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Research Article

Utilizing Digital Body Tracking Systems to Develop Sustainable and Ideal Workspace

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Abstract.

Artificial intelligence (AI), with its accuracy and nonbiased performance, has the potential to analyze human needs and provide more appropriate spaces. AI, especially body tracking systems, has the potential to detect human necessities based on their behaviors and body conditions. This research aims to explore AI's body tracking systems to detect detailed human motion, position, and body temperature, to fulfill human-specific necessities in their workspaces. The results showed that the body tracking system effectively identifies human necessities for spatial comfort based on their preferences and habits. It also showed responsive and accurate data to control energy and material efficiency used and needed. To conclude, the body tracking system has the potential to generate a sustainable and ideal workspace. A healthy and well-being environment can be fulfilled through a sustainable workspace and support creative industries' sustainability through human productivity.

Keywords: artificial intelligence, body tracking system, human comfort, human necessities, sustainable workspace

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1. Introduction

Human needs are to live a decent and sustainable life following the World SDGs (Sustainable Development Goals), especially Points three about health and well-being, Points nine about sustainable infrastructure and innovation, and Points twelve to ensure sustainable consumption and production [1].

Workspace comfort significantly affects human productivity and greatly impacts industrial and economic sustainability [2]. However, overcooling, overventilation, and uncomfortable lighting are commonly found in office buildings [3]. In addition, general control systems in offices also give people less control over their personal space and cause workspace discomfort [4]. This situation also affects sustainability related to human well-being, control over energy efficiency, and the materials used.

Spatial behavior is a crucial aspect of human needs for space comfort, namely thermal, lighting, visual, and spatial comfort [5]. Besides that, human demands towards their personal space differ based on body composition, age, physiological response to their environment, habits, and preferences [4], so comfort standards cannot be generalized for everyone.

AI (Artificial Intelligence) is many technologies and methods that have the potential to support sustainable human life [6]. Research on AI utilization in the workspace has been carried out, such as designing robots to monitor and detect workspace conditions [7] and machine sensing to detect workspace comfort in terms of thermal, visual, and audio [8]. However, most prior research detected workspace comfort based on the existing space conditions without considering human activity and behavior. In addition, the results of these studies only produce the room data, whether the room meets the ideal comfort requirements or not. The workspace design has yet to be implemented based on the comfort data. Further studies that collaborate and integrate art, design, and technology to design a sustainable and ideal workspace are needed.

Machine learning features in AI can be capable of personal adjustments automation to accommodate individual needs, save energy, and reduce operating costs in the workspace [9]. So, AI can be a personal assistant to analyze individual human needs and provide more appropriate spaces. AI, especially body tracking systems, has the potential to detect human unconscious and conscious necessities based on their behavior and the condition of their bodies. Furthermore, the data obtained from human behavior can be processed by AI logic into a spatial response that supports human comfort.

This study aims to utilize AI, especially body tracking systems, to detect detailed human motion, position, and body temperature, to fulfill personal human necessities in their workspaces. The body tracking system also has the potential to generate a sustainable health and well-being environment by fulfilling human comfort, controlling energy, and controlling material efficiency in the workspace. This research further aims to support the growth and sustainability of the economy and industry, including the creative industry, through human productivity.

2. Research Methods

2.1. Methods of data collecting

The method used in this research is mixed; qualitative and quantitative. The data about general human needs for the comfort of workspaces and data on human preferences for these needs were collected by literature review. Furthermore, body tracking system experiments were conducted using a Kinect camera, moving-head lights, and Touchdesigner software. A Kinect camera was used to detect human depth information, such as the movement of human joints in detail and human position based on the x, y, and z axes. Moving-head lights were used as lighting output and Touchdesigner software to create an intelligent system based on code and data. All experiments were carried out to detect human comfort based on their behavior.

2.2. Methods of data analysis

The literature review data was analyzed and became an input database for the coded software. Furthermore, the results of several experiments using the Touchdesigner software were analyzed to produce an intelligent system method that can be applied to produce a workspace design that supports the user's personal needs. The input aspects tested were human chest positions to detect their activities, human palm movements to detect their responses towards thermal comfort, and human body temperature to detect their body conditions and thermal space requirement. The output aspects tested were movement, angle, intensity, and color of lights, digital mechanic ventilation, and thermal control.

3. Result And Discussion

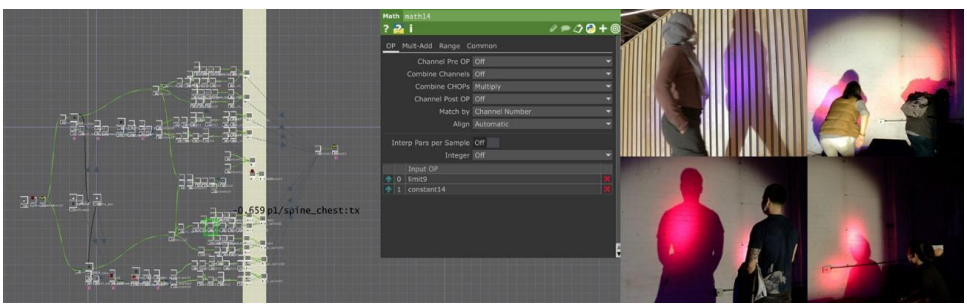

Figure 1: Chest Position Detection Experiment.

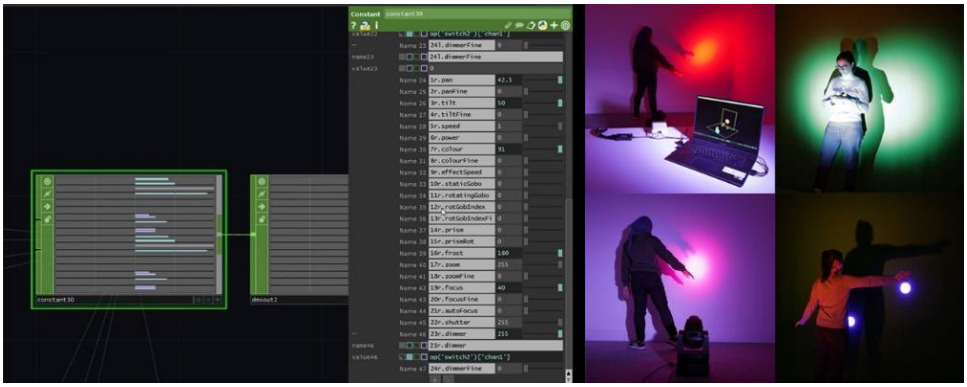

Figure 2: Palm Movement Detection Experiment.

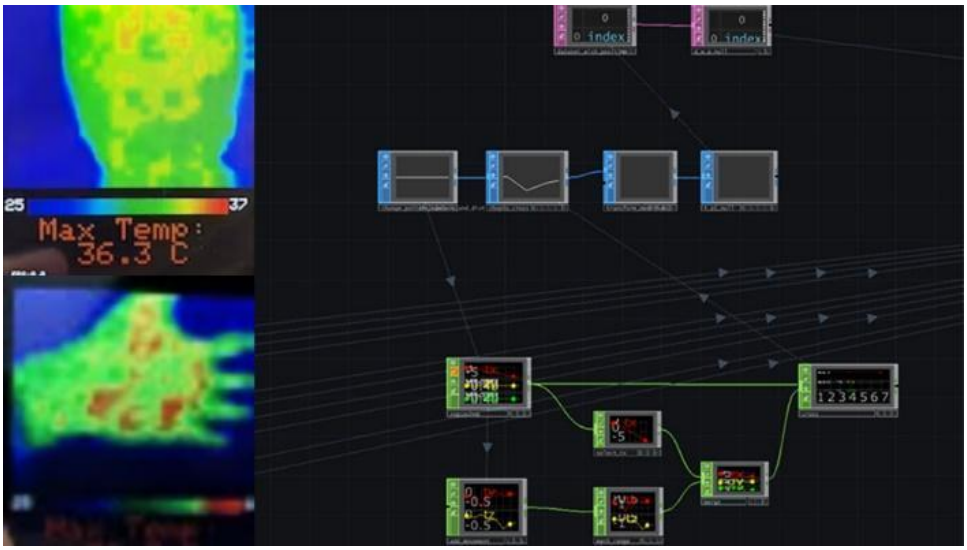

Figure 3: Body Thermal Detection Experiment.

Body tracking experiments were conducted to detect human behavior and then generated designated output related to the room or environment. Figure 1 shows that chest position data was detected by a Kinect Camera, coded in Touchdesigner software, and then connected to moving-head lights. The chest data was chosen to detect human behavior and activities; sitting, standing, or lying down. The palm movement experiment shown in Figure 2 was chosen to detect their reaction toward the room temperature. If they feel hot, they will fan their hands because of the heat; if they feel cold, they will cross their arms over their chests to warm their bodies. The Kinect camera detects the palm movement, and the moving head lights will respond to the palm movement based on codes in Touchdesigner software. The Body Thermal Detection Experiment, shown in Figure 3, was conducted using data from a thermal camera and Touchdesigner software as a simulation to detect human body conditions and room temperature requirements. Chest position, palm movement, and body thermal data were also connected to digital

TABLE 1: Scenario of Workspace Design.

Human Behavior	AI Response	Workspace Conditions (can be set based on preference)
Hand fanning	Feels hot	Open natural ventilation/Air conditioner drops per 1 degree C until hand movement stops (max 19 degrees C*)
Arms crossed	Feel cold	Closed natural ventilation/Air conditioner off or rise per 1 degree C in front of chest until arms position changed (max 25 degrees C*)
Sitting	Working	Bright & neutral lighting adjustment (300-350 lux, 4000 K*)
Standing	Neutral	Neutral lighting adjustment (100-300 lux, 4000 K*)
Lying down	Resting	Dim & warm lighting adjustment, warm/mild temperature (<100 lux, 3000 K*)
Warm body thermal	Sick	Open natural ventilation/Air conditioner off
Normal body thermal	Healthy	Open natural ventilation/Air conditioner normal
Cold body thermal	Freezing	Closed natural ventilation/Air conditioner off or rises per 1 degree C until body temperature returns to normal (max 25 degrees C*)

*temperature (C/Celsius), lighting intensity (lux), and lighting color (K/Kelvin) on the table was the setting example based on the comfort standard data (10–13)

ventilation and temperature data in Touchdesigner software, as shown in Figure 4, as a simulation to adjust the natural ventilation mechanics and room temperature.

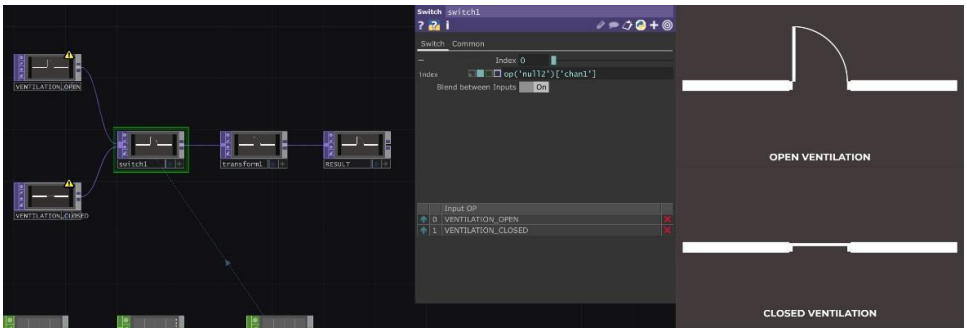

Figure 4: Digital Ventilation Experiment.

Based on the experimental results, the human chest position, palm movement, and body temperature data successfully adjusted the direction, intensity, and color of lights, room temperature data, and mechanics for digital ventilation. The scenario of workspace design that can generate the interaction between human behavior and spatial conditions is as follows.

The body tracking system also showed responsive and accurate data, so it can control energy efficiency and does not need manual control by humans, who tend to overlook or be biased toward unconscious necessities. Material applied in the room wall can also be used only one type of material with a neutral color to reduce cost because the room color can be set based on the lighting color. The tendency of differences in human preferences, habits, and needs can be answered using AI's body tracking method.

4. Conclusion

Based on the experimental results that collaborate and integrate art, design, and technology, a Kinect camera and touch designer software system can effectively detect human activity and behavior in space. So, the experiments supported the artificial sensing system in prior research Fields(7,8).

The body tracking system proved to have detailed, fast, and accurate capabilities, so it supported the statement that AI systems can learn personal necessities to improve the workspace environment and support various human behavior fields (9). Besides that, the body tracking system also shows responsiveness and accurate data to control energy efficiency. It supported the statement that "automation has been shown to save energy and lower operating costs" (9). This research also answered future studies about designing AI systems to generate sustainable and ideal workspaces that support workers' productivity, health, and well-being (9).

Further research that can be carried out is a design simulation for 1:1 scale testing in a workspace. Furthermore, the method also has the potential to be implemented on a larger scale. The method can detect more than one person in a workspace of several people since a Kinect camera can detect six people simultaneously (14). The body tracking system also has the potential to generate a sustainable health and well-being environment by fulfilling human comfort, controlling energy, and controlling material efficiency in the workspace. This research further aims to support the growth and sustainability of the economy and industry, including the creative industry, through human productivity.

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