Emoti-Office, Using Emotional and Contextual Data to Improve Employees' Working Needs in the Office

Rutger Verstegen(✉) and Regina Bernhaupt

Eindhoven University of Technology, Het Eeuwsel 53, 5612 AZ Eindhoven, Netherlands
r.verstegen@student.tue.nl, r.bernhaupt@tue.nl

Abstract. In a world of connected smart devices where data is easily available, there is an opportunity to enhance existing technology to better adapt towards office workers' needs. In this work, we explore the idea of how emotion can be one of many data points to be taken into account in a room planning calendar environment. We present Emoti-Office, a system that (1) collects emotional and contextual data in an office setting, (2) considers how to use this data and (3) how to link emotions with the desired output of a room suggestion or work environment to be reserved and used. Emoti-Office contributes to the field of office working research and development by proposing a context-aware and adaptive design which uses emotions to improve office workers' environment by adapting to their needs.

Keywords: Office · Emotions · Workers · Needs

1 Introduction

One of the key aspects when it comes to the productivity of people in an office environment is the emotional state. With current technological advancements, measuring data and controlling elements of office environments already gives many opportunities, on how to support people in the office environment. Nevertheless, the domain still seems underexplored when it comes to how emotions can be taken as data input for certain types of decisions and recommendations in office software and systems.

With the Internet of Things (IoT), everyday objects can have networked interconnections, allowing for communication with other devices or humans [1]. However, using these data and technologies to improve office settings is not a trivial task. It requires understanding what the user(s) needs and their desires are, in a wide range of situations where locations, participants, emotions and other variables might differ. The research question that this paper focuses on, is

Published by Springer Nature Switzerland AG 2022
R. Bernhaupt et al. (Eds.): HCSE 2022, LNCS 13482, pp. 191–200, 2022.
https://doi.org/10.1007/978-3-031-14785-2_13

the following: "How can emotional- and contextual data be gathered and used with existing technology to adapt office environments to support employees' working needs?". This paper explores this design space and proposes a design concept called Emoti-Office.

Emoti-Office uses self-reported emotional state and calendar data as input. With this data, office situations can adapt accordingly for both individuals and groups of employees. This design is relevant because it researches the usage of existing IoT hardware with emotional input. In a workplace setting, this could allow for better adaptation of the workplace towards users' needs. Differentiating on workplace design has been identified as one of the three major factors that could improve the performance of knowledge workers [6].

The contribution of this work lays in the field of smart industry, exploring emotion as a possible element and proposing an initial design for such a system.

2 Related Work

Computers might benefit from knowing the situation of a user during interaction to adapt the environment more accurately to the user's needs [11]. More specifically, emotions have vital roles in background processes (such as decision-making, perception and creativity), and some subsets of emotions could improve systems [26]. Traditional inputs for computer interaction ignore the implicit emotional indicators, which is why they do not provide human-like natural interactions [29]. Expanding the area of Human-Computer Interaction with the inclusion of emotional communication and handling of the data is called Affective computing [24]. The literature there is vast and goes beyond this contribution to be detailed.

A key fact is that emotions and mental state can influence productivity. Previous studies show that happiness of employees is positively related to employee productiveness [3,15,23]. On the other hand, negative emotions are positively associated with counter-productive work behavior [2]. Emotions can change our attitude towards our current and next actions [25]. Emoti-Office measures emotions to better understand users, their needs and to let the workplace adapt to these needs.

For categorizing human emotions, there are two conventional methods: the discrete basic emotion description and the dimension approaches [18]. With the basic emotion description, are set numbers of basic emotions, such as research by Izard, which found 12 basic emotions [12] and more recently Jack et al. who argue for four basic emotions [13]. With the dimension approach, several dimensions organize emotional responses. Most often valence, arousal and approach-avoidance (urge towards or away from something) are used [20].

Understanding what people's emotions are, can be done by deriving these emotions from the body or by asking participants to self-report. Deriving emotions can be done using facial video and audio [21], heart rate variability [27], blood volume pressure [16] and head movements [29]. For self-reporting emotions, a wide range of designs have been already proposed in research, with a 2016 meta-review analyzing 40 interfaces from the past 11 years [9].

Bernhaupt et al. [4] have been doing seminal work in the early 2000s on how emotions can be integrated in a work environment, asking users to improve their emotion by smiling to control a game. While such a behavior change might not always be welcomed by users, a more neutral way to allow to self-identify emotions to influence for example room booking selection seems appropriate.

For understanding emotions in the office, some work already exists. For instance, the Mood Squeezer which allowed employees to set emotions to allow for discussion on emotion [10]. Next to that a system has been proposed to detect emotions using sensors and then regulate negative emotions in an office to improve productivity [22].

Both in scholarly writings and in everyday language, the words mood and emotion are often used interchangeably [7]. However, there are slight differences between mood and emotion, which will be described in the table below.

Table 1. Comparing Emotion and Mood on different properties [7].

	Emotion	Mood
Relative duration	Short	Long
Intensity	High	Low
Antedencents	Identifiable antecedents	Gradual onset with cumulative antecedents
Directed to	Particular object	World as a whole
Feeling	Specific feeling states	Diffused feeling states
Impact	Behaviours and thoughts	Global, pervasive influence on perception and motivation

As Table 1 shows, the focus of Emoti-Office lies on mood in office spaces and how this differs slightly from emotions. However, because both definitions often are used interchangeably and both concepts are this closely related, this paper will still refer to emotions as a key term.

3 Design Process

With a focus on using emotions in office situations, possibilities and design needs were explored together with potential users. The focused user group is office workers ranging from 18–40 years old. For this reason, the exploration sessions with users were held in real office situations to provide context. This research was conducted with approval from the ERB board of the Eindhoven University of Technology, Industrial Design.

3.1 Exploration Sessions

To gain a deeper understanding and get additional perspectives, participants were invited for design ideation sessions [14]. These were structured sessions for co-constructing stories [5] of what the solution could behave like, set in a focus group format. Following this methodology [5], participants were first introduced into the topic and asked for current experiences (sensitization phase). After this phase, the concept was introduced and participants were asked to write ideal scenarios where emotions were used in an office context (envisioning phase). From here, dialogue with the researcher and the participants in a focus group setup was had on these concepts to come to rich stories, design suggestions etc. with the group. After a pilot test, the choice was made for sessions with two participants to allow for more time per participant for in-depth explanations.

From two sessions with participants, the following results were generated during the discussion of the stimulation phase. Currently participants from both groups confirmed that (open) spaces were not good locations to allow office workers to work focused. Next to that, it was found that open office setups do not allow for having extreme emotions. For instance, participants indicated that feeling sad or happy could not be openly expressed in such a setting.

From discussing the envisioning phase, several key points for designs were generated. Firstly, participants stated that the design should help people process how they feel and support them in their working activities, instead of trying to change their emotions. From here, the idea arises from participants to focus on routines that people having in their working days, which could be combined with the idea of using Outlook calendars. Next to that, participants felt that the system should be transparent on how your data is used to generate results and that they would like control over the final decision.

4 Design: Emoti-Office

To understand the working needs of employees in different situations using existing technology, there are many variables that change an employee's desired response. To give a basis for understanding needs, Emoti-Office uses contextual and emotional data. Below, the functioning of the design will be explained in different sections.

4.1 Emotions

As discussed in the related work, various models on emotions have been proposed. This research uses the emotional model from Ekman [8] which has six basic emotions. This model was chosen over other work for its large testing in other fields. Next to the selection of an emotion, intensity of this emotion can also be selected.

To gather the emotion and intensity from employees, self-reporting was chosen as the preferred methodology. This is motivated from an ethical standpoint

for two reasons. Firstly, the user of the system is aware that the emotion is being input and thus has more control over this personal data. Secondly, from a larger societal perspective humans can express their emotions differently based on culture [19]. The usage of self-reporting also can have the benefits of being portable, less intrusive, simple to implement and more accurate [9].

4.2 Context

Dependent on the situation of the employee, different needs might arrive. For instance, at your desk you have different needs compared to sitting in a meeting room or joining for a digital meeting. To understand the context, a company agenda solution such as Outlook could be used. Using the Outlook calendar event functions[1] data such as meeting location, participant amount etc. can be retrieved. For managing resources such as meeting rooms, desks or company equipment, communication with outlook can also be used. Here, room groups with labels could be introduced such as 'silence desks', 'talking desks' and 'meeting rooms'. These labels could differ per company and it's needs. This way, different room types for different activities could be booked using existing software infrastructure. By communicating with existing technology, adoption threshold of this new system is very low, because of low changes that need to be made in infrastructure, education and employee time investment.

4.3 Application Design

To combine the elements of self-reporting data, importing context and translating these into adaptations, an application can be used. This allows for entering of emotions regardless of an employee being close to a computer. From exploration sessions, users' preference towards a personalized and transparently functioning system were made clear. To do achieve this, users can set personal 'Routines' that are based on rules from variables. For instance, employees who like to sit at a certain desk on Mondays, or who want to sit in a 'quiet space' when answering emails. Whilst certain routines can most likely be applied for multiple people, many routines will be inherently personal and could depend on professional needs and an employee. Processing and storage of emotional and routine data, could be done locally to give employees more safety and security over their data, and to lower chances of employers viewing or deriving emotional data. A visualisation of data flow

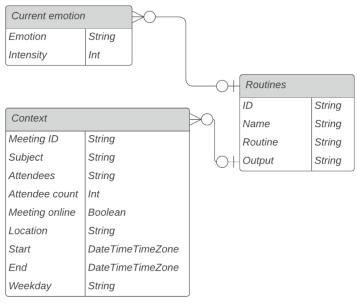

Fig. 1. Entity Relationship Diagram showing how rules and context determine routine activation.

[1] Microsoft documentation, last accessed 28-05-2022: https://docs.microsoft.com/en-us/graph/api/resources/event?view=graph-rest-1.0.

for this system is presented using an Entity Relationship Diagram which can be seen in Fig. 1.

Employees could set these routines up in the application. When the system creates a suggestion, it will show the respective suggestion for each routine. Users can then accept or deny these suggestions. Denying gives the options of allowing for one-time deviations, changing the routine outcome or making the routine more specific. This way, users are aware of how data is used, and have full influence over the system.

The application interface can be seen below in Fig. 2. A so-called 'Digital Twin' asks for current emotion, and duplicates the user's emotion in the application. Sketches for different emotions were designed specifically for this prototype for copyright reasons, but a platform such as Bitmoji[2] might be integrated to show customized digital twins.

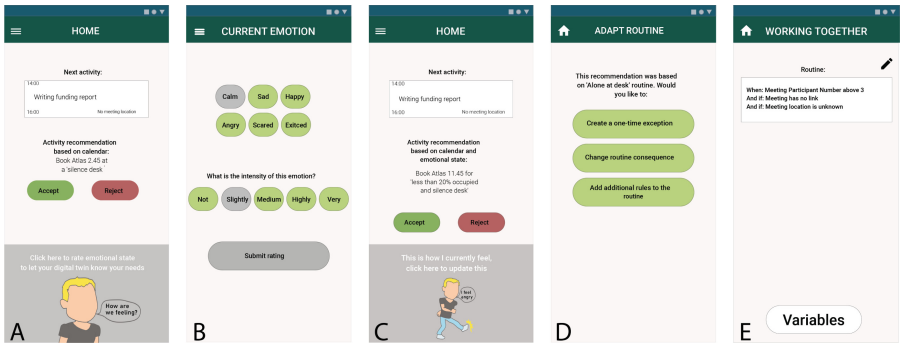

Fig. 2. Application screens for: A) Home screen with suggestion based on context B) Rating emotional state C) Digital Twin reflecting current emotion and improved suggestion D) Options when rejecting routine outcome E) Routine setting screen.

5 Evaluation

To evaluate the initial design, an remote online evaluation was performed by 46 participants (all above 18 years, 25 male, 18 female, 2 prefer not to say, 1 non-binary). Participants had experience in office situations. Online scenario testing was done for its feasibility and ability to test with a large and diverse group of participants.

Three scenarios with the designed system were created, which can be seen in Fig. 3. Each scenario showed a different element of the system: (A) changing an existing routine (B) using Outlook meetings to give spatial advice for working locations and (C) measuring emotion and executing a linked routine.

[2] Bitmoji platform, last accessed 28-05-2022: https://www.bitmoji.com/.

Scenario order was randomized to avoid sequencing effects. After each scenario, the After Scenario Questionnaire [17] was used to understand perceived task difficulty. After completing the three scenarios, the questionnaire combination by [28] was used to measure technology and personalization quality, empathy and behavioural intention for their fit with accessing the relevant features of the design. Here, the word 'products' was changed to 'space changes' in questions 4 and 11 to fit the research probe. Then, self-formulated questions were added to rate perceived influence on working needs, supporting emotions, and comparing situations with and without this system. Lastly, participants were asked to indicate whether they would use this system, and for reasoning on this choice.

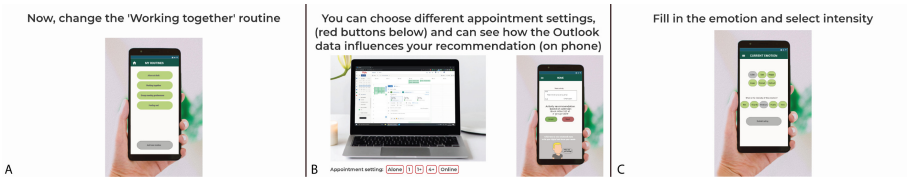

Fig. 3. Screen captures from the three digital scenarios: A) Changing a routine B) Interaction between Outlook and system C) Rating emotional state. Images (before editing) retrieved from Pexels

5.1 Outcomes

Per scenario, after Scenario Questionnaire ratings and average rating per scenario were analyzed. Comparing the average values per scenario, no problems with perceived task difficulty were found (Scenario A: 5.14 avg, Scenario B: 5.14 avg, Scenario C: 5.34 avg).

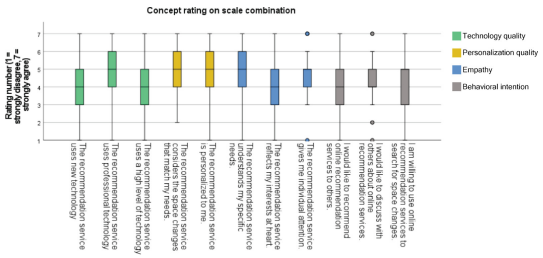

Fig. 4. Boxplots of ratings, color sorted on question category

Ratings on the combination scales [28] can be seen in Fig. 4. Averages were all in the mid-range of the 7 point scale and showed overall rather positive appreciation for the statements.

The final questions on the influence of this design on the working environment, support of needs in current work environment and the preference towards using this system were also analysed. The influence of the system leans towards positive in terms of supporting needs and giving space for emotions. Making negative −1, neutral 0 and positive 1, gives support in working needs an average of 0.43 and space for emotions an average of 0.36. Most respondents (65.2%)

indicate how working needs are already supported in their current working environment. 63% states to prefer having this design in their working environment. The evaluation thus shows no major usability problems and indicate that the proposed design is welcome by users.

6 Conclusion and Future Work

Emotions can be an important aspect in a work environment. Emoti-Office explores the possibility to integrate emotions in a calendar planning system and was perceived as a welcome addition.

First findings show how this system is perceived to improve working needs and space for emotions in the office on average. As future work, next to the contextual elements from Outlook, other data sets (such as weather) and sensors (such as personal smart devices, connected cars) could potentially be investigated as data input for such scenarios. Next to that, the addition of more prominently introducing emotions into the office could have (unforeseen) consequences, and thus deserves further research.

Next to that, further development and more implemented testing should be done. A possible limitation is the self-reporting of emotions. On the one side, users might not be truthful about them [9], however, as long as the emotional input is enhancing the system, we argue for using emotions to improve the user experience.

Emoti-Office contributes to the field of smart offices with design space exploration, a design, validation and future work recommendations. This work has significance in how it could yield existing technologies to further improve the needs of office workers.

Acknowledgement. The authors of this paper want to thank all participants of the evaluation study for contributing to this research and would like to thank Bas Goossen and Günter Wallner for their input.

References

1. Ashton, K., et al.: That 'Internet of Things' thing. RFID J. **22**(7), 97–114 (2009)
2. Bauer, J.A., Spector, P.E.: Discrete negative emotions and counterproductive work behavior. Hum. Perform. **28**(4), 307–331 (2015)
3. Bellet, C., De Neve, J.E., Ward, G.: Does employee happiness have an impact on productivity? Saïd Bus. Sch. WP **13** (2019)
4. Bernhaupt, R., Boldt, A., Mirlacher, T., Wilfinger, D., Tscheligi, M.: Using emotion in games: emotional flowers. In: Proceedings of the International Conference on Advances in Computer Entertainment Technology, ACE 2007, pp. 41–48. Association for Computing Machinery, New York (2007). https://doi.org/10.1145/1255047.1255056
5. Buskermolen, D.O., Terken, J.: Co-constructing stories: a participatory design technique to elicit in-depth user feedback and suggestions about design concepts. In: Proceedings of the 12th Participatory Design Conference: Exploratory Papers, Workshop Descriptions, Industry Cases-Volume 2, pp. 33–36 (2012)

6. Davenport, T.H., Thomas, R.J., Cantrell, S.: The mysterious art and science of knowledge-worker performance. MIT Sloan Manag. Rev. **44**(1), 23 (2002)
7. Desmet, P.M., Vastenburg, M.H., Romero, N.: Mood measurement with Pick-A-Mood: review of current methods and design of a pictorial self-report scale. J. Des. Res. **14**(3), 241–279 (2016)
8. Ekman, P.: An argument for basic emotions. Cogn. Emot. **6**(3–4), 169–200 (1992). https://doi.org/10.1080/02699939208411068
9. Fuentes, C., Herskovic, V., Rodríguez, I., Gerea, C., Marques, M., Rossel, P.O.: A systematic literature review about technologies for self-reporting emotional information. J. Ambient. Intell. Humaniz. Comput. **8**(4), 593–606 (2016). https://doi.org/10.1007/s12652-016-0430-z
10. Gallacher, S., et al.: Mood squeezer: lightening up the workplace through playful and lightweight interactions. In: Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing, pp. 891–902 (2015)
11. Gross, T.: Towards a new human-centred computing methodology for cooperative ambient intelligence. J. Ambient. Intell. Humaniz. Comput. **1**(1), 31–42 (2010)
12. Izard, C.E., Libero, D.Z., Putnam, P., Haynes, O.M.: Stability of emotion experiences and their relations to traits of personality. J. Pers. Soc. Psychol. **64**(5), 847 (1993)
13. Jack, R.E., Garrod, O.G., Schyns, P.G.: Dynamic facial expressions of emotion transmit an evolving hierarchy of signals over time. Curr. Biol. **24**(2), 187–192 (2014)
14. Jonson, B.: Design ideation: the conceptual sketch in the digital age. Des. Stud. **26**(6), 613–624 (2005)
15. Kadoya, Y., Khan, M.S.R., Watanapongvanich, S., Binnagan, P.: Emotional status and productivity: evidence from the special economic zone in LaoS. Sustainability **12**(4), 1544 (2020)
16. Khezri, M., Firoozabadi, M., Sharafat, A.R.: Reliable emotion recognition system based on dynamic adaptive fusion of forehead biopotentials and physiological signals. Comput. Methods Programs Biomed. **122**(2), 149–164 (2015)
17. Lewis, J.R.: Psychometric evaluation of an after-scenario questionnaire for computer usability studies: the ASQ. SIGCHI Bull. **23**(1), 78–81 (1991). https://doi.org/10.1145/122672.122692
18. Liu, J., et al.: EEG-based emotion classification using a deep neural network and sparse autoencoder. Front. Syst. Neurosci. **14**, 43 (2020)
19. Marsh, A.A., Elfenbein, H.A., Ambady, N.: Nonverbal "accents": cultural differences in facial expressions of emotion. Psycholog. Sci. **14**(4), 373–376 (2003)
20. Mauss, I.B., Robinson, M.D.: Measures of emotion: a review. Cogn. Emot. **23**(2), 209–237 (2009)
21. Mower, E., Matarić, M.J., Narayanan, S.: A framework for automatic human emotion classification using emotion profiles. IEEE Trans. Audio Speech Lang. Process. **19**(5), 1057–1070 (2010)
22. Munoz, S., Araque, O., Sánchez-Rada, J.F., Iglesias, C.A.: An emotion aware task automation architecture based on semantic technologies for smart offices. Sensors **18**(5), 1499 (2018)
23. Oswald, A.J., Proto, E., Sgroi, D.: Happiness and productivity. J. Law Econ. **33**(4), 789–822 (2015)
24. Picard, R.W.: Affective computing for HCI. In: HCI (1), pp. 829–833. Citeseer (1999)
25. Picard, R.W.: Affective Computing. MIT Press, Cambridge (2000)

26. Picard, R.W.: Affective computing: challenges. Int. J. Hum. Comput. Stud. **59**(1–2), 55–64 (2003)
27. Quintana, D.S., Guastella, A.J., Outhred, T., Hickie, I.B., Kemp, A.H.: Heart rate variability is associated with emotion recognition: direct evidence for a relationship between the autonomic nervous system and social cognition. Int. J. Psychophysiol. **86**(2), 168–172 (2012)
28. Yoon, N., Lee, H.K.: AI recommendation service acceptance: assessing the effects of perceived empathy and need for cognition. J. Theor. Appl. Electron. Commer. Res. **16**(5), 1912–1928 (2021)
29. Zhao, Y., Wang, X., Goubran, M., Whalen, T., Petriu, E.M.: Human emotion and cognition recognition from body language of the head using soft computing techniques. J. Ambient. Intell. Humaniz. Comput. **4**(1), 121–140 (2013)