photorealistic digital humans in the browser.

DeepFace [11]



DeepFace can recognize facial expressions.

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Our System:: Creating Facial Expression Data

Actor

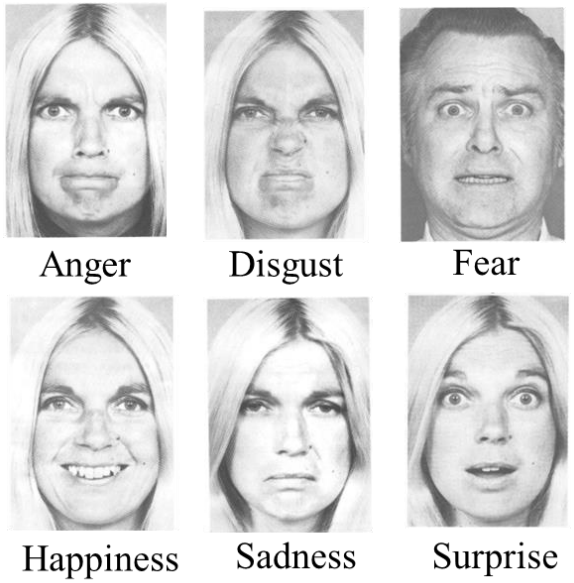
- 22-year-old
- Japanese female

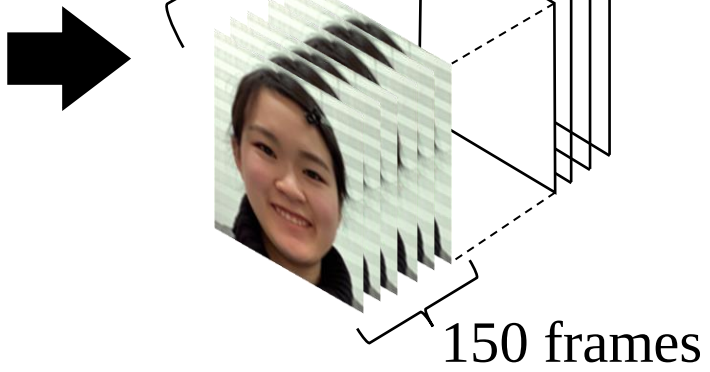
Actor

Digital human

Mimicked Expression

- The actor imitate six facial images for 5 seconds.
- The facial expression is captured at 30 fps.





Facial images [5]

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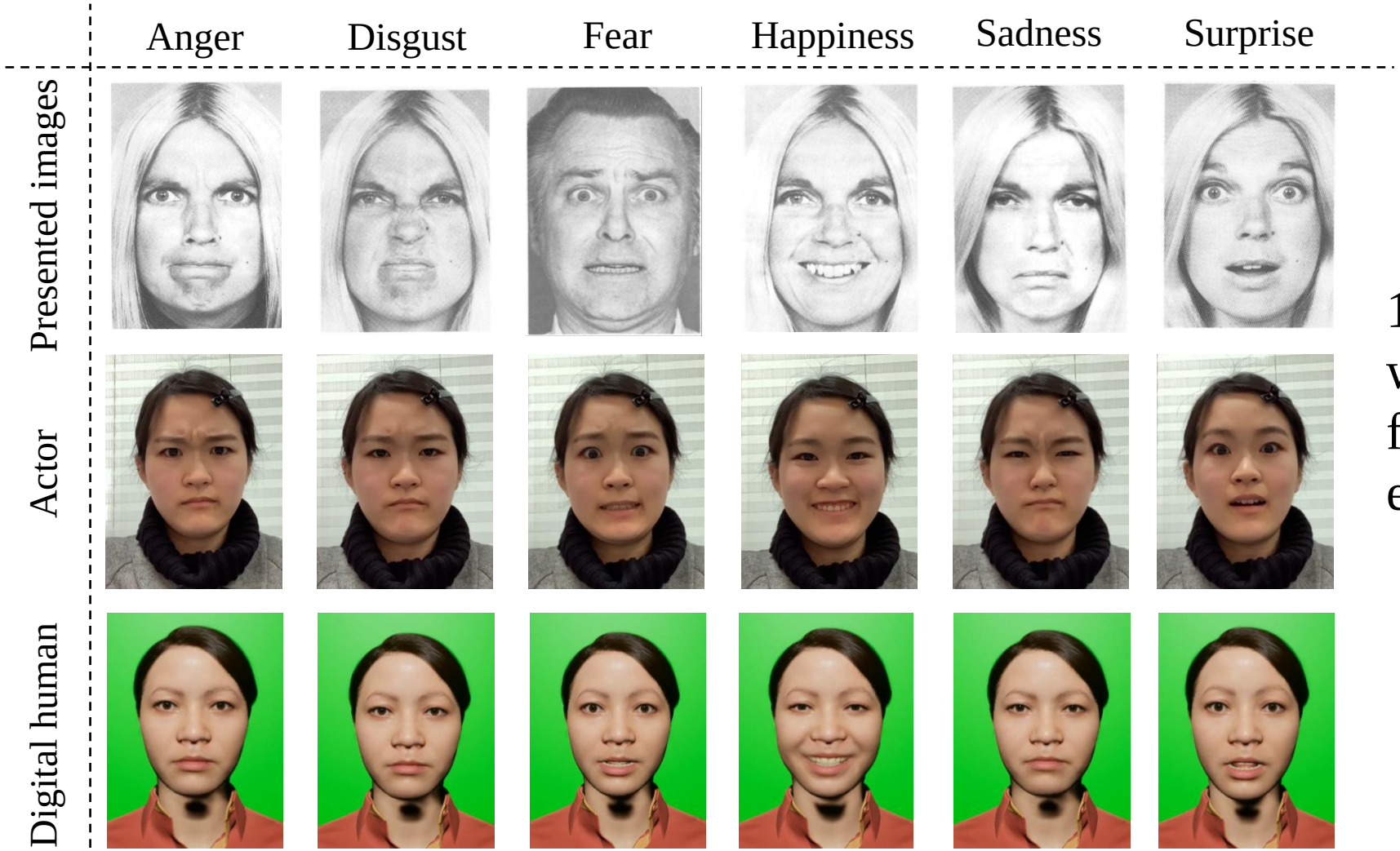
Our System:: Creating Facial Expression Data



150 frames of facial images were collected from each five-seconds video of each emotion.

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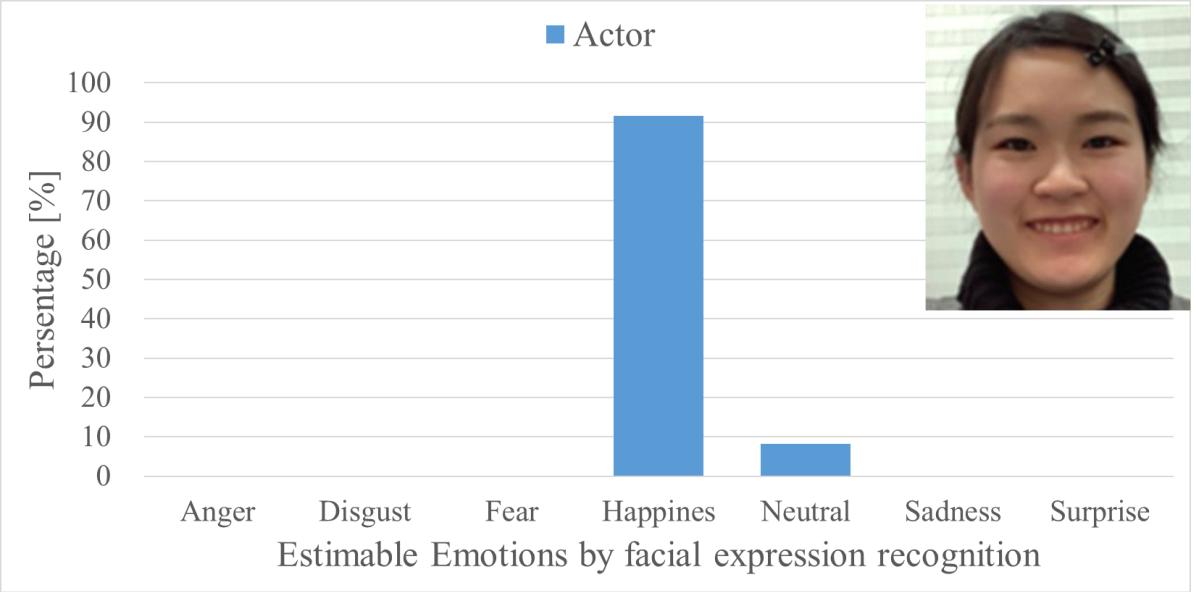
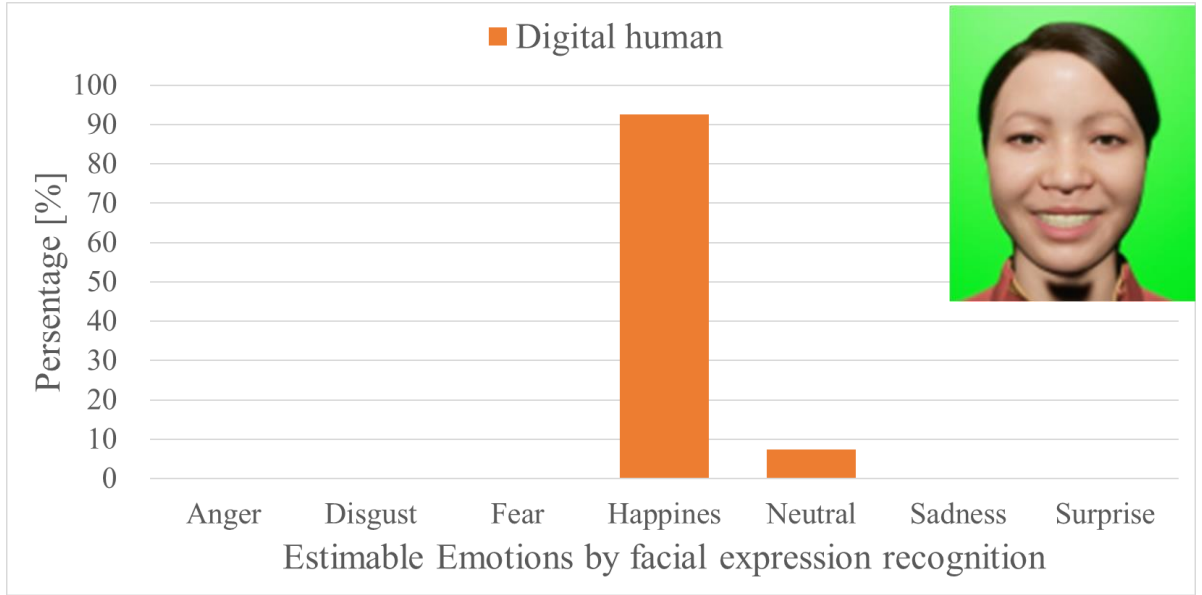
■ Our System:: Quality Evaluation of Facial Expression

Estimation of the six basic emotions and neutral from a single face image.





Actor's result

Digital human's result

Facial image	Anger	Disgust	Fear	Happines	Neutral	Sadness	Surprise
Actor	0.00	0.00	0.07	91.58	8.19	0.02	0.14
Digital human	0.00	0.00	0.00	92.57	7.32	0.01	0.09

[%]

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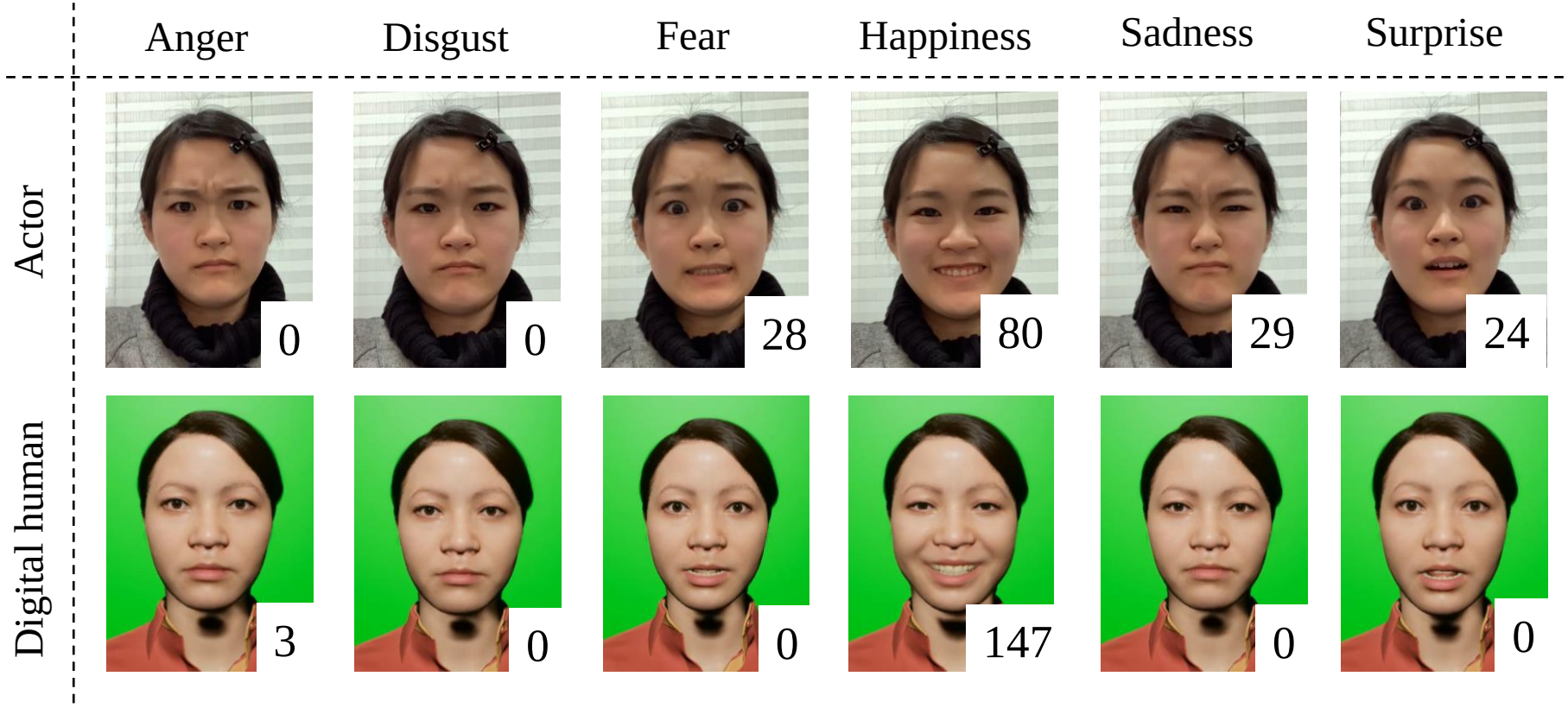
Results

- “Happiness” was correctly identified from the digital human’s facial images.
- “Anger” and “Disgust,” were not correctly identified from the actor’s facial images.



Number of frames of face images for which the emotion was correctly estimated [frame]

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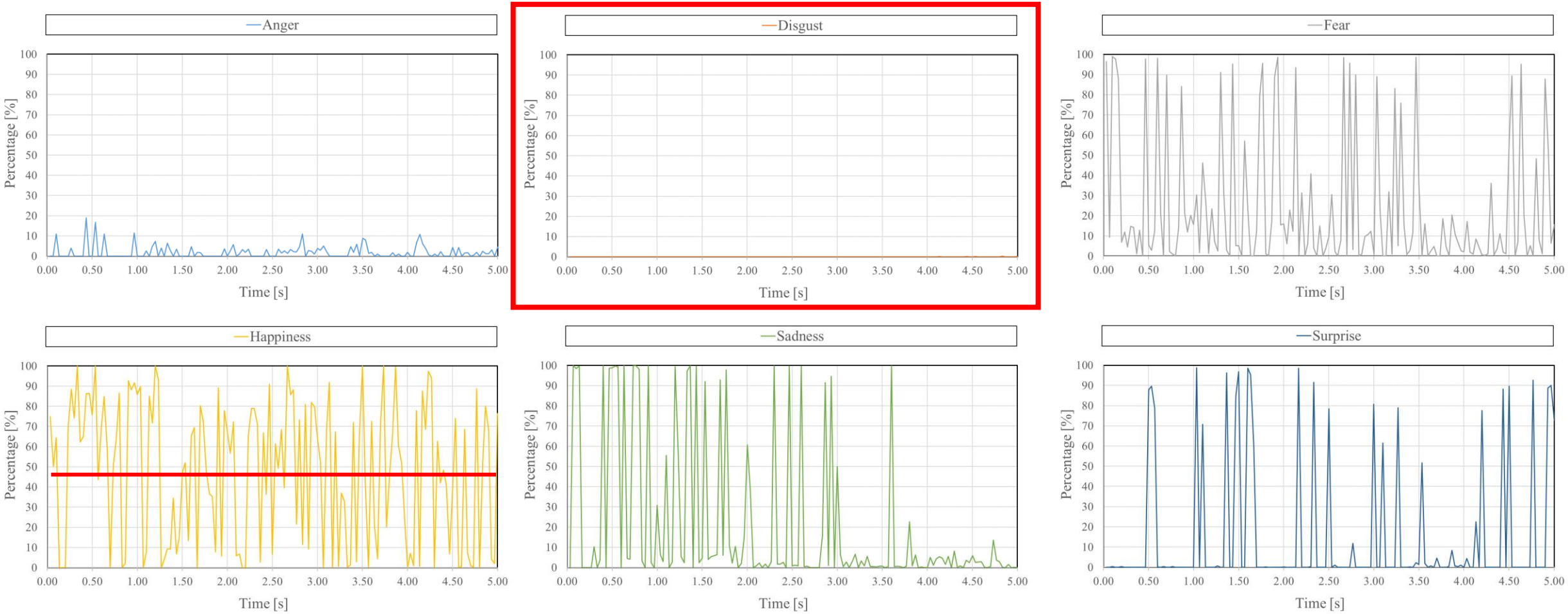
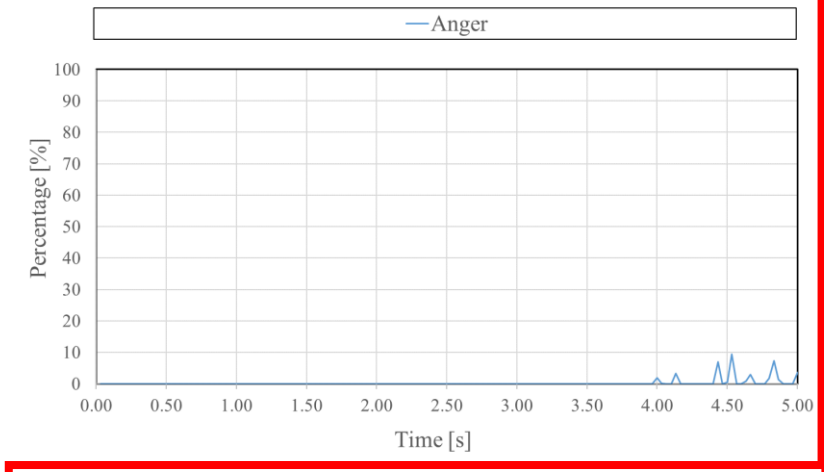
■ Results:: Actor's Facial Expression Recognition

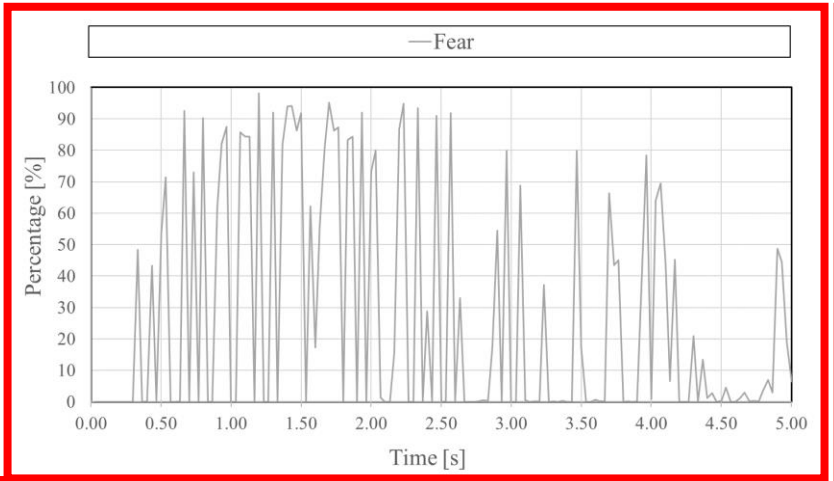
These graphs show the raw results of emotion estimation for the actor for each frame.

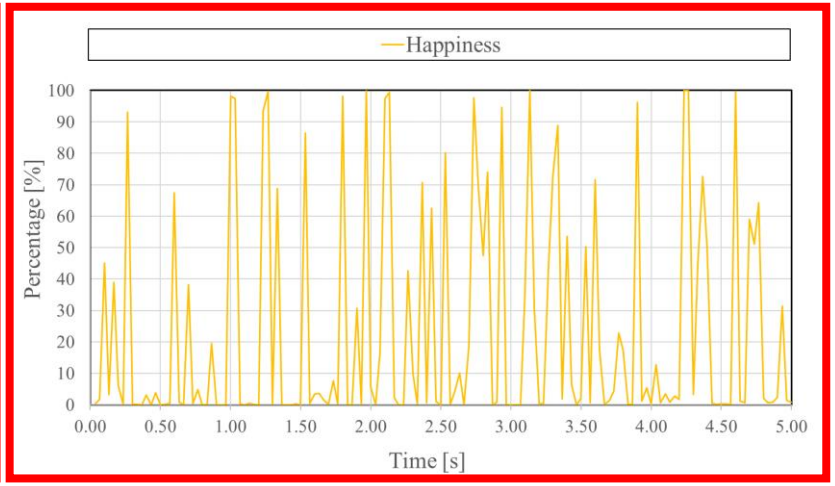


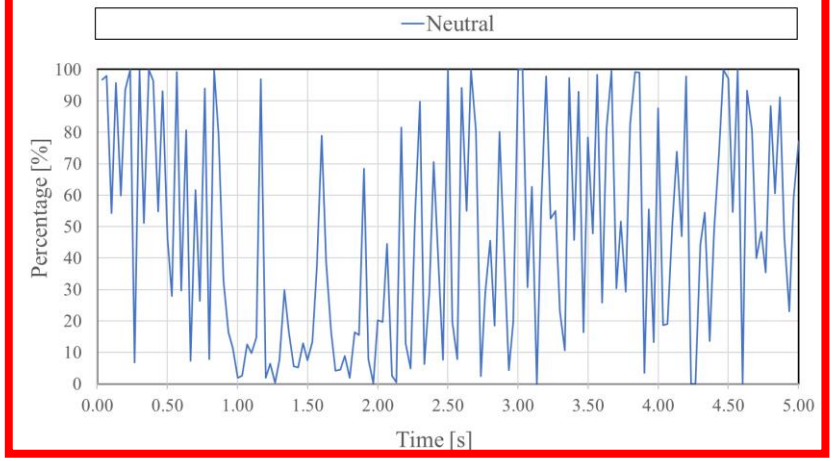
■ Results:: Actor's Facial Expression Recognition

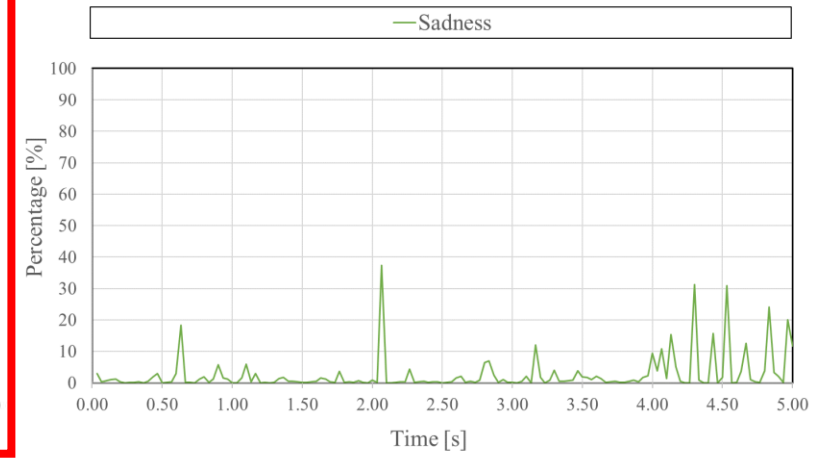
This is the result of facial expression recognition of a "disgust" video by the actor.
The actor's emotion of "Disgust" was misidentified mostly as "Fear", "Happiness", and "Neutral".

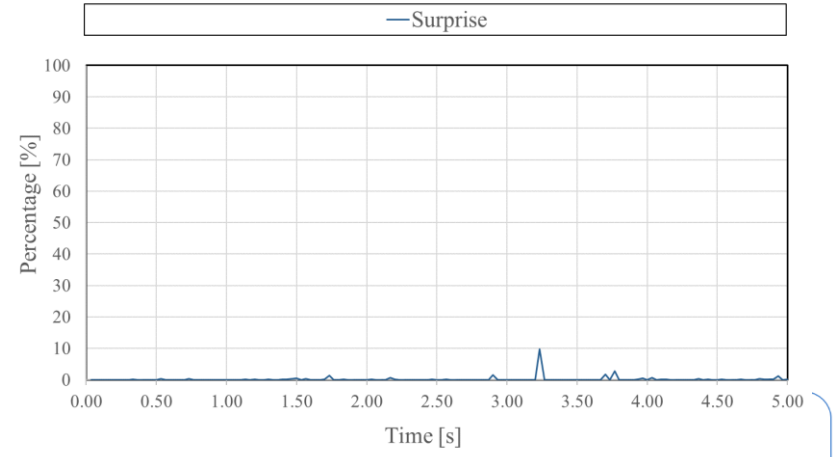












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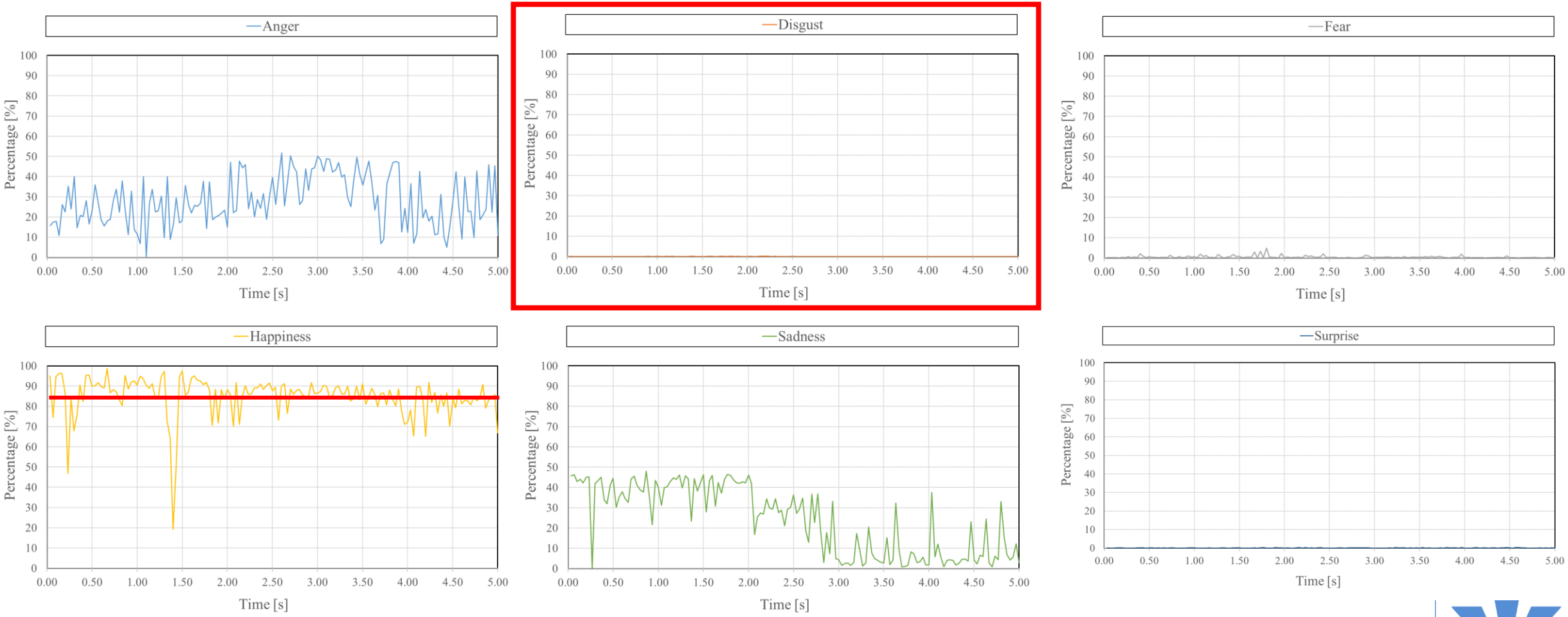
■ Results:: Digital Human's Facial Expression Recognition

These graphs show the raw results of emotion estimation for the digital human for each frame.



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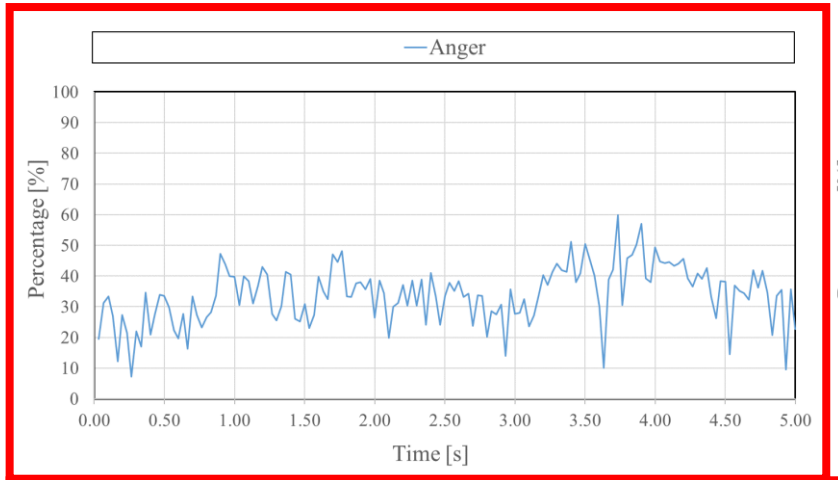
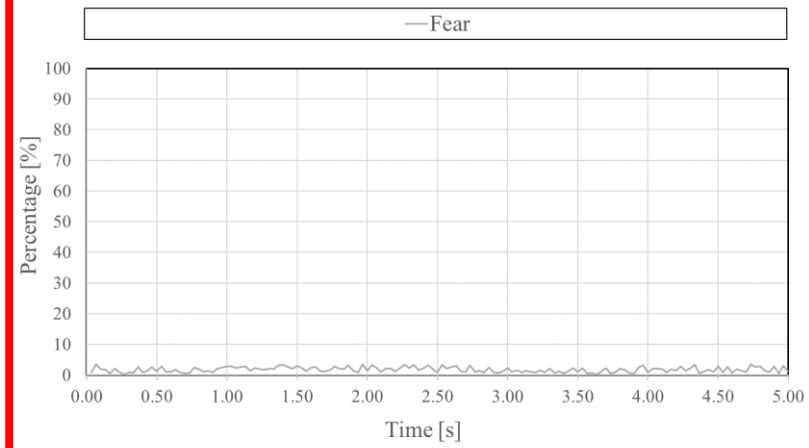
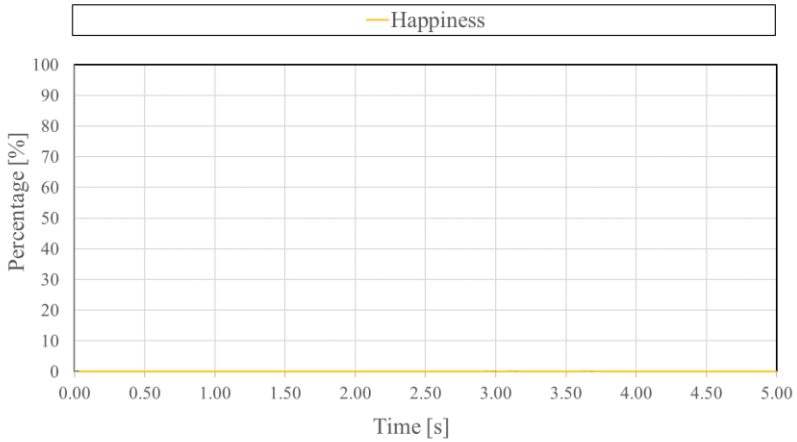
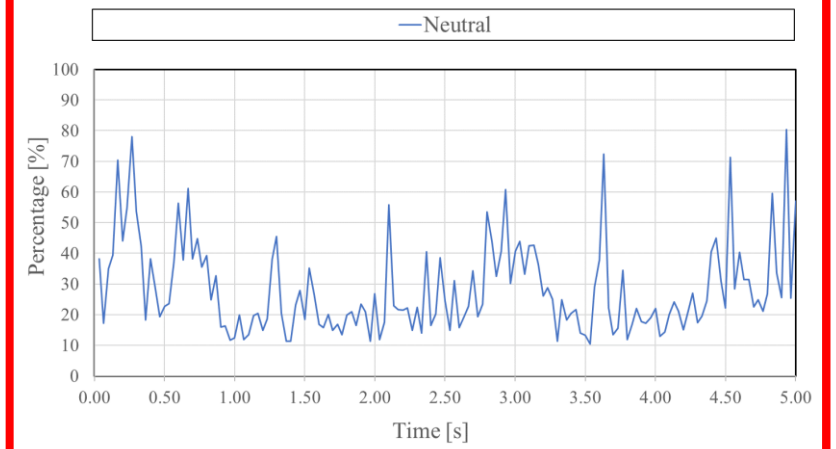
■ Results:: Digital Human's Facial Expression Recognition

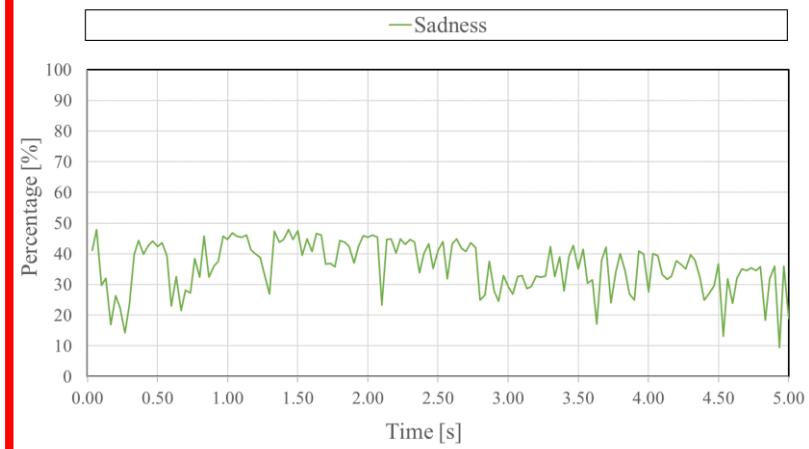
This is the result of facial expression recognition of a "disgust" video by the digital human. The digital human's emotion of "Disgust" was misidentified mostly as "Anger", "Neutral", and "Sadness".

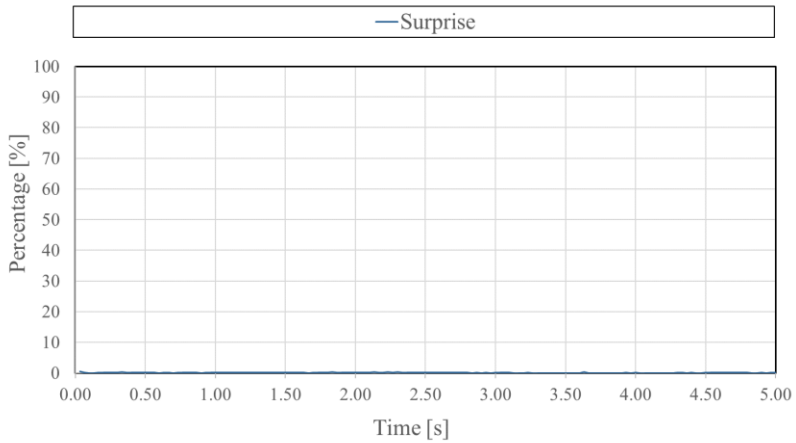












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■ Conclusion

Achievement

- The emotion of “Happiness" was the most similar between the actor and the digital human.
- The quality of “Happiness" by the digital human was high.
- Using multiple frames may improve the estimation of emotions.

Future Work

- Learning facial expression recognition using digital humans.
- Improving facial expression estimation from continuous frames.
- Validating the expression representation of digital humans.

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