

The Mechanical Aspects of Martial Arts: Total Time of Execution and Kinematics of *Kaedah A*

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Abstract The ability of *Kaedah A* as a technique to fend off an attack with bare hands is questionable since the estimated ordinary human minimal reaction time is 0.18 s while the offensive force can reach its target in less than 0.1 s. Therefore, this study aimed to analyze the effectiveness of *Kaedah A* based on its total execution time and to describe the kinematic characteristics of the hand movements during *Kaedah A*'s execution. The experiment was carried out using the motion capture method. The Kinect sensor detects the hand motion, while the Virtual Sensei Lite directly processes the motion capture through a digitizing procedure to prepare the coordinate data for further analysis. The execution of *Kaedah A* was repeated five times by four experienced *Seni Silat Cekak Malaysia* (SSCM) practitioners to investigate its accuracy and repeatability. The obtained data have provided the input for the trajectory mapping procedure for initial and end point identifications. Time difference, Δt , between these two points has demonstrated that the total time of execution for *Kaedah A* is less than 0.1 s. Further analysis involved smoothing out the obtained coordinate data in order to generate the polynomial equations of the motions of the hand during *Kaedah A*'s execution. Based on the velocity-time graph generated by the equation of motion,

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it can be concluded that the execution of *Kaedah A* has the features of a ballistic movement. The findings have provided useful data for reliability prediction as well as enhancement of *Kaedah A*'s execution.

Keywords Defensive · Ballistic · Martial art · Silat Cekak

1 Introduction

A fist or a punch is targeted to defeat the opponent at a controlled distance in a short time rate [1]. The time for a punch to reach its target is about 0.1 s [2]. The reactions upon receiving a punch are numerous. The opponent may evade, grab, fend off or just be stunned without doing anything. In addition, the estimated minimal theoretical time for a normal human reaction toward such attack is 0.18 s. This is the summation of the minimum time for each of these three phases: (i) realization of the stimulus (0.05 s), (ii) selecting an adequate reaction (0.05 s), and (iii) start movement (0.08 s) [2]. Based on this argument, the ability to defend oneself from such offensive attacks only with bare hands is almost impossible and is often associated with having supernatural skills.

Seni Silat Cekak Malaysia (SSCM) has a different perspective regarding this matter. SSCM is a genuine traditional Malay combat-oriented art and is different from other martial arts due to its focus on defensive aspects. SSCM consists of components of movements known as *Kaedah*, *Buah Asas*, *Buah Janah*, *Buah Potong* and *Buah Serang*. Table 1 summarizes the definition of each terminology used to represent the techniques included in the SSCM syllabus. SSCM applies 99 % defending techniques and 1 % attacking technique.

SSCM practitioners are introduced to alternative methods to deal with various types of attacks. They do not evade when dealing with an attack. Instead, they will effectively fend off the attack and move forward. There are four fend off techniques in SSCM; *Kaedah A*, *Kaedah B*, *Kaedah C*, and *Kaedah D*, that serve as the first moves in every *Buah Asas* in SSCM. All of these *Kaedah* are able to repel attacks depending on the point of concentration of the attack.

Kaedah A is a simple and effective fending off move to be executed to repel an attack—such as a punch—within the thorax area, as indicated in Fig. 1. The execution begins by moving the hand to slap away the opponent's arm. Figure 2 shows the hand's (a) initial and (b) final position during the execution of *Kaedah A*.

However, there is currently a lack of biomechanical analysis for the execution of *Kaedah A*. The fundamental understandings on the mechanics of the human hands during *Kaedah A*'s application are important as they help to predict the reliability of the technique as well as increase its effectiveness.

According to a study in the psychology of human movements, movements with high-force and high-velocity characteristics are considered as being ballistic in nature [4]. Ballistic movements involve spontaneous propulsion of the limbs, a