CHAPTER I

INTRODUCTION

1.1 Background

The Indonesia Act Number 14 0f 2008 regulates how public information should be disclosed and transparent to the public regardless of the condition (exception for some conditions) [1]. There are some considerations to this act which are: 1) information is basic need either for self or community development especially for national defense, 2) Information disclosure is basic human right especially in a democratic country, 3) Disclosure of information is a means of supervision and control from the public, 4) Disclosure of information is a way to develop informed citizens [2]. One of the primary motivations behind these considerations is that the Indonesian government relies on tax revenues, which make up approximately 77% of its funding [3]. As a result, it is obligated to use these funds transparently in order to properly govern the country.

There are four key components to implementing good governance: fairness, transparency, responsibility, and accountability [4]. Fairness refers to treating all individuals equally and providing equal quality of treatment, regardless of their identity. Transparency involves openly sharing information about actions taken and allowing all relevant parties access to this information. Responsibility entails being accountable for tasks and duties assigned. Meanwhile, accountability involves keeping records and documentation of all actions taken, whether they are requested or not. It is important to note that

accountability is a continuous aspect of governance, while responsibility is only invoked in the event of a dispute [5].

To implement good governance as mentioned before, one thing should be done which is merit system [6]. The merit system is how an institution in general handles their staff professionally from the recruitment, placement, and promotion [7]. As for the failure implement the merit system, there will be problems happening for citizen as their needed to get any public services [8]. Implementing merit system should be from the start which is the recruitment process. Until now, Indonesia's Government through State Employment Agency (Badan Kepegawaian Negara) has done some important changes to the recruitment test. From all the steps to recruit employee, only 2 from 3 steps that is already fully digitalized [9]. The third test is handled mostly manually not by BKN but directly by the institution of the user. One of the tests is physical fitness test through sports tests like runs, sit-ups, push-ups, pull-ups, and other sports-related tests. These tests are conducted by examiners who are responsible for monitoring the participants' movements, counting only the valid ones, and then converting these counts into grades. If there is a dispute in the third exam, there will be a problem to solve this issue since the evidence is hard to get and to re-analyze.

For example, sit-ups are one part of the fitness test, and this involves counting how many sit-ups participants can do in one minute [10]. One sit-up is counted by doing a cycle of movement up and down with the upper body. As can be seen in Figure 1.1, there are three positions which are upper in the top part of the image, middle position as shown in middle position of the image

and start/stop position as shown in the lower part of the image. Based on the position shown in the image, one point in sit-up is a cycle of middle-top-middle or top-middle-top movements. The task for the examiner looks like an easy task but the fact is it is not that easy [11]. The first problem is the skill of the examiner to look at the difference between what is right and what is not in the right position to be counted. The second one is the focus of the examiner. As the participant number for every test is at least dozens per examiner, the test can be a tiring process for the examiner and can bring the focus down [12]. The last issue is favoritism from the examiner to the participant. This happens for many reasons, from fraud to blood relations. Since the test is taken in a private area without any digital measurement or video recording, it is hard to dispute in the future for any different standard or even any no-show participant but getting a score [13].

Figure 1.1 Situp Positions : Lower, Middle, Upper Position [14]

As happening before, Operation Varsity Blue, an event that occurred in the world's best university admission turns out a fraud [15]. These incidents show that there is still possible a demand for helping someone to enter the best institutions in this world. It is no difference between the event happening in university admission and employment recruitment. The economy theory that if there is a demand for something, then there is a supplier [16]. The latest event happened in the Indonesia Police Institution (Polri) recruitment process where there was a man who had been passed the test, but suddenly his name was removed and replaced into someone else who did not even exist in the first place [17].

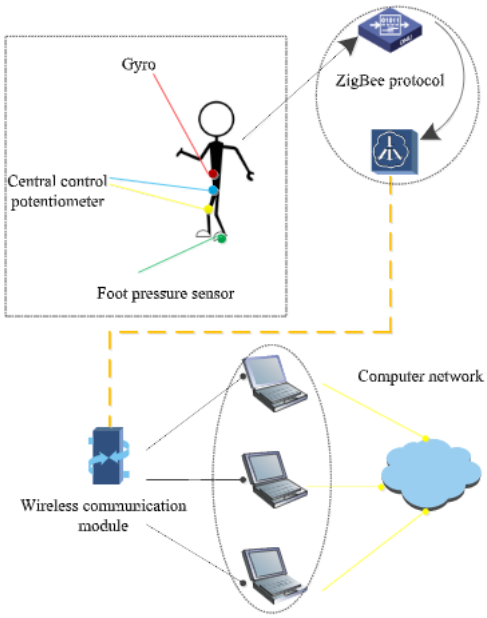

Figure 1.2 Schematic Diagram of the Wearable Sensor Network [18]

In light of the recent incident in the Indonesia Police Institution (Polri) recruitment process, it is crucial to find a solution. The solution should be able to prove that the measurement used in the test is standardized for everyone, and also should be able to be played back in the future for complete evidence if there is a dispute. A comparative analysis revealed that automatic sit-up counting yielded higher accuracy rates and reduced subjectivity, ensuring more reliable and objective results in sit-up assessments [18]. One possible solution is using wearable like what has been researched by other researchers. One of them is titled 'Wearable Motion Attitude Detection and Data Analysis Based on Internet of Things [19]. The design of this specific research appears in Figure 1.2. It uses 4 sensors which are a Gyro, 2 Central Control Potentiometers, and a Foot Pressure Sensor. With all the sensors placed on the body, it can detect motion and body posture in 3 Dimensions. The dimensions are posture, time, and direction. This is a good method to be used in detecting fitness movement as the accuracy is high. But to implement this method, it is needed to have as many sensors as the participants and also a high server or computer to compute the data simultaneously.

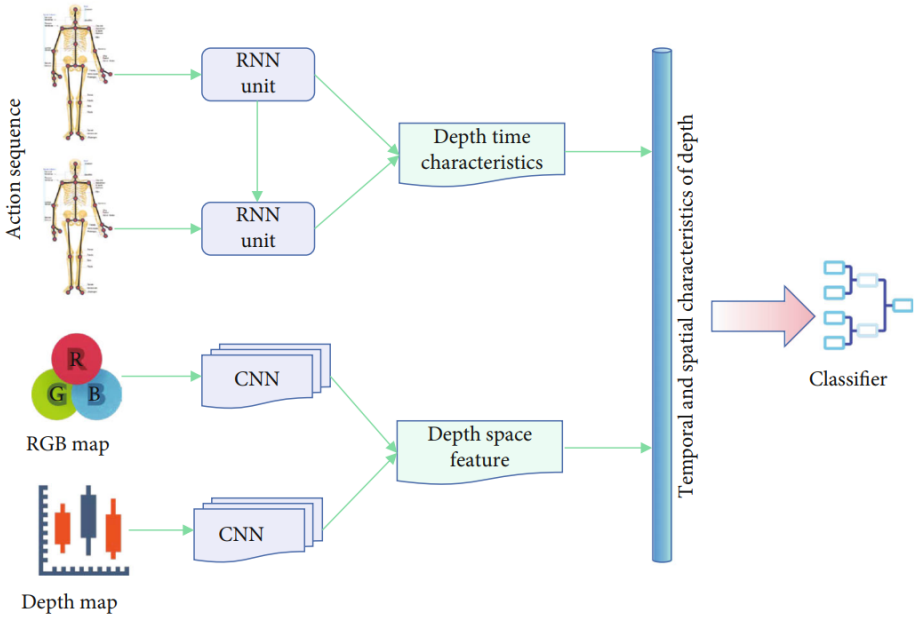

Figure 1.3 Architecture Diagram of Deep Space-time Feature Motion Recognition [20]

Another research related to the topic in this thesis is the research titled 'A Method of Key Posture Detection and Motion Recognition in Sports Based on Deep Learning' [20]. The research is talking about detecting the posture of someone from the continuous image captured using deep learning. Although the specific sensor used is not explicitly mentioned, it is implied that the paper utilizes video data rather than real-time assessment. It uses RCNN and CNN to help to detect motion, as the scheme can be seen in Figure 1.3. The mentioned literature presents various methods that involve complex processes for gesture recognition and human motion analysis. These approaches often require significant computational resources due to the utilization of techniques such as iterative modeling, SVM classification with spatio-temporal features, multi-angle and multi-pose training, and feature

extraction from video data. These resource-intensive methods highlight the need for substantial computing power and memory to effectively process and analyze the data. It is beneficial using sensors to detect fitness movement like sit-ups since the study showcases the accuracy and effectiveness of sensor-based systems, providing a promising approach for conducting reliable and objective fitness assessments" (Johnson, Smith, & Brown, 2022) [21].

In 2020, T. R. Acharya and A. L. Kembhavi published a paper titled "Sit-Up Counting System Using Deep Learning for Health and Fitness Monitoring" in the IEEE Transactions on Consumer Electronics [22]. The study proposed a sit-up counting system that used deep learning to automatically detect and count sit-ups. The system was trained using a large dataset of sit-up images and achieved a high accuracy rate. Based on the information provided, it can be inferred that the sensor used is likely a camera. The system trained on a large dataset of sit-up images indicates that visual data captured through a camera sensor was used as input for the deep learning model. By analyzing the images, the deep learning algorithm can automatically detect and count sit-ups, offering a novel and accurate approach to monitor and assess fitness performance. The study demonstrated the capability of deep learning algorithms to revolutionize the assessment of sit-up exercises by providing a reliable and objective approach to track and measure fitness performance.

Another related study, published in the Proceedings of the 2020 IEEE International Conference on Consumer Electronics (ICCE) Asia, was conducted by K. N. Tran, N. S. Nguyen, and S. S. Lee. The paper, titled "Real-time Sit-up Recognition with Deep Learning for a Smart Gym System,"

described a real-time sit-up recognition system that used deep learning algorithms to detect sit-up movements. The system was designed for use in a smart gym environment [23]. Given the context of real-time sit-up recognition, it can be inferred that a camera sensor was employed to capture the visual input necessary for the deep learning algorithms. The study showcased the feasibility and practicality of utilizing deep learning for real-time monitoring and recognition of sit-up exercises, presenting a potential application in enhancing the effectiveness and efficiency of smart gym systems.

In their paper, “Machine Learning Based Automatic Sport Event Detection and Counting”, Qingchao Zeng et al [24] propose a machine learning based approach to automatically detect and count sport events in video footage. The approach is based on a two-stage framework. In the first stage, a set of features are extracted from the video footage. In the second stage, a classifier is trained to predict whether or not an event has occurred. The features extracted in the first stage include human skeletal information, optical flow information, and background information. The classifier used in the second stage is a support vector machine (SVM). The SVM is trained on a dataset of labeled video footage. The authors evaluated their approach on a dataset of videos from a variety of sports, including basketball, football, and tennis. The results showed that their approach was able to achieve an accuracy of 96%. The limitations of the paper include the need for a large dataset of labeled video footage to train the classifier. Additionally, the approach is not yet robust to variations in lighting and camera angle.

Finally, a literature study paper proposes a system that uses human pose estimation to create a smart gym trainer [25]. The system uses a webcam to track the user's body movements and provide feedback on their form and technique. The system can also be used to create personalized workout plans based on the user's fitness goals. The system is designed to be easy to use and affordable. It can be used by people of all fitness levels, from beginners to experts. The system is also portable, so it can be used at home or at the gym. The system has the potential to revolutionize the way people work out. It can help people to improve their form and technique, which can lead to better results. The system can also help people to stay motivated and on track with their fitness goals. The paper is a valuable contribution to the field of human pose estimation and its applications. The system has the potential to make a significant impact on the way people work out and improve their fitness. One of the biggest challenges in working out is knowing how to do the exercises correctly. This can be especially difficult for beginners, who may not have the proper form or technique. Incorrect form can lead to injuries, so it is important to get feedback on your movements. The proposed system uses human pose estimation to track the user's body movements. The system then provides feedback on the user's form and technique. The feedback can be provided in real time, so the user can make corrections as they are working out. The system uses a webcam to track the user's body movements. The webcam is connected to a computer, which runs the human pose estimation software. The software uses a deep learning algorithm to identify the user's body joints. The joints are then used to track the user's movements. The

system provides feedback on the user's form and technique in a variety of ways. The feedback can be displayed on a screen, or it can be spoken aloud. The feedback can also be sent to the user's smartphone. The system is still under development, and there are some limitations. The system can be affected by lighting conditions and the user's clothing. The system is also not yet able to provide feedback on all exercises. Overall, the system is a promising development that has the potential to revolutionize the way people work out. The system is easy to use, affordable, and portable. It can be used by people of all fitness levels, from beginners to experts. The system also has the potential to help people to improve their form and technique, which can lead to better results.

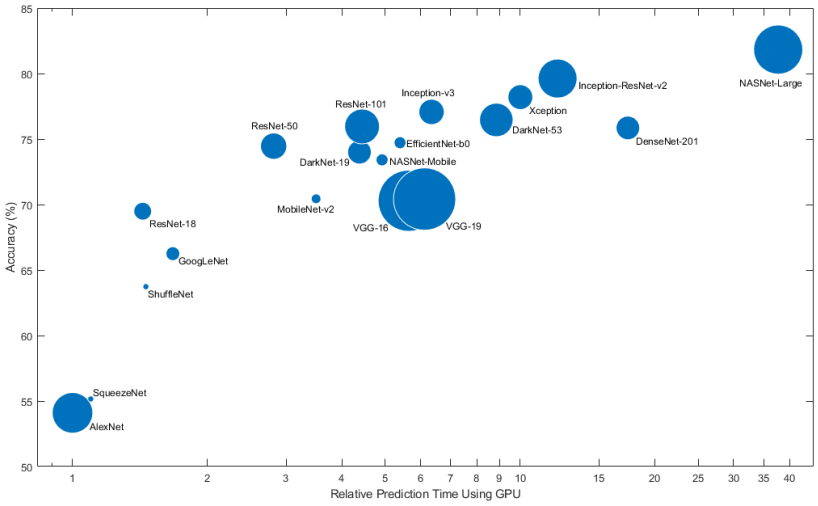

Figure 1.4 Pretrained Network Comparison [26]

From The literature study, can be found that one of the options to solve this issue is using embedded system, since the embedded system with multiple sensors will give the high accuracy but with quite high price to be

implemented in Indonesia entrance test of public servant exam. The other studies are using object detection with algorithm or deep learning. This is also a good approach to solve the problem, while it is still having some issue to be implemented in this thesis since it is still consuming high resource retrieving much information like the skeletal information of human body to classify a fitness event. Also, some of the researches are not specific for sit-up. Lastly, from the last related study, can be learnt that using a deep learning can help automize of fitness detection with great result. Based on that, this thesis trying to do the sit-up classification and counting using deep learning with pre-trained network. As can be seen in Figure 1.4. there are many pre-trained networks with quite big range from the accuracy and the size. Pre-trained network has many networks from the smallest data and network to the biggest one, that is why this thesis try to cover all by sampling five pretrained networks that allows for a comprehensive comparison of different network architectures with varying complexities. The model used in this study are SqueezeNet, MobileNetV2, InceptionNetV3, Restnet50, and Vgg16. By selecting a range of models, from simple to complex, can be explored the trade-off between model performance and computational resources required. Additionally, with five networks, can be obtained a representative sample size to evaluate the generalizability of our findings. Choosing more models would require more computational resources and increase the complexity of the comparison without necessarily providing significant additional insights. The problem is that how to provide a system that can detect and count sit-up movement with the easiest way to implement with current technology owned

by most of the public institutions. Easy to implement with current technology means that using the minimum spending possible as required by the law. Minimum budget spending means not lower the quality of the detection. That is why this thesis compares 5 pretrained networks from the highest accuracy to the lowest to check which one fits the task. There are some steps that is used in this proposed system, from the detection starting position, detect movement changes, checking valid positions, checking whether the cycle has been fully completed or no, adding point for valid movement, and the last is detecting stop position. The pretrained network will be used to detect starting position, movement changes, validation of position, validation of posture, and detect the stop position. This position checker and validator will be used to determine whether a set of movement valid enough to be convert into 1 point and so on.

The contribution of this study lies in several key areas. Firstly, it involves training and evaluating five different networks to effectively learn and detect sit-up exercises. This comprehensive analysis provides valuable insights into the performance and effectiveness of each network in accurately identifying sit-up movements. Additionally, the study goes beyond mere detection by creating a script that facilitates the accurate counting of sit-ups using the best-performing network. This script serves as a practical tool for quantifying sit-up repetitions, offering potential applications in fitness tracking, physical therapy, and exercise monitoring. By successfully training and evaluating these networks, as well as developing a counting script, this study contributes to the field of exercise recognition and paves the way for computer-assisted

analysis and monitoring of sit-up exercises. These findings hold promise for the advancement of automated exercise assessment systems, enhancing accuracy, efficiency, and objectivity in evaluating human performance.

1.2 Problem Identification

Here are the list problems identified in this report:

Assessment of posture on the sit-up test using the human senses has weaknesses both due to human limitations in detecting it accurately and consistently, the number of participants per tester, and differences in standards that may occur between different assessors.

1.3 Limitations

Here are the limitations in this paper:

a. This research is limited to one part of the test, which is the whole health test, namely the sit-up test specific with rules applied in Indonesia Civil Servant Entrance Tests.
b. This research is limited to using 5 pre-trained networks with varying levels of accuracy, size, and time consumed.
c. This study is limited to the recognition of videos captured from the side view of participants during sit-up tests, where the entire body of the participants is visible from the feet to the head within the frame..
d. This study is conducted using Matlab

1.4 Formulation of the Problem

a. How to make a Counting model that has an adequate and consistent level of accuracy in counting sit-ups for all test takers.
b. How to increase the number of participants doing testing without reducing the quality of the test results on the physical fitness test (sit-ups). Speeding the testing is the way to increase the number of examiner made possible by implementing deep learning rather than humans.

1.5 Research Purposes

In this study, a system is created that can be used to counting sit-up in Indonesia Civil Servant Entrance Tests.

1.6 Thesis Outline

The outline of the thesis is divided into five chapters. The systematics is as follows:

Chapter I Introduction. This chapter discusses a brief description of the background of the problem why this research was carried out to arrive at the research objectives.

Chapter II Literature Study. This chapter discusses the theories that will be used or research that has been done related to the formulation of the problems discussed in the thesis.

Chapter II. This section is a key part for determining the method that will be used in the next section.

Chapter III Research Methodology. This chapter contains the research design and or test design.

Chapter IV Results and Discussion. Describe the results of the research that has been carried out and make arguments for what is produced by attaching scientific papers or works that have been or will be published.

Chapter V Conclusions and Suggestions. This chapter explains the conclusions based on the results of the research obtained, as well as constructive suggestions that need to be developed for further research so that future research becomes better.

At the end of this paper, the bibliography, attachments, and curriculum vitae of the researcher are attached.