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AI4Work Project: Human-Centric Digital Twin Approaches to Trustworthy AI and Robotics for Improved Working Conditions in Healthcare and Education Sectors

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Abstract. AI and robotics aim to transform workplace landscapes in a several sectors such as manufacturing, logistics, healthcare, construction, agriculture, and education. Central to this evolution is the innovative use of Digital Twin technology, which creates real-time updated virtual replicas of physical systems and entities. This technology is especially transformative in healthcare and education, promising customized and efficient experiences for all involved. This paper outlines the AI4Work project's approach to leveraging Digital Twin Technology to improve work environments in these sectors. The goal of AI4Work is to formulate a workplace where AI and robots seamlessly collaborate with humans, while explores how to best share tasks between humans and machines in six different domains. For healthcare, AI4Work will explore how Digital Twin technology can assist occupational doctors and psychologists in monitoring the physical and mental health of hospital personnel in order to predict burnout symptoms and to create a sustainable working environment. In education, AI4Work will investigate how to uphold the mental health of both educators and students while fostering a more supportive and enduring educational setting.

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1. Introduction

AI and robotics hold the potential to revolutionize work environments across various sectors, including industry, logistics, healthcare, construction, agriculture, and education. These technologies offer assistance to human workers in a broad range of activities, from physically demanding and monotonous tasks to intricate decision-making. Specifically, the Digital Twin technology creates virtual replicas of real-world systems, constantly updated with real-time data. This powerful tool holds immense potential in healthcare and education. In healthcare, digital twins can represent individual patients or entire healthcare systems. Patient twins, fed with medical records, sensor data, and AI analysis, can predict disease risks, optimize treatment plans, and personalize medicine [1]. Additionally, digital twins of hospitals can simulate patient flow, resource allocation, and even test the impact of new equipment before implementation [2]. Education can also benefit from digital twins. Virtual classrooms can be created, allowing for personalized learning experiences and remote access. Teacher twins, powered by AI, can analyze student data and tailor instruction to individual needs. Furthermore, digital twins of educational institutions can optimize resource allocation and predict student outcomes [3].

The AI4Work project aspires to enhance the synergy and communication among humans, AI, and robots, with the aim of fostering better work conditions in numerous organizational processes. This involves elevating work efficiency, alleviating employee stress, and bolstering confidence in making decisions. AI4Work is dedicated to exploring effective strategies and tools for optimally dividing tasks between humans and AI/robots, given the prevalent uncertainties in modern workplaces such as industries, healthcare, and educational institutions [4,5]. Achieving a balanced integration of human and robotic capabilities, particularly in decision-making, is crucial [6,7]. The concept of Sliding Work Sharing (SWS) [8], which adjusts the division of labor between humans and machines based on contextual needs, machine confidence levels, and human interaction, is proposed as a fitting approach for contemporary organizations. A significant hurdle in AI-enhanced work environments is ensuring machines and humans can accurately interpret the context of their tasks, aiding in a better comprehension of AI-provided support, recommendations, or decisions [8]. Given the fast-paced and flexible nature of modern work settings, it's vital to continuously recognize and adapt to the changing context, tailoring AI and robotic support accordingly. This not only aids in making more informed decisions but also helps in improving the perception and acceptance of AI and robot-assisted tasks across various organizations [9].

The aim of this paper is to present the scope of the AI4Work project regarding the utilization of the Digital Twin Technology to improve the working conditions in Healthcare and Education sectors.

2. AI4Work Objectives and Approach

AI4Work aims to facilitate task sharing between digital systems and human workers, enhancing efficiency and redefining processes in areas such as logistics, healthcare, education, manufacturing and construction. The project's primary challenge is to create

a unified set of methodologies and tools, such as a framework, digital twin service platforms, and software components for Sliding Work Sharing (SWS), that are adaptable across different sectors and AI/robotic applications, promoting effective knowledge sharing.

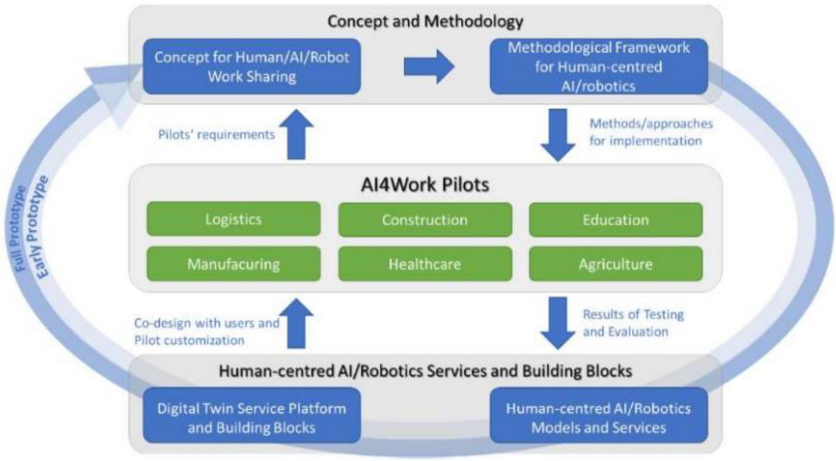

Figure 1. AI4Work overall approach.

The AI4Work initiative is focused on advancing the collaboration between humans and AI/robots by employing SWS principles, with the objectives of elevating job quality and fostering more dignified work conditions for human operators [10]. This involves conducting pilot studies in various sectors to test and refine these solutions (figure 1). These strategies will enable dynamic work allocation between human operators and AI/robots, tailored to the specific context of each task, and will enhance the clarity of AI and robotic decisions.

To ensure AI and robotics solutions operate seamlessly throughout the entire process lifecycle, the project will employ living digital twins that mirror operational systems/entities across various fields. These digital twins will be perpetually refreshed with live data from their physical counterparts, enabling their use in AI/robotics testing and training, especially when processes undergo changes or adaptations. They will also facilitate the simulation of human actions, serving as a foundation for ideally distributing tasks between AI/robots and human workers. The project will be tested in real-world settings through six pilot programs in different industries, including logistics, manufacturing, construction, healthcare, education, and agriculture.

3. AI4Work Pilot Studies

3.1. Healthcare Sector Pilot

Clinicians and Healthcare professionals face severe burn-out symptoms due to the high Workload, stress of their daily work and other risk factors [11-13]. The Healthcare Sector pilot targets healthcare professionals as the focus group. In this pilot, the proposed by the AI4Work project technological approaches for the healthcare sector will be tested. Specifically, the pilot will explore how Digital Twin technology can assist occupational doctors and psychologists in monitoring the physical and mental health of hospital

personnel [14-15]. In the context of this pilot an integrated platform that allows the monitoring of vital signs through smart devices and wearables will be utilized. This platform leverages medical Internet of Things (IoT) capabilities to continuously monitor participants' biosignals, including physical activity and stress levels [16].

The value of the proposed solution is twofold. Firstly, occupational doctors and psychologists will have the ability to monitor multiple employees for a longer time and secondly the occupational doctors' and psychologists' workload will be reduced as the personnel's measurement data analyses will be held automatically and they will be engaged only when the system detects "abnormalities" on the personnel's measurement (ex. sleep partners or anxiety levels). By implementing the described technology, an indirect improvement in work-life balance and overall well-being of the hospital's staff it is anticipating. This could ultimately lead to a more positive and productive work environment within the demanding field of the healthcare.

3.2. Education Sector Pilot

Student, Researchers, Professors, and other professionals sometimes are facing health issues that could affect their daily performance and behaviour [17]. A high percentage of educators showed anxiety, depression, and stress symptoms during the pandemic [18]. Furthermore, variables such as gender, age, job stability, the level of education at which they teach, and parental status also influence this symptomatology. Based on above, there is a need to safeguard the mental health of educators in order to improve both the quality of teaching and the mental health of students. In this pilot, the contribution of Digital Twins and AI technologies will be examined in the Education Sector.

AI4Work will investigate how the proposed technologies could be used in order to monitor the Universities' Staff and Students health and mental status. The universities staff and students will be monitored by the occupational doctors and psychologists (student services) on a daily basis using a remote monitoring system [17]. Appropriate wearable devices will be assigned to each user enrolled in the study, to monitor physical and mental activity. The devices will also measure additional variables, such as sleep, heart rate/heat rate variability and stress level that can be used when developing models for Digital Twins approach [18].

The usage of the above system will lead to a better understanding of the stress level changes in the education sector personnel and students especially on the high demanding periods (deadlines, exams, projects/essays etc).

4. Expected Outcomes - Conclusions

Digital Twin technology heralds a transformative era for the fields of healthcare and education, offering tailor-made, efficient, and empowering experiences for patients, medical staff, students, and teachers. Recognizing the pivotal role of healthcare workers' mental and physical well-being in the efficacy of healthcare services, the AI4Work initiative aims to enhance the quality of the care provided by healthcare organizations. This enhancement is expected to boost the overall health and well-being of communities. Simultaneously, the application of AI4Work technologies in education sector promises to uphold the mental health of both educators and students, while identifying any unusual conditions. The benefit here lies in fostering a more supportive and enduring educational setting, from which students stand to gain significantly.

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