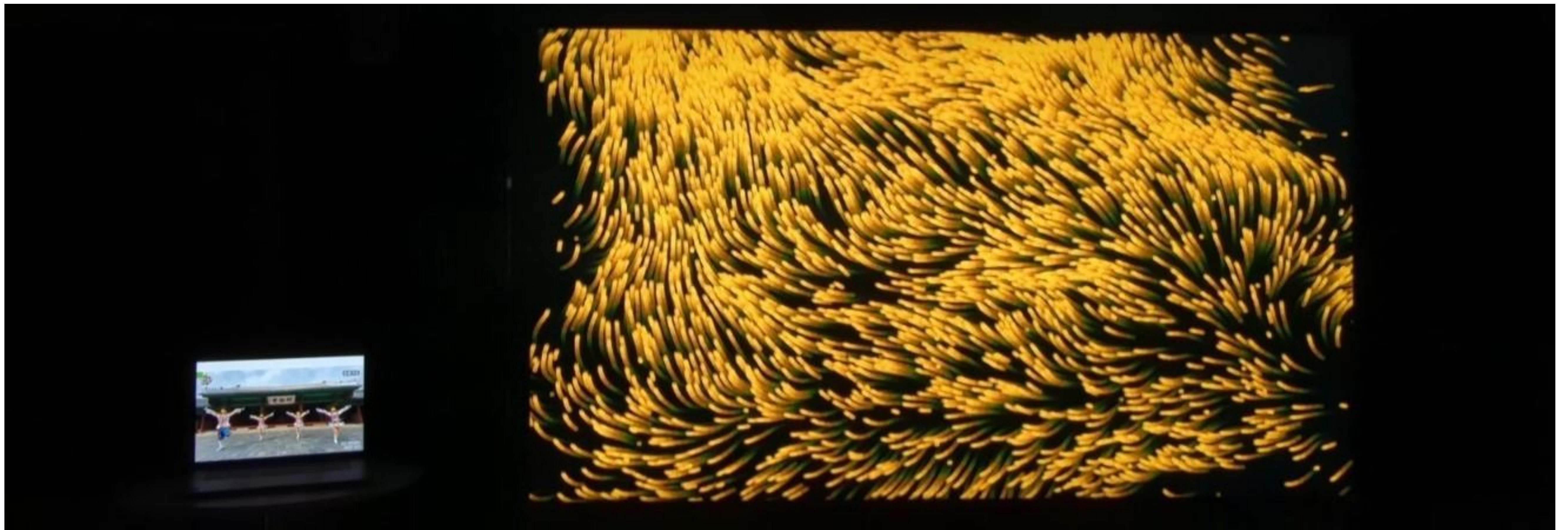# CheerUp: A Real-time Ambient Visualization of Cheerleading Pose Similarity

Soohwan Lee, Kyungho Lee
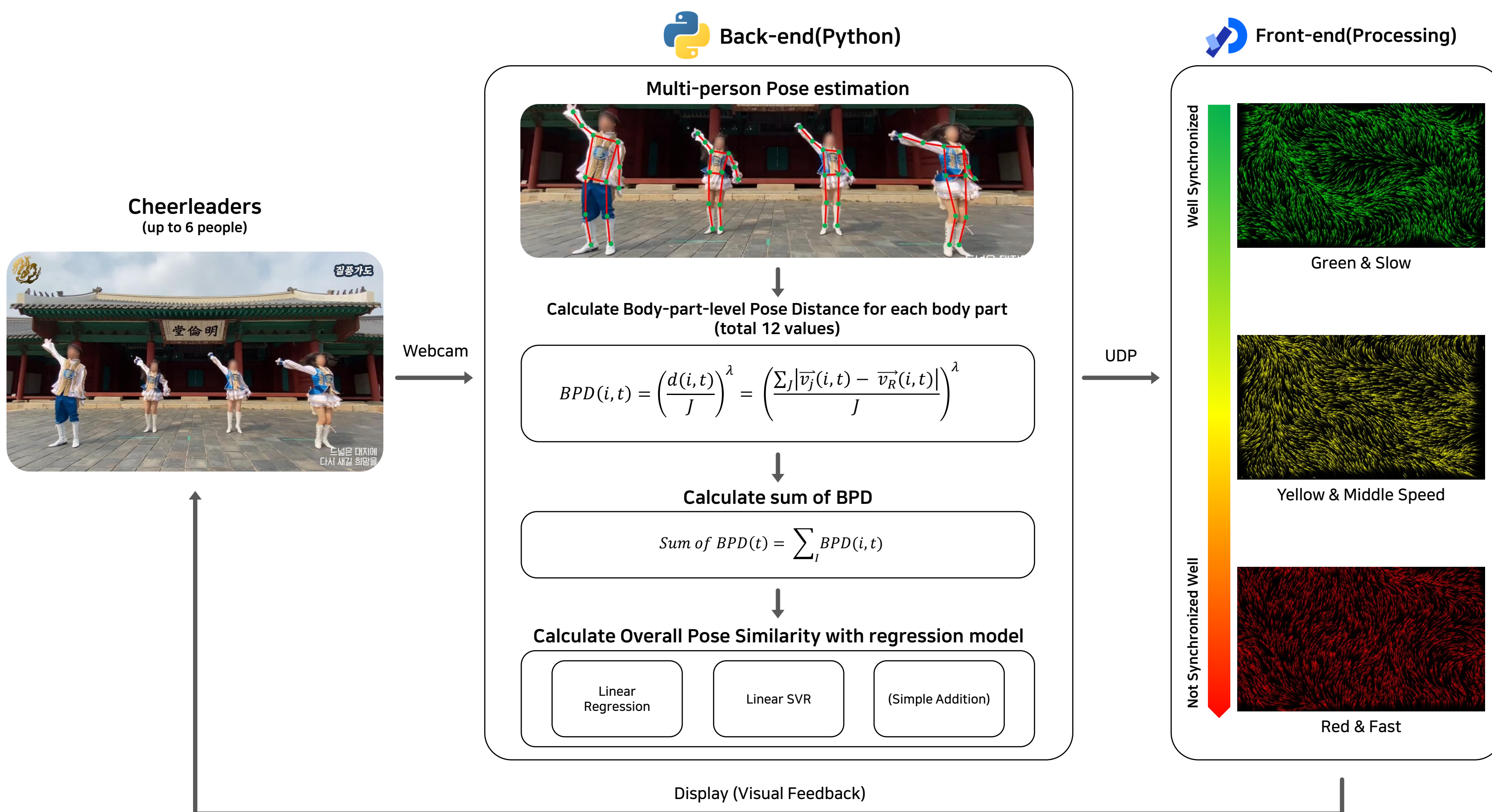
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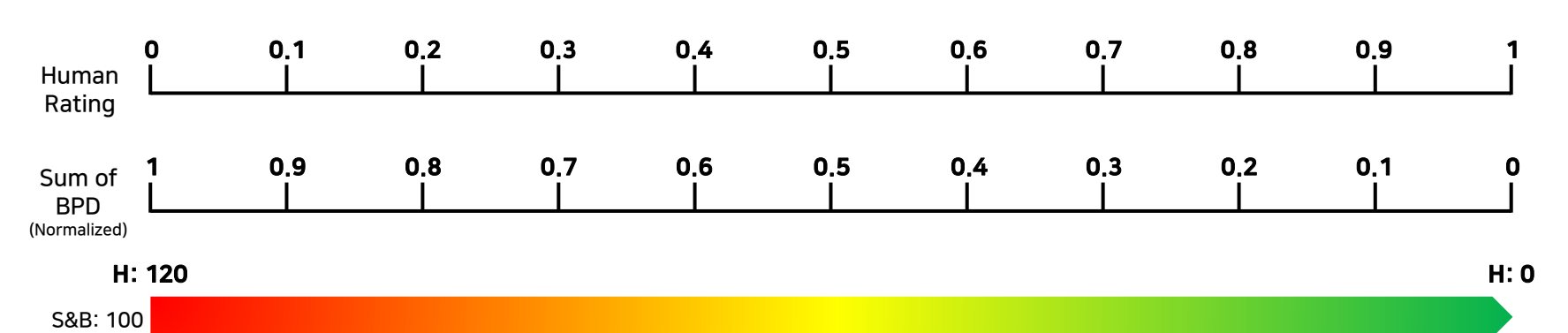*CheerUp: a real-time ambient visualization of how well cheerleaders' movements are synchronized*

SYSTEM OVERVIEW

Multi-pose estimation & calculating overall pose similarity([0,1]) with regression model were processed in Python, then the result was sent from Python to Processing with UDP protocol. Finally, show the pose similarity with colored particle movement at Processing.

Back-end(Python)

Multi-person Pose estimation

Calculate Body-part-level Pose Distance for each body part (total 12 values)

$$BPD(i,t) = \left(\frac{d(i,t)}{J}\right)^{\lambda} = \left(\frac{\sum_j |\overrightarrow{v_j}(i,t) - \overrightarrow{v_R}(i,t)|}{J}\right)^{\lambda}$$

Calculate sum of BPD

$$Sum\ of\ BPD(t) = \sum_i BPD(i,t)$$

Calculate Overall Pose Similarity with regression model

| Linear Regression | Linear SVR | (Simple Addition) |

Cheerleaders (up to 6 people)

Webcam

Front-end(Processing)

Well Synchronized — Green & Slow

Yellow & Middle Speed

Not Synchronized Well — Red & Fast
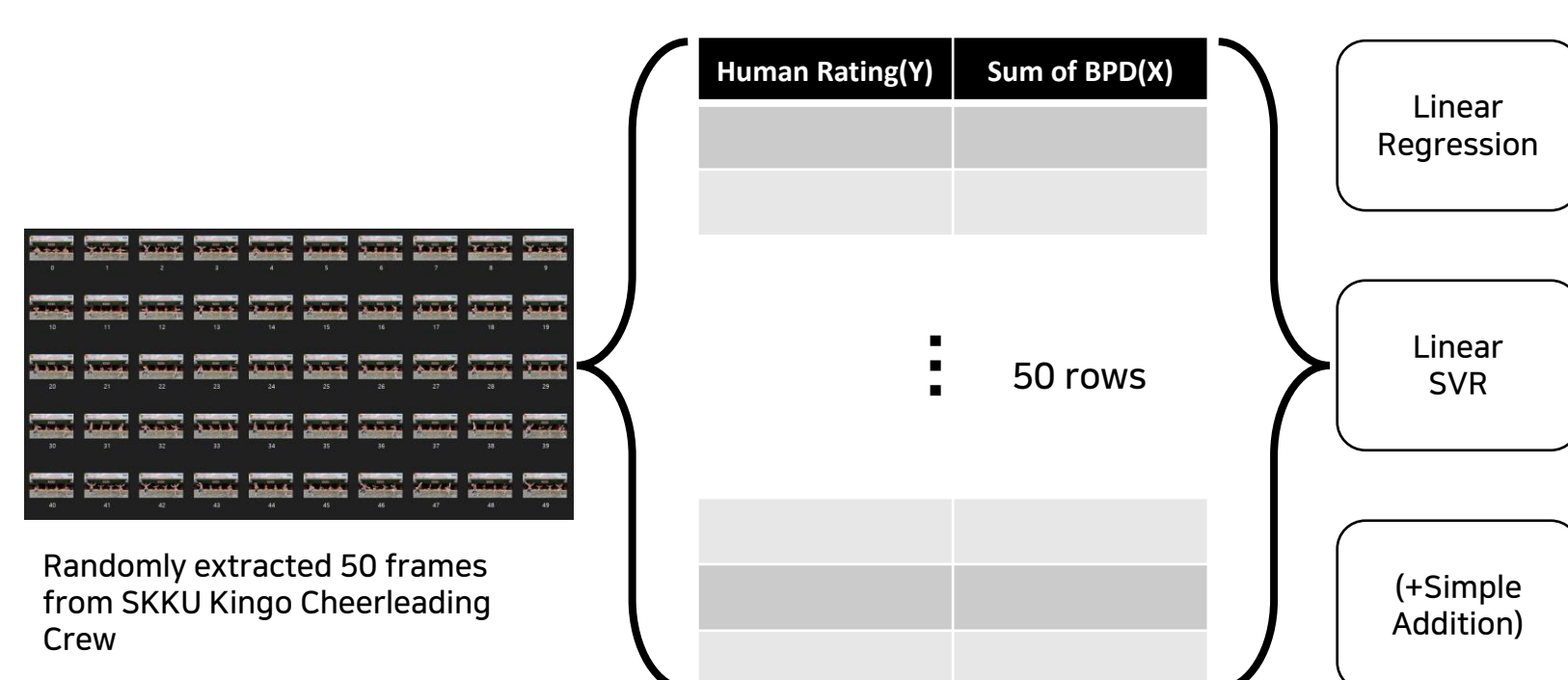
UDP

Display (Visual Feedback)

DESIGN MOTIVE & RATIONALE

It was thought to be similar to the fish's dynamic and orderly movement in that the cheerleaders' movements matched exactly every moment. And simple color mapping strategy and movement were used as design rationale. Therefore, if motions were well synchronized, then green particles move slowly. However, if it is not synchronized, red particles move fast.

| Human Rating | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1 |
| Sum of BPD (Normalized) | 1 | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |

H: 120 — H: 0
S&B: 100

REGRESSION MODEL

Through a sample video created by the university cheerleading team, Kingo Crew, we tried to create a regression model that calculates the overall pose similarity in the same way as the existing methodand to create a real-time system by applying it to the webcam input.

Human Rating(Y)	Sum of BPD(X)		
50 rows		Linear Regression
		Linear SVR
		(+Simple Addition)

Randomly extracted 50 frames from SKKU Kingo Cheerleading Crew

RESULT & DISCUSSION

Three system prediction values were analyzed. Each RMSE values are as follows simple addition(0.210), linear regression(0.117), and linear SVR(0.173). Notably, the result shows a parabolic pattern of a quadratic function from the simple addition baseline. As a result, a regression model that targets the human rating value, instead of relying solely on the sum of BPD value as a representation of pose similarity, is necessary. The more closely the system's predictions align with the original human rating value, as demonstrated by a straight line form on the graph, the more effective the model is. Given the baseline's parabolic form, adding the squared value of the sum of BPD when constructing the linear regression model is expected to result in improved performance. The purpose of the study was not simply to present a high-performance regression model, and we considered how to apply the existing model to better user scenarios with the real-world sample video.

(a) Simple Addition (Baseline)

(b) Linear Regression

(c) Linear SVR