APPLICATION OF COMPUTER VISION IN THE PREVENTION OF TEACHER BURNOUT

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Abstract. *Burnout syndrome, characterized by intellectual, emotional, and physiological exhaustion, poses a significant challenge, especially within the realm of education, where the effectiveness of the entire educational system hinges on the well-being of educators. This academic article suggests a preventative strategy for teacher burnout, employing computer vision and AI machine learning algorithms integrated into a cyber-physical and socially oriented educational platform.*

Key Words: Computer vision, Cyber-physical social system, Burnout.

Introduction

Burnout syndrome, characterized by intellectual, emotional, and physiological exhaustion, manifests as a multifaceted challenge affecting individuals both professionally and personally, resulting in negative repercussions in relationships and interactions with the broader world, as well as within work and personal environments [1]. Recognizing initial symptoms and proactively addressing them is crucial for the overall mental and physical well-being of individuals. Early detection is increasingly vital in preventing the onset of this state. This article emphasizes the application of computer vision algorithms [2] as a proactive measure in averting teacher burnout, offering tools and data analysis to enhance the scholastic environment and provide support to educators. The analysis encompasses various facets of teachers' responsibilities, encompassing aspects such as:

- Observing teachers' emotional states during classes involves the analysis of sensor data obtained from cameras designed to measure their emotional expressions.
- Evaluating emotional signals entails employing algorithms to identify emotions in teachers' facial expressions and voice characteristics.

- Examining teachers' gestures and behavior within the classroom aims to identify indications of tension or physical fatigue.

By employing suitable AI methodologies on the gathered data, teachers receive feedback on their emotional state, accompanied by advice for managing stress and tension. Consequently, this facilitates an analysis of teachers' workdays, leading to a proposal for a more balanced distribution of time among class work, school tasks, and teachers' self-training. It is imperative to underscore that the entire process involved in preventing burnout among teachers necessitates strict adherence to ethical and legal standards for safeguarding personal data, while also considering the interests and preferences of teachers.

The article will explore various approaches to implementing computer vision and AI processes for monitoring and preventing teacher burnout within a cyber-physical educational school platform. Motivation and approaches

Motivation and approaches

"Burnout" syndrome represents a state of professional exhaustion that has become increasingly prevalent across various sectors and professions in recent years, including but not limited to teachers, doctors, technology sector employees, administrators, journalists, and researchers. The primary challenges associated with burnout can be succinctly summarized in two key directions:

- In personal life, burnout syndrome manifests in the alteration of one's perception of the world and interactions with both the environment and close relationships.

- In professional life, burnout syndrome is characterized by a diminished sense of commitment, reduced productivity, and lower levels of proactivity and autonomy.

Proactively addressing the syndrome offers added value and brings about positive outcomes by:

- Fostering a proactive approach against the syndrome contributes to cultivating a positive attitude towards the surrounding environment.

- Engaging in proactive measures against the syndrome enhances the working capacity and adequacy of the individual.

- Proactive efforts against the syndrome result in an increased level of concentration and a heightened desire to perform, among other positive outcomes.

As a result of addressing the "BURNOUT" syndrome, the psychological and physiological factors of the individual are normalized, preserving both their personal and professional fulfillment.

This syndrome poses a particular challenge for educational institutions, especially for school headmasters. Teachers experience daily stress and tension in their interactions with students, parents, colleagues, and in fulfilling administrative duties [3]. Recognizing and preventing the syndrome early on, and promptly addressing it, are crucial for both teachers and school headmasters. However, the scarcity of adequately skilled psychologists in schools complicates this task. This circumstance motivates the exploration of an alternative approach to the problem, involving the application of computer vision and appropriate machine learning algorithms within a cyber-physical and social educational platform.

Modern AI technologies, when implemented in authentic training and work environments, offer the potential to surpass current levels of results compared to traditional methods. The utilization of cyber-physical and social multi-agent platforms enables:

- Personal monitoring of each lecturer/employee is facilitated through the use of cyber-physical and social multi-agent platforms.
- A personalized approach for proactive interaction is established between the cyber-physical platform and each specific individual, ensuring tailored engagement.
- Preserving the life and professional value of an individual involves employing an individualized approach tailored to the specific phase of their condition. This approach is informed by historical data and dynamically gathered information.
- Offering personalized analysis relies on historical data, machine learning (ML) [4], artificial intelligence (AI) [5], databases, and analytical tools for a comprehensive understanding of an individual's circumstances.
- Supplying preventive approaches and services to proactively ad-

dress the problem is an integral part of the strategy.

Burnout syndrome prevention approach in cyber-physical educational platform

Cyber-physical and social systems CPSS provide convergence between the physical and virtual worlds, where the social factor is of particular importance [6]. Virtual Physical Space ViPS [7] is a reference CPSS-architecture that can be adapted to different application fields, including for education [8]. The provision of appropriate services for users requires interaction between intelligent components of different nature (physical, virtual). This process can be implemented through several basic steps. The first step in developing customer services in CPSS is the virtualization of objects from the physical world in which people de facto live. The second step is representing all participants in these services – people, digital devices, IoT, software components and systems in a unified way. There are various formal systems by which to model these services. Ambient-oriented modelling [8] makes it possible to virtualize physical objects. In addition, through this formalism, all interacting objects can be represented in a unified way, regardless of their nature.

Using the characteristics and capabilities of cyber-physical social systems (CPSS), we formulated the idea of creating a Burnout Prevention System (BPS). The system relies on computer vision algorithms and sensors for meticulous analysis and interpretation of human actions, facial expressions and body language. Its overarching purpose is to discern signs of stress, exhaustion, or other indicators of burnout in users in a given environment. It also proposes proactive measures to prevent burnout, as well as promote the development of a healthier and more sustainable physical environment.

The key features of BPS are presented in the following Table 1.

Table 1. BPS key characteristics

Key Characteristics	Description
Network of cameras	– Strategically placed in the environment, cameras capture visual data from different angles to provide comprehensive coverage. – High resolution cameras equipped with low light capabilities for accurate monitoring in various lighting conditions.

Facial recognition technology	– Use facial recognition algorithms to identify faces and track changes in facial expressions. – Observe for signs of fatigue, stress or emotional distress through facial cues.
Positioning and Movement Analysis	– Include computer vision algorithms to analyze body positioning and movements. – Detect signs of fatigue or discomfort, such as slouching, slow movements, or repetitive patterns of interaction with CPSS
Activity recognition	– Track user activities to identify work patterns, breaks and rest periods. – Recognize long periods of continuous work or lack of breaks that can contribute to burnout.
Integration of physiological sensors	– Optionally integrate wearables or sensors to monitor physiological parameters such as heart rate and skin conductance. – Provide additional data for a more holistic understanding of an individual's well-being.
Machine learning models	– Use appropriate machine learning models to analyze collected data and establish baseline behaviors for each individual. – Personal models that adapt over time to analyze individual differences in behavior.
User feedback interface	– Provide feedback to users about their behavior, stress levels and recommended self-care interventions through their personal assistant (PA). – Encourage users to take breaks, engage in stress-reducing activities, or seek support when needed.

Simple scenario in BPS

The modelling of the BPS system requires development of baseline scenarios. Let's consider the following example scenario: BPS recognizes signs of stress, fatigue and anxiety in the behavior of one of the teachers. In a timely manner, the system takes prevention actions such as:

- Through facial recognition technology, the system has identified changes in the teacher's facial expressions compared to available data. Facial expressions have shifted to signs of fatigue and stress.
- Continuous monitoring of the teacher's posture and movements reveals prolonged periods of sitting and writing, suggesting a lack of breaks and potential overwork.
- The system has noticed a diviation from its usual patterns of work

and rest, with fewer breaks and longer periods of continuous operation.

- Additional wearable devices integrated with the system have shown an increase in heart rate and an increase in skin conductivity during working hours.
- Machine learning models trained on the tutor's underlying behavior have found a significant deviation from their norm, indicating an increased risk of burnout.
- BPS generates a warning indicating the potential risk of burnout for the tutor. Simultaneously, his personal assistant (PA) receives the signal.
- PA sends a personalized notice to gently warn him of the detected signs of burnout, expressing concern for his well-being.
- PA provides a comprehensive feedback interface on the tutor's digital device, visualizing appropriately the available historical information, his recent behavior, stress levels, and the potential risk of burnout. It suggests taking regular breaks, engaging in stress-relieving activities, and seeking support from relevant mental health professionals.
- The system (with the agreement of the tutor) notifies the headmasters of the situation, including a summary of changes in behavior and recommendations for support.
- BPS and PA continue to monitor the behavior of the tutor, adjusting their analysis based on the results of the actions taken. This ongoing monitoring ensures that the support measures are effective and allows for further adjustments if necessary.

The proposed scenario includes interaction between the teacher's personal assistant, the repository with the historical information about the specific user's behavior, the machine learning and analysis component, as well as the system of physical devices (IoT) located in the physical space of the school building. The specificity of the task under consideration requires the extension of the adapted ViPS architecture of the CPSS educational platform with appropriate additional modules and components. For the preliminary modelling of the baseline scenarios in the system, it is appropriate to use ambient-oriented modelling to test and verify the interactions between the presented components.

Conclusion

The dynamic interaction between the Burnout component and the personal assistant (PA) in a multiagent CPSS platform represents preventive handling of "burnout" among educators. Using computer vision and machine learning, the system can detect subtle signs of stress. This integrated approach will not only provide prevention from burnout but could also create an opportunity to promote a supportive and attentive environment.

Notwithstanding the undoubted advantages of the modelled BPS system, there are also many problems and limitations. The use of computer vision for burnout prevention of teachers can be useful, but there are also potential problems that need to be taken into account such as: loss of personal contact with colleagues; potential dependence on IT technologies and additional stress and load in their use; protection of personal data, confidentiality and storage of personal space and much more. There is a need to ensure that technology is used only with the consent of the users and in the context of the overall strategy for maintaining teachers' good health and effectiveness.

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