

SYSTEM ON RENOVATION ACCEPTATION COMPRISES OF REACT

User Manual

Turinys

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1. Gathering multimodal data for personalised quality management in smart spaces with the REACT system

The REACT model base and model management system have been developed to integrate and control the system's components. The REACT system allows its users to set their starting preferences such as the indoor temperature, relative humidity, illuminance or the colour of light. The system has the option to control each parameter individually without making any changes to other parameters. The software can use a purpose-designed algorithm to adjust all parameters and try to ensure the occupant the best possible comfort, lower stress and higher productivity. Figure 1 shows the user interface of the REACT system.

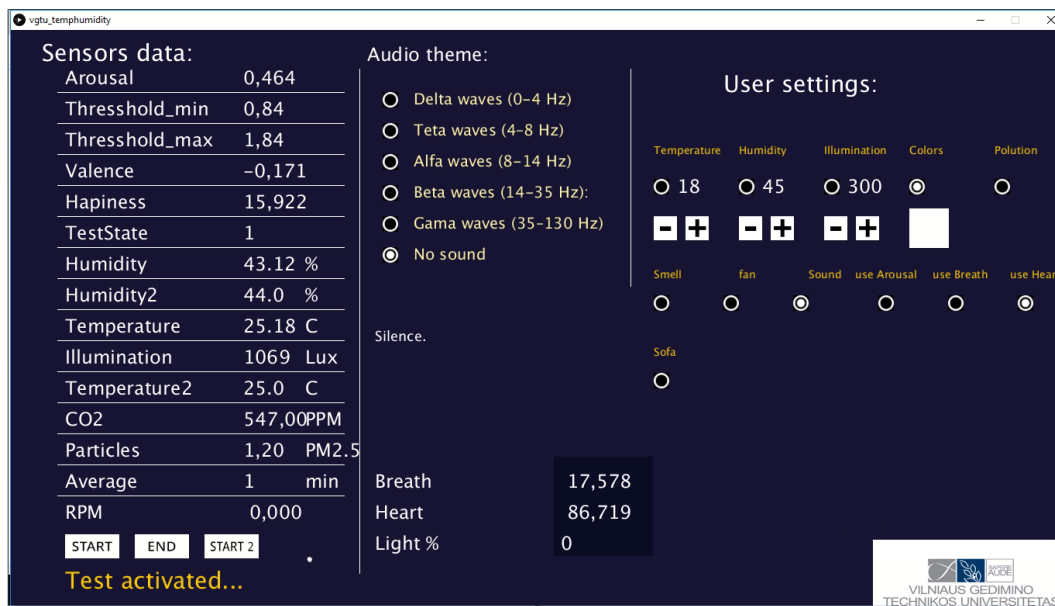


Fig. 1. The user interface of the REACT system

The window of this software has three sections: Sensors data (data from the measuring sensors), Audio theme (background music) and User settings (the user's preferences).

The system measures the following indoor parameters:

1. Arousal, Valence, and Happiness measured by a video camera and FaceReader, a specialised software designed to identify human emotional states.
2. Indoor Temperature and Humidity measured by Tongdy MSD-1828C/D, a calibrated unit designed to measure environment parameters. To ensure its reliability, the system also keeps track of Temperature2 and Humidity2. These two parameters are measured by SONOFF TH16, an additional controller with the temperature and humidity sensor SI7021.
3. Illumination
4. CO2
5. Particles. PM2.5
6. The respiratory rate Breath and the heart rate Heart measured by Batman BM201-VSD mmWave EVMm, a radar.

Users set their preferences themselves. They can choose their preferred starting Temperature, Humidity, Illumination, and the Colour of the background lighting in User settings. They can also choose either to control a single selected parameter or use a special algorithm to make the system control all available parameters.

The following is the list of all individual parameters users can choose (Fig. 2):

- Smell to control smells
- Fan to control the fan
- Sound to control background music
- Temperature to control temperature
- Humidity to control relative humidity
- Illumination to control lighting
- Color to control the colour of light
- Pollution to control the air purifier

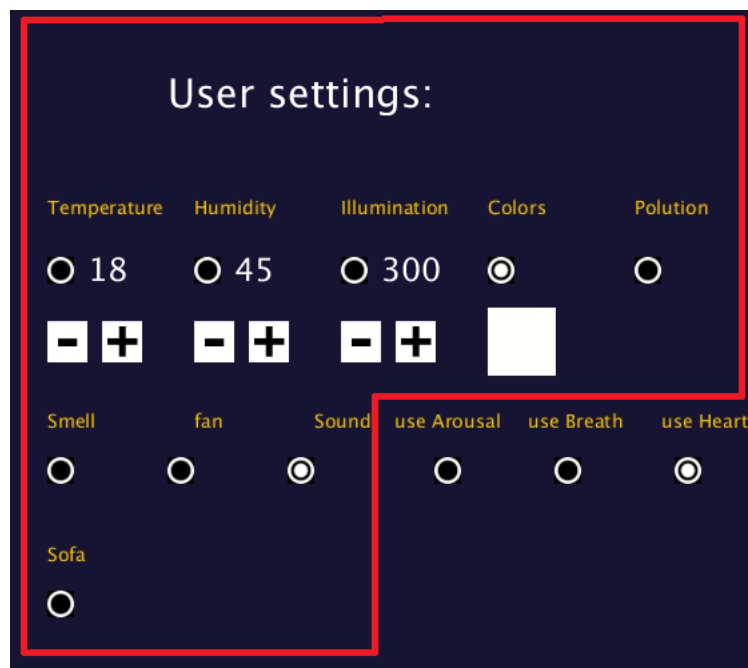


Fig. 2. The section to select starting preferences and individually controlled parameters

The first version of the control algorithm was built with Arousal at its basis: the system would observe a person's level of arousal and then change certain parameters based on the preset limits. Tests then had shown that FaceReader, a software package that can identify human emotions from facial expressions, sometimes fails to capture a person's emotional state. A slightly turned face was enough to render the system incapable of identifying the prevailing emotions and the level of arousal. A decision was, therefore, made to add to the indoor parameter control system a sensor for the additional remote monitoring of the respiratory rate and heart rate. Batman BM201-VSD mmWave EVM, a millimetric wave radar, was selected to serve that purpose.

This addition to the system allows users choose one of the following three parameters: use Arousal, use Breath or use Heart (Fig. 3).

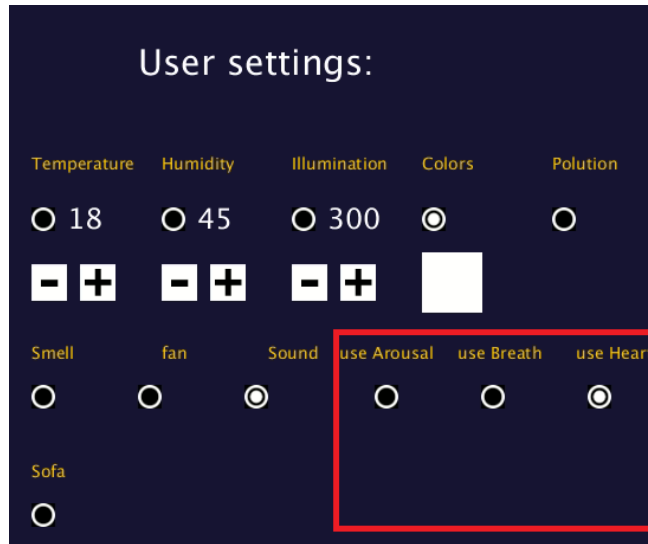


Fig. 3. The section to chose control parameters

Users can set their preferred range and the system will then control the indoor climate and environment within the limits of the minimum value `Threshhold_min` and maximum value `Threshhold_max` (Fig. 4). When all parameters are set, users can click Start 2 to start the system, which then will use the set algorithm and follow the set limits. If users prefer not to select individual parameters, they can click the Start button and the system will then use the default algorithm. The REACT system's algorithm is overviewed in Chapter 2.

Sensors data:	
Arousal	0,464
Threshhold_min	0,84
Threshhold_max	1,84
Valence	-0,171
Hapiness	15,922
TestState	1

Fig. 4. Setting the minimum and maximum range values

2. Algorithm for personalised quality control in smart spaces with the REACT system

The installed equipment of the REACT system is shown in Figure 5..



Fig. 5. The installed equipment of the REACT system

2.1. How to boost arousal, respiratory rate or heart rate

If they prefer, users can choose continuous monitoring of their real-time arousal (A_r), respiratory rate (F) and heart rate (P). Then the minimum, average and maximum levels of arousal, respiratory rate and heart rate of a specific user are determined every few days. When arousal ($A_r < A_{1/3}$), respiratory rate or heart rate is below average, the following parameters will be changed in smart indoor spaces to improve quality:

- The starting value of illumination is set at 500 lux (lx). Users can also present their preferred starting value of illumination. If the user's real-time arousal, respiratory rate or heart rate is below average ($A_r < A_{1/3}$), the illumination will then gradually be raised up to 1,000 lx or up to the maximum value set in the hygiene regulations. If arousal fails to reach the average level, the system will keep the user's preselected value of illumination and move to the next step.
- The indoor humidity will be either reduced or raised by 1%. To make arousal, respiratory rate and heart rate reach the average level, the indoor humidity will be first reduced down to the limit set in the hygiene regulations. If arousal fails to reach the average level, indoor humidity will then be raised up to the limit set in the hygiene regulations. If arousal still fails to reach the average level, the system will keep the user's preselected humidity and move to the next step.
- To make arousal, respiratory rate and heart rate reach the average level, the indoor temperature will be reduced by 0.5°C down to the limit set in the hygiene regulations. If arousal fails to reach the average level, the system will keep the user's present temperature and move to the next step.
- The system will play energising music (to stimulate the sympathetic nervous system) with specific musical features such as major scales (to increase blood pressure), dissonance, accents (to make pupils dilate), strong beat, emphasised pulse, abrupt changes in melody, staccato.

- The system will emit stimulating scents (to stimulate the sympathetic nervous system) such as grapefruit, jasmine, ylang-ylang and others. If arousal fails to increase, the system will turn on the Arousal Management Recommender Subsystem.
- All steps will be repeated until arousal, respiratory rate or heart rate will reach the average level.

2.2 How to bring arousal, respiratory rate or heart rate down

When arousal, respiratory rate or heart rate is above average, the system will make the following adjustments in indoor smart spaces to improve quality taking into account the user's preferences:

- The level of pollution (particulate matter, aerosols, CO, CO₂, NO_x, NO, NO₂, etc.) will be gradually reduced in steps of 10 mg/m³. If, when the system reduces pollution to the user's present level, arousal fails to drop to the average level, the system will keep the user's present pollution level and move to the next step.
- The starting value of illumination is set at 500 lux (lx). If the user's real-time arousal, respiratory rate or heart rate is above the set limits, the illumination will be gradually reduced down to 200 lx or to the minimum limit set in the hygiene regulations. If arousal fails to drop to the average level, the system will keep the user's present illumination and move to the next step.
- The indoor humidity will be either reduced or raised by 1%. To make arousal drop to the average level, the indoor humidity will be first reduced down to the limit set in the hygiene regulations. If arousal fails to drop to the average level, indoor humidity will then be raised up to the limit set in the hygiene regulations. If arousal fails to drop to the average level, the system will keep the user's present humidity and move to the next step.
- To make arousal drop to the average level, the indoor temperature will be raised by 0.5°C up to the limit set in the hygiene regulations. If arousal fails to drop to the average level, the system will keep the user's present temperature and move to the next step.
- The system will play soothing music (to stimulate the parasympathetic nervous system) with specific musical features such as minor scales (to decrease blood pressure), low volume with soft sound (to slow down respiratory rate and heart rate), soft rhythm (to make pupils contract), flowing melody. If music fails to bring arousal down to the average level, the system will turn on the Arousal Management Recommender Subsystem.
- The system will emit soothing scents (to stimulate the sympathetic nervous system) such as lavender, camomile, lemon and others. If arousal fails to drop, the system will turn on the Arousal Management Recommender Subsystem.
- All steps will be repeated until arousal, respiratory rate or heart rate will drop to the average level.