CHAPTER I
INTRODUCTION

1.1. Background

Sports are simply physical activities to improve physical fitness in a structured, planned and sustainable manner by following a movement pattern to get optimal benefits for the body and health (Prasetya et al., 2024; Zulkarnain & Nugraha, 2023). Not only does it maintain health, but sport is also used as entertainment, as well as a platform to showcase abilities and improve performance (Fadilah et al., 2023; Romadona et al., 2022). With the development of the times, sports have become an integral part of people's lives with rapid developments, such as the emergence of effective sports methods, as well as sports technologies in the form of both hardware and software (Alda et al., 2023; Hindun & Agustin, 2022). Many people utilise technological innovations in their sporting activities, such as scheduling, monitoring the number of calories burned during activities, or using exercise repetition counters.

With its development, it has encouraged public interest in various types of sports, one of which is calisthenics. This sport has become increasingly popular since the pandemic because it can be done without leaving the house and without expensive equipment (Perez, 2021). It began in 2012, when the Barilla, Work Out Embassy, and Indobarian calisthenics communities held joint training sessions and formed AKSI (Asosiasi Kalistenik dan Street Work Out Indonesia) (Yulianto, 2022). Calisthenics is a type of exercise that uses body weight, through basic movements such as gripping, pushing, pulling, squatting, standing, and so on. The focus of this exercise is to increase strength, flexibility, and stamina, with one of the most popular movements being push-ups (Lulie, 2024). To achieve optimal results, movements must be performed correctly by following the rules. However, many people still find it difficult to perform push-ups correctly or are unable to determine whether their push-ups are correct or incorrect. This is demonstrated in the study by Artanayasa et al., (2022) which shows that 77% of respondents had difficulty performing push-ups, unable to perform the movement with the correct and consistent position. The sample consisted of 256 respondents, including 10 lecturers from the Faculty of Sports and Health, and 246 athletes from the National Sports Committee (KONI) representing the regencies of Badung, Buleleng, Bangli, and the city of Denpasar. Additionally, the study stated that when performing manual push-up tests, 86.7% or 222 respondents felt that the calculations for performing push-ups correctly were inaccurate.

This shows the need for a push-up test that can provide consistent assessment in measuring push-up movements. There have been many technological innovations in the form of hardware devices that use sensors as detection tools (Ahire et al., 2024; Artanayasa et al., 2023; Mardela et al., 2023; D. A. Putra, 2023; Utami, 2023). This solution has limitations in terms of flexibility, as it requires the use of tools in predetermined positions. In addition, users need to spend money on purchasing the tools needed to build the push-up counter device. The use of this hardware also requires in-depth knowledge, especially when the tool encounters problems during use or when the tool needs to be assembled.

However, due to its lack of flexibility, its use is prone to calculation errors. To reduce these calculation errors, a deep learning model can be used to recognise correct and incorrect movements. By utilising landmarks combined with an LSTM model, it can calculate correct or incorrect push-ups by observing changes in the coordinates of key points on the body and changes in the angles of several joints. With this solution, movement validation can be performed, and it offers greater flexibility of use compared to hardware-based solutions. This solution also provides easier and more cost-effective access compared to hardware, which requires purchasing components and assembling the device to function properly. Thus, it is easier and more cost-effective to use.

The LSTM method itself makes it possible to remember information from a sequence of data within a certain period of time (Wisesa et al., 2023). The LSTM algorithm itself is superior in detecting human activity compared to the CNN and SVM algorithms with radar data, with accuracy results of 0.86 for LSTM, 0.86 for CNN, and 0.84 for SVM. Despite having the same accuracy, LSTM has a lower computational load compared to CNN (Azhar et al., 2023). In addition, the LSTM algorithm can detect yoga movements well, with an accuracy of 0.89 in its trial (Tanugraha et al., 2022). In the same case, the K-NN algorithm used achieved an accuracy of 0.847, but there were several errors in assessing the correct body posture in push-ups (Arlin & Munir, 2021).

The use of landmark technology and LSTM offers a solution for calculating push-ups with consistent standards and is more practical than hardware. This system is necessary because many people still have difficulty performing push-ups correctly with consistent assessment. (Artanayasa et al., 2022). With easier access, this application can be used more widely, both for athletes, coaches, physical education teachers, or people who want to exercise, especially for push-up training. The app also provides consistent repetition calculations and helps users perform movements according to the correct standards. This development can also encourage technological advancement in the field of sports, improve the quality of training, and expand access to modern and practical sports methods for the community. It is hoped that this innovation will contribute to improving the effectiveness and efficiency of calisthenics training and open up better technological development in the field of sports in the future.

1.2. Problem Limitation

This research has several problem limitations that are used to focus the scope of study, namely:

1. The research focuses more on developing a model to calculate push-up repetitions and testing the accuracy and precision of the model, as well as the latency in making predictions.
2. In data collection and testing using adult male subjects and the developed model, push-ups were also assessed for adult men aged 18 to 50 years.
3. The type of push-up used is the original push-up in accordance with the Technical Guidelines for Physical Fitness Tests for Soldiers and Prospective Soldiers of the Indonesian National Army (TNI).
4. During data collection and testing, the camera position remains stationary and does not move.
5. The dataset was collected using the left side of the body facing the camera, specifically the left side, lower left side, lower left side, front left side, lower front left side, and upper front left side.

6. Several camera angles were used in the testing to obtain good joint angles in accordance with push-up movement standards. The camera angles used were right side, upper right side, lower right side, front right side, upper front right side, lower front right side left side, upper left side, lower left side, front left side, upper front left side, and lower front left side.
7. The model will be trained using angle change data and key points from each frame of a video that serves as the dataset.
8. The angles used as data are the angles at the elbow using the shoulder, elbow, and hand points; the angles at the shoulder using the ear, shoulder, and waist points; the angles at the waist using the shoulder, waist, and knee points; and the angles at the knee using the waist, knee, and ankle points.
9. The key points used are the wrist, elbow, shoulder, ear, waist, knee, and ankle.

1.3. Problem Statement

Based on the background, this research has a problem formulation, namely the lack of applications that can calculate calisthenics movements, especially push ups that can validate the movements performed.

1. How to develop an LSTM model for correct push up motion detection?
2. What is the accuracy, precision and latency of the prototype model for calculating valid push up movements?

1.4. Research Objectives

The objectives of this research are as follows:

1. To know and understand how the LSTM model can calculate valid push-up movements by utilizing body landmark data.
2. To determine the accuracy, precision and latency of the prototype model to perform valid push-up movement calculations

1.5. Research Benefits

With this research, it is hoped that it can provide good benefits in calisthenics training, especially doing push up movements. The results of this research are expected to have a positive contribution in helping individuals, athletes, coaches or sports communities in calculating push up repetitions accurately and consistently. The results of this research are also expected to be a more practical solution compared to the use of hardware in calculating push up movements, as well as encouraging the motivation of people who are doing exercises. In addition, it is hoped that this research can contribute to the development of technology in validating sports movements with the landmark method and the LSTM algorithm.