Analysis of Direct Punch with a View to Velocity

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Abstract. This paper is focused on analysis of a direct punch which was chosen from many striking techniques of professional defence. The analysis is aimed to find the velocity and dependences of this velocity on input parameters. Our goal was to find out if the velocity is suitable physical value for analysis of the direct punch. During the experiment a high-speed camera Olympus i-Speed 2 was used. For data analysis two pieces of software were used – i-Speed Control Software and MINITAB. 30 participants took part in this experiment. The results are presented in this paper – especially dependence mean velocity on time and difference in velocity between genders.

Keywords: Direct punch, Professional defence, Velocity, Gender Differences

1 Introduction

Physical protection has a very long history and it belongs among basic parts of effective protection of people and property. Human factor is very important for data analysis and for quickly solving some unexpected situation. For these people professional defence training is necessary for effective work. During the training the participants are taught to stop attacker, to neutralize an attack or to solve conflict situations.

The striking techniques are one of the basic elements of the majority of combat sports [2], martial arts [5] or combat systems [9]. In these techniques the striking energy [8] is transferred through arms, legs or head. In this paper the direct punch velocity is closely analyzed. The direct punch is delivered by the arm following a direct line. The hitting area is a closed fist [11]. The aim is to stop the attacker and increase distance between the defender and an attacker. In the following experiment the punch was delivered by the back hand (see Fig. 1).

The aim was to measure the velocity of direct punch and then to find out dependence of velocity on inputs parameters – a training level, body's height and weight and a gender.

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Fig. 1. Direct punch [11]

2 Measuring station

A high-speed camera Olympus i-Speed 2 was used for measuring of velocity. This camera has CMOS 800x600 sensor, full resolution recordings to 1000 fps (fps = frames per second) and 33000 fps maximum recording speed. We used recording speed 1000 fps. [1, 4, 6]

During this experiment we used only one camera, so we choose direct punch from all striking techniques because only this punch is made directly. The result is that during the whole movement of the hand we have had a focused image.

The measuring station consists of a punching bag and a construction of its suspension. Paper with two perpendicular lines was stuck on the right of the punching bag. Horizontal line was for leading the hand during movement. The aim of the vertical line was to determine the beginning of data analysis. The result was that the all direct punches were measured in the same distance from punching bag. This distance was 60mm. The end of the measuring was at the moment when the movement of the hand was stopped in axis "x" – the deformation of punching bag was at the maximum.

Fig. 2. Measuring station with the camera and the punching bag

3 Experiment

The total of 30 participants took part in the experiment; 24 men and 6 women. Based on the previous training and experience the participants were divided into following three groups:

- Untrained – These people have never done any combat sport, martial art or combat system. They have no theoretical knowledge of the striking technique. The technique was presented to these people before the experiment for safety reasons. Noted further as UTM (for men).
- Mid-trained - These people have the theoretical knowledge of striking techniques and they have attended the Special physical training course for at least six months. The course is focused on self-defence and professional defence. Noted further as MTM (for men) and MTW (for women).
- Trained – These people do some combat sports, martial arts or a combat system for longer than two years. Noted further as TM (for men).

During the experiment each person made one strike (Except one man from training group. He did two strikes.). During the measurement the target was positioned in such manner that the center of the punching bag was in line with the striking person´s shoulder. That way the punches have the maximum velocity and force (as there is no decomposition of force or velocity into the other axes). The person was made to stay at the same place for the whole experiment. Any unnecessary movement (e. g. lunge etc.) would lead to data distortion.

Reflective markers with diameter 10mm have been stuck on the hand of each person.

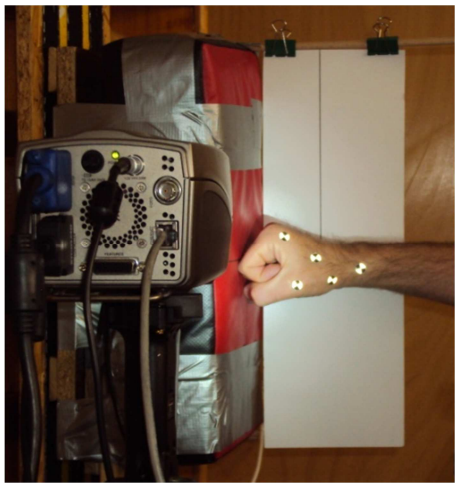

Fig. 3. Reflective markers

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4 Results

For data analysis we used i-Speed Control Software. It is used for image analysis and for work with images – modification of contrast, brightness etc. On the basis of sequential labelling of markers on hand the software it is able to calculate the velocity of the hand. The rate of images (1000 fps) and the distance of markers between two images are known.

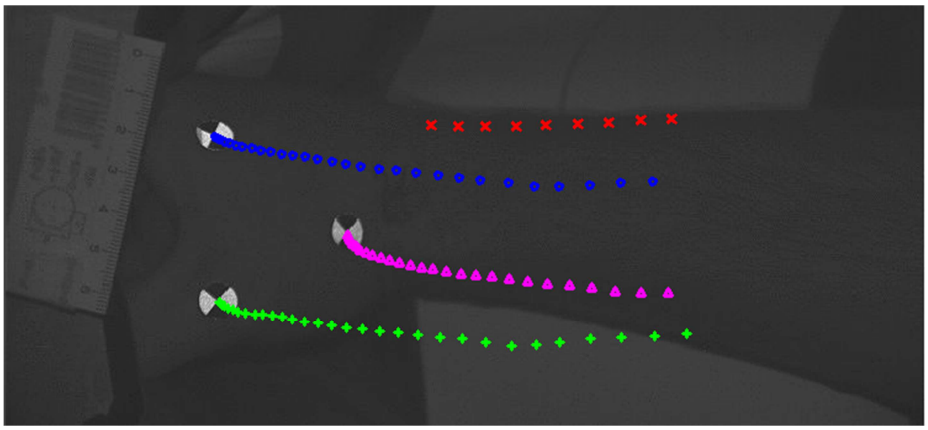

Fig. 4. I-Speed Control Software

For velocity analysis we used software MINITAB. It was possible to find out dependence of the mean velocity on time, dependence of the maximum velocity on body's height and weight, dependence of the maximum velocity on training level and also on gender.

Fig. 5 shows dependence of the velocity on time. There are clear differences among signals due to the training level and the gender. The aim was to find out a simple statistical classifier which would helps us to classify people on basis of their training level. Possibilities are the maximum of velocity and its standard deviation (Table 1).

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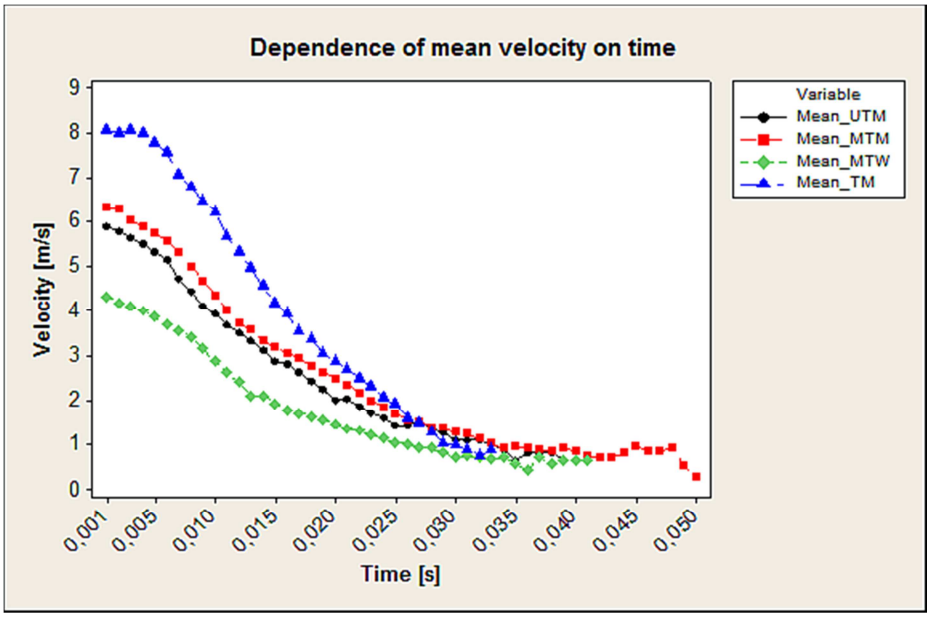

Fig. 5. Dependence of mean velocity on time

Table 1. Results overview

	Mean	StDev	CoefVar	Minimum	Median	Maximum	Number of samples
UTM	3,169	1,6269	51,85	0,8354	2,916	5,989	8
MTM	2,848	1,8631	65,65	0,4849	2,474	6,325	13
TM	4,203	2,545	60,13	0,727	3,705	8,109	4
MTW	2,0223	1,239	61,05	0,4493	1,663	4,347	6

Very important part of experiment was to find out if it is possible to determine dependence of maximum velocity on body's height and weight. This is so important because it is expected that tall men with bigger weight would have stronger punch than small and thin men.

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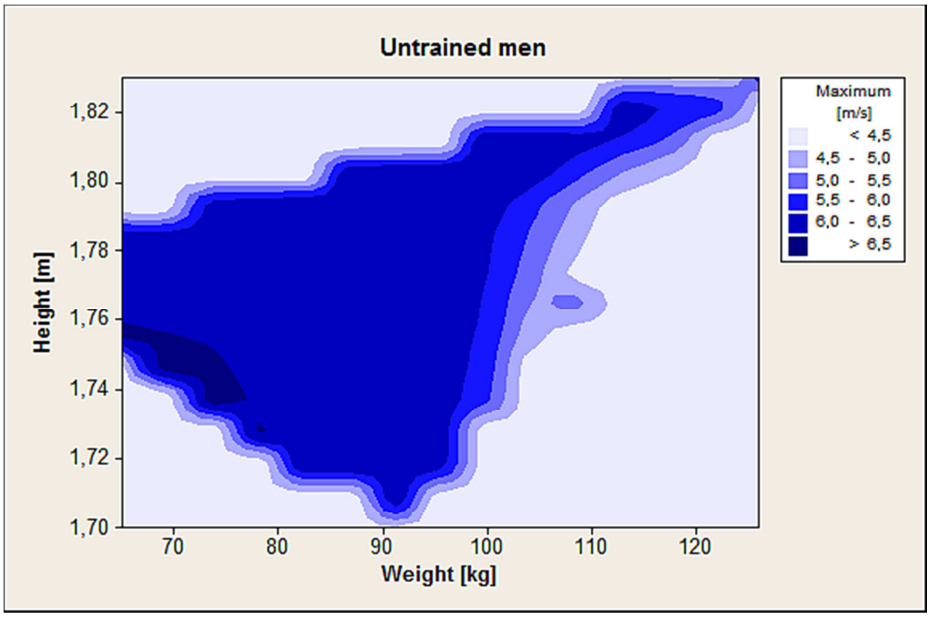

Fig. 6. Dependence of maximum velocity on body's height and weight for untrained men

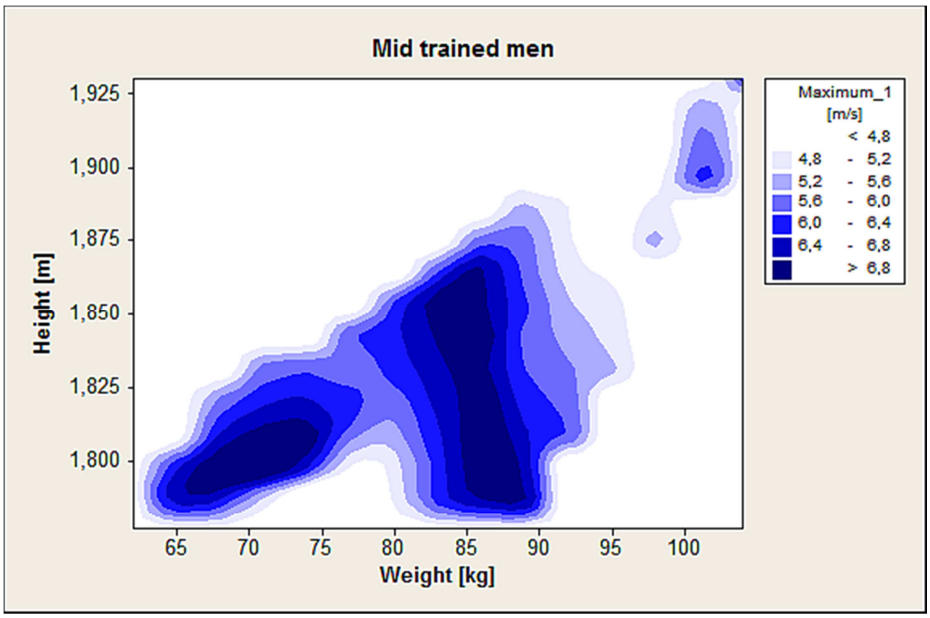

Fig. 7. Dependence of maximum velocity on body's height and weight for mid trained men

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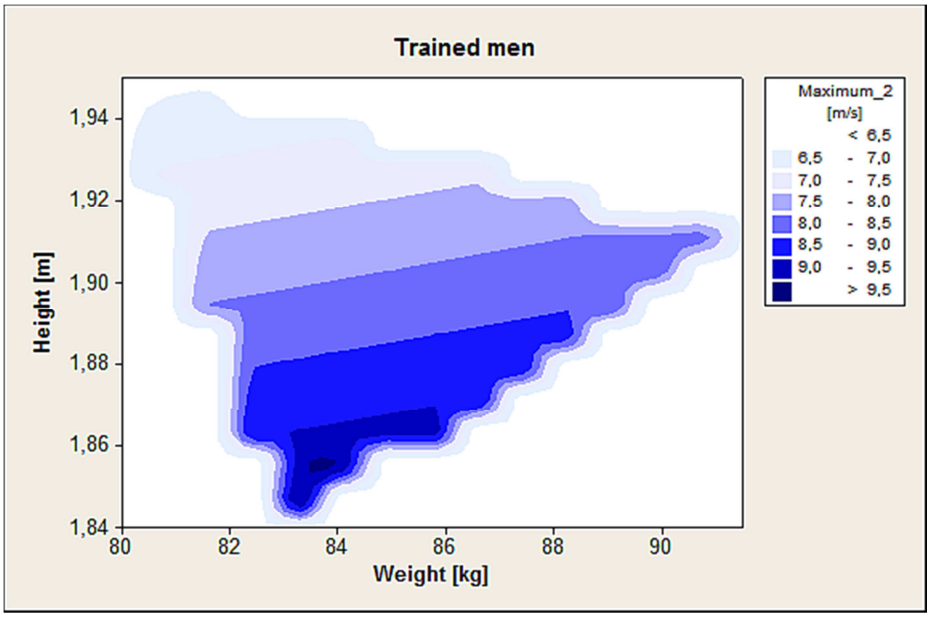

Fig. 8. Dependence of maximum velocity on body's height and weight for trained men

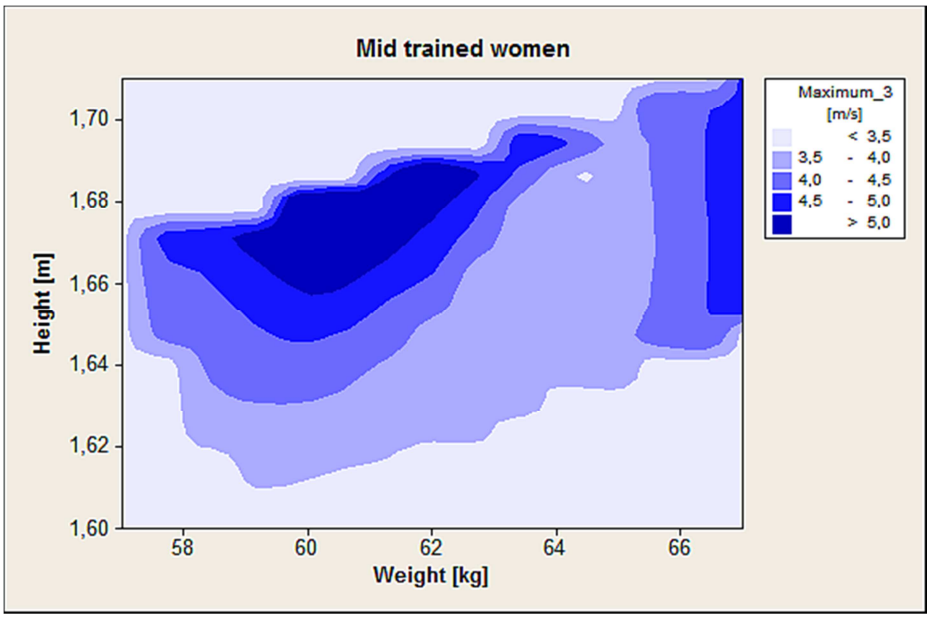

Fig. 9. Dependence of maximum velocity on body's height and weight for mid trained women

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It can be seen there is no evident dependence of the maximum velocity on body's height and weight. Only in category of trained men there is a trend of bigger maximum velocity with lower height. In category of untrained men there is a trend of bigger maximum velocity with lower height and also with lower weight.

5 Conclusion

The experiment was focused on analysis of direct punch with a view to velocity. The high-speed camera Olympus i-Speed 2 and software i-Speed Control Software and MINITAB were used. The results are measuring of velocity in time and the maximum velocity. The aim was to find dependences of velocity on input parameters such as body's height and weight, gender and training level. It can be stated that there is a big difference between genders on the same training level. Dependences on body's height and weight are not evidential. The future experiment will be focused on gathering larger sample of people and then we can establish if some dependence exists.

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