29 April 2024

Dear Editors and Reviewers,

We are pleased to resubmit our revised manuscript titled "Smart-Sensing Chairs for Sitting Posture Detection, Classification, and Monitoring: A Comprehensive Review" for consideration for publication in MDPI Sensors, specifically for the Special Issue on "Advanced Non-invasive Sensors: Methods and Applications".

We appreciate the time and effort the editors and reviewers have dedicated to evaluating our manuscript. In response to the feedback received, we have thoroughly revised our manuscript, particularly focusing on clarifying our search strategy and enhancing the overall structure of the paper. Below, we outline our responses to the comments received and detail the amendments made to the manuscript. The corresponding revisions/corrections have been highlighted in red in the re-submitted manuscript*.* We have also updated the list of references to reflect the extended content of the paper.

We have strived to address all the points raised by the reviewers comprehensively and hope that our responses now meet the reviewers' satisfaction.

We believe these revisions have significantly improved our paper, clarifying key aspects that enhance its contribution to the field. We are grateful for the opportunity to refine our work and look forward to the possibility of its publication.

Thank you once again for your insightful feedback and consideration.

Sincerely,

Janusz Kulon

|  |  |
| --- | --- |
| **Dr Janusz Kulon** BEng(Hon), MEng, PhD, FHEA **,** SMIEEE  Athro Cysylltiol | Associate Professor | |
| +44 (0) 1443 654136 [j.kulon@southwales.ac.uk](mailto:JKulon@glam.ac.uk) | |
| Pontypridd, Cymru, CF37 1DL  [decymru.ac.uk](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.southwales.ac.uk%2Fcymraeg%2F&data=04%7C01%7Cj.kulon%40southwales.ac.uk%7C417b8926c51f4d8fe8e108da12710ac6%7Ce5aafe7c971b4ab7b039141ad36acec0%7C0%7C0%7C637842574054263281%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000&sdata=F7cZaIU%2F4Za%2FMUuCnKD2izQd%2BYqPhq7BJAqrNcWjxfo%3D&reserved=0) | Pontypridd, Wales, CF37 1DL  [southwales.ac.uk](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.southwales.ac.uk%2F&data=04%7C01%7Cj.kulon%40southwales.ac.uk%7C417b8926c51f4d8fe8e108da12710ac6%7Ce5aafe7c971b4ab7b039141ad36acec0%7C0%7C0%7C637842574054419957%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000&sdata=Pxj4Oeb33tMUHt7oSDEBKK6g79hYY9xpPdbuC0gE8PA%3D&reserved=0) | |
| A picture containing text  Description automatically generated                Ymchwil │ Research:   [Biomedical Engineering and Computing Research Group](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fces-web2.southwales.ac.uk%2Fstaff%2FKBS%2Fdefault.php&data=04%7C01%7Cj.kulon%40southwales.ac.uk%7Cddf35bdcd817434e0f1708d8d96aaecf%7Ce5aafe7c971b4ab7b039141ad36acec0%7C0%7C0%7C637498399507050639%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=Jt5G3fbA3bDJv7vrfBzU7cW6Dfi96cAvXQFy1SqETns%3D&reserved=0) | |

## Reviewer 1 Report

|  |  |  |
| --- | --- | --- |
| Response to Reviewer 1 Comments | | |
| **1. Summary** |  |  |
| We would like to thank the reviewer for their generous evaluation of our manuscript, insightful comments and taking the time to review our work. Please find the detailed responses below and the corresponding revisions/corrections. | | |
| **2. Questions for General Evaluation** | **Reviewer’s Evaluation** | **Response and Revisions** |
| Is the work a significant contribution to the field? |  |  |
| Is the work well organized and comprehensively described? |  |  |
| Is the work scientifically sound and not misleading? |  |  |
| Are there appropriate and adequate references to related and previous work? |  |  |
| Is the English used correct and readable? |  |  |
|  |  |  |
| **3. Point-by-point response to Comments and Suggestions for**  **Comments 1:** The authors should provide more details on the search strategy, including the specific keywords used and any additional inclusion/exclusion criteria applied during the screening process. | | |
| **Response 1**: In response to the reviewers’ comments, we have provided additional details regarding the search strategy used in our study. We acknowledge the importance of transparency in the research methodology to allow for reproducibility and verification of the review process.  From line 118 to 124 we added the following:  “These search terms and phrases were specifically chosen to target topics related to smart sensing chairs and sitting posture classification, as detailed in Table 2. To enhance the search efficiency across databases, the terms were concatenated using the “OR” operator. The refined search string employed to query the relevant research databases was as follows: Smart Sensing Chair OR Sitting Posture Recognition OR Posture Classification OR Sitting Posture Classification using Machine Learning OR Sitting Posture Monitoring OR Sitting Posture Detection*.”*  Additionally, in Section 2.3 from line 130-136, we provided the list of exclusion criteria which facilitated the selection of the relevant research studies for inclusion in the review. | | |
| **Comments 2:** You need to include a table summarizing the key findings of each study, such as the sensors used, number of postures classified, classification accuracy, and user feedback mechanisms (if any). | | |
| **Response 2:** As advised, Table 3 – (Summary of the short-listed papers), was added to the manuscript. The summary table highlighted the key findings in each paper, such as the sensor type, number of postures, classification method, classification accuracy, and user feedback. | | |
| **Comments 3:** The discussion section can be expanded to explore the potential implications of integrating multiple sensor types for enhanced posture classification and the challenges associated with such an approach. | | |
| **Response 3:**  We agree with the reviewer’s comment and have expanded the discussion. The new Section 6.1.1 entitled *Multiple Sensor Types* outlines the benefits and challenges of using multiple sensor types in posture classification systems. Integrating various sensors not only improves accuracy and system robustness but also enables health monitoring and rehabilitation features. However, it presents issues like complex data fusion, higher costs, and data privacy concerns, stressing the need for advanced techniques and strict compliance with privacy regulations. | | |
| **Comments 4:** You need to discuss the feasibility and cost-effectiveness of implementing smart sensing chair systems in real-world settings, such as offices or healthcare facilities. | | |
| **Response 4:** In response to the reviewer’s recommendation, we added Section 6.4 to the manuscript entitled *Feasibility of Implementing Smart Sensing Chair Systems in Real-World Settings.* The section explores the practicality of smart sensing chairs in real-world settings, emphasizing their benefits in monitoring sitting postures and promoting wellness in offices and healthcare environments. Key challenges include ensuring user adoption, maintaining sensor accuracy, integrating with existing technological systems, addressing privacy concerns, and managing costs. Successful implementation requires careful consideration of these factors to fully harness the potential of smart sensing chairs | | |

## Reviewer 2 Report

|  |  |  |  |
| --- | --- | --- | --- |
| Response to Reviewer 2 Comments | | | |
| **1. Summary** |  |  | |
| We would like to thank the reviewer for perceptive comments as well as taking time to review our manuscript. Detailed responses are given below, and the corresponding revisions/corrections have been highlighted in the re-submitted manuscript*.* | | | |
| **2. Questions for General Evaluation** | **Reviewer’s Evaluation** | **Response and Revisions** | |
| Is the work a significant contribution to the field? |  |  | |
| Is the work well organized and comprehensively described? |  |  | |
| Is the work scientifically sound and not misleading? |  |  | |
| Are there appropriate and adequate references to related and previous work? |  |  | |
| Is the English used correct and readable? |  |  | |
| **3. Point-by-point response to Comments and Suggestions for** | | | |
| **Comments 1:** Although several papers are found in Sensors (Besel), the biggest concern is that it has not been reviewed in relevant databases such as PUBMED and Web of Science, Scopus. | | | |
| **Response 1**:  We appreciate reviewers’ concern regarding the comprehensiveness of our literature search, particularly in relation to the use of databases such as PubMed, Web of Science (WoS), and Scopus. Given the highly specialized topic of our literature review, we identified that the majority of high-quality, peer-reviewed studies pertinent to our review were located in Sensors, Electronics, and Biomedical journals, as well as conference proceedings. These sources were accessible through our searches in Google Scholar, IEEE Xplore, and MDPI databases.  It is also important to note that Google Scholar indexes articles from a diverse range of comprehensive databases, including PubMed and WoS. Nonetheless, we acknowledge the value of conducting direct searches in specialized databases to ensure a thorough systematic review. In response to reviewer’s concerns, we expanded our search to include direct queries in the Scopus and PubMed databases, as our institution does not have a subscription to WoS. We have updated Figure 1 to reflect this expanded search.  This expanded search yielded an additional five research papers relevant to our review, bringing the total to 39 research studies. While these additional papers did not alter the fundamental conclusions of our review, they did enhance its statistical representativeness and breadth.  We are grateful for your insightful feedback and believe that these additional steps have sufficiently addressed the reviewers’ concerns regarding the scope of our literature search. We hope this demonstrates our commitment to ensuring a rigorous and exhaustive review process. | | | |
| **Comments 2:** The sensor parts are relatively well written, but the detection technologies are not well reviewed. A chapter should be devoted to explaining posture detection and detection techniques. The author presented detection models in 4.3. and the authors should present traditional statistical models as well as rule-based and intelligent techniques besides CNN. | | | |
| **Response 2:** We would like to thank the reviewer for their valuable feedback regarding the coverage of detection technologies in our manuscript. As advised, we have added a new section entitled "Techniques for Posture Detection in Smart Sensing Chairs," which appears on page 15-17 of the revised manuscript. This section of the review paper provides a comprehensive overview of the various methods and algorithms used in the classification of sitting postures within smart sensing chair systems.  We agree with the reviewer that including this section in the review paper is beneficial as it not only highlights the evolution and range of techniques used for posture detection but also assists researchers and developers in understanding the strengths and limitations of each method. | | | |
| **Comments 3:** At present, the sitting posture pattern is characterized individually for each user. The conclusion of the detection analysis survey is not sufficient for the review. | | | |
| **Response 3**: We would like to take the opportunity to clarify and expand on the conclusions drawn from the detection analysis survey in light of the reviewer’s comment.  Our review acknowledges the inherent subjectivity and variability of "ideal" sitting postures, as they indeed differ markedly across individuals, particularly for those with specific health conditions or disabilities. Despite these variations, the review systematically categorizes broad sitting posture categories that are commonly analyzed by researchers in the field. These categories provide a foundational framework for understanding and comparing how different sitting postures are detected and classified by smart sensing chair systems.  As highlighted in Section 3 of our review, even though sitting posture is characterized individually, researchers have identified and analyzed common postural categories that include but are not limited to upright sitting, leaning forward (slouching), leaning to the sides, and leaning backward. These categories reflect a range of sitting behaviors that, while subject to individual variation, serve as a useful reference for developing and testing posture detection technologies.  Furthermore, it is important to reiterate the conclusion of our review which underscores a significant limitation in the current research landscape—the reliance on healthy individuals from a narrow demographic to simulate incorrect sitting postures. This practice raises legitimate concerns about the broader applicability of these findings, especially for individuals with musculoskeletal disorders who may experience sitting postures differently due to pain, discomfort, or physical limitations. The review calls for future research to include a more diverse participant pool that better represents the full spectrum of potential users, particularly those with varying health conditions that could affect posture.  Moreover, our analysis includes data from a wide range of studies, as depicted in the pie chart in Figure 2, which provides a quantitative overview of the prevalence of each studied posture within the reviewed literature. This visualization not only supports the breadth of our review but also highlights the primary pressure points and necessary adjustments for each posture, thereby contributing valuable insights into ergonomic design and health implications.  In conclusion, while individual variability in sitting posture is recognized and valued, our review provides a systematic examination of broadly categorized postures and their detection by smart sensing technologies. We have also identified and discussed critical gaps in the literature, particularly the need for more inclusive research that considers the unique needs of all potential users. This approach ensures that our findings and recommendations are both comprehensive and relevant to advancing the field of posture detection technology. We hope that this clarification adequately addresses the reviewers concern. | | | |
| **Comments 4:** In addition, the discussion section, lines 389-393 and lines 419-423, should be moved to the previous chapter, as Figures 8 and 9 show only the results of the reviewed data | | | |
| **Response 4:** We thank the reviewer for the suggestion regarding the placement of the discussion pertaining to Figures 8 and 9.  However, after careful consideration, we believe that the discussion of Figures 8 and 9 should remain within the discussion section of the manuscript. These figures synthesize and analyze the findings from the reviewed literature, highlighting key statistical trends and drawing comparisons across various machine learning models used in the classification of sitting postures. This analysis is central to the discussion section as it extends beyond merely presenting results from the literature review to interpreting these findings in the context of broader research implications.  Figure 8 illustrates the historical preference for specific sensor types in the detection of sitting postures, emphasizing the predominance of Force Sensing Resistors (FSR) over other types, such as textile pressure sensors. This trend analysis is integral to discussing the evolution and effectiveness of sensor technologies in posture detection systems, which directly supports the critical analysis of current technologies and guides future research directions.  Similarly, Figure 9 provides a comparative analysis of machine learning models, specifically highlighting that despite the advanced capabilities of deep learning models like CNNs and ANNs, they do not significantly outperform traditional statistical models in terms of classification accuracy when applied to sitting posture detection. This insight is important for the discussion as it challenges the assumptions about the superiority of deep learning models and explores the reasons behind these findings, such as the limitations imposed by the size of the training datasets and the number of test subjects.  Therefore, moving this analysis to a previous chapter would detract from the coherence of the discussion, where these insights contribute to a better understanding of the effectiveness and limitations of current posture detection technologies. We believe that keeping this discussion aligned with the visualization provided by Figures 8 and 9 allows for a more integrated and impactful exploration of how data from the reviewed studies informs current challenges and future advancements in the field.  We hope that this explanation clarifies the rationale behind our structural choices to the satisfaction of the reviewer. | | | |