CHAPTER V
CONCLUSIONS

5.1 Conclusions

This study demonstrates the potential of the developed maze game in improving balance ability and promoting engagement in the rehabilitation process. The experimental results showed that participants' Balance scores increased after playing the game from 89.6 ± 9.23 to 95.5 ± 1.6, reflecting the game's effectiveness in enhancing balance control. Additionally, changes in parameters such as RMS amplitude, RMS velocity, and COP velocity further suggested the game's potential to enhance stability and movement control.

Moreover, the increasing Average reward per round highlights the capability of the RL model to learn and adapt, helping participants better control their COP. This improvement led to a reduction in COP distance and a continuous increase in Reward. The use of Average reward across all participants reflects the overall effectiveness of the model. Additionally, the system's ability to adjust game difficulty automatically based on the participants' COP status further supported the continuous improvement of participants' performance. However, the variability in Average reward observed suggests differences in individual players' abilities. The participants in this experiment were individuals with normal COP and good baseline balance, which contributed to the consistent effectiveness of the RL model. Furthermore, familiarity with the gameplay may have also contributed to reducing COP distance and increasing Average reward. Future experiments should aim to separate the effects of RL adaptation, difficulty adjustments, and gameplay familiarity to ensure more accurate assessments.

Feedback from participants reflected positive satisfaction, especially in the "Game Safety" category, which received the highest level of agreement, emphasizing the game's

appropriateness and safety for use. The "Game Principles" category also highlighted the suitability of the technical design. However, responses from the "Patient Survey" indicated the need for further improvements on challenge physical ability patients.

It is important to note that this experiment was conducted with participants who had normal balance abilities. This may have limited the observable changes compared to patients with balance impairments. Therefore, future studies should be conducted with patients who have balance limitations to comprehensively evaluate the game's effectiveness. Additionally, the game's difficulty levels should be adjusted to better match the capabilities of different groups of users.

In conclusion, the developed maze game demonstrates its potential as tool for balance rehabilitation while also motivating patients to engage in physical therapy. Nevertheless, further improvements are necessary to ensure the game can accommodate a more diverse range of users. Long-term studies are also recommended to validate the game's effectiveness in broader contexts such as, for the elderly and patients with Parkinson's disease, stroke, sarcopenia, and balance impairments.

5.2 Future work

Future research will focus on trials involving elderly individuals with balance impairments to evaluate the game's effectiveness in restoring balance within the target group. Efforts will also be made to enhance game engagement and optimize maze levels to match the abilities and limitations of older adults and incorporate supportive features such as user-friendly instructions and feedback mechanisms that enhance motivation. Additionally, long-term follow-ups will assess the sustainability of the game's outcomes and its potential to reduce the risk of falls among elderly users.

For future development, consideration will be given to adding an additional state that reflects not only the position of the COP within a specific quadrant but also includes information about the distance from the center point. In the current system, only the COP quadrant is considered; for example, if the COP is at a first position close to the center and at a second position farther away, although both positions are in the

same quadrant, the system still selects the same maze level. Incorporating distance-based states would allow the model to distinguish more precisely and select actions that are better matched to the player's actual balance ability.

Additionally, there are plans to enhance the game's ability to detect improper playing behaviors, such as applying weight incorrectly, which may induce ball movement, but from incorrect posture. Mechanisms for monitoring and alerting will be added to ensure that players apply weight properly, promoting effective balance training and preventing ineffective or incorrect practice.