Dynamic Mauy Thai Kick!

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Side View

Abstract

The skillful execution of martial arts maneuvers requires dedicated study and concentration. The spiritual aspects of the martial arts are well known and have been studied scientifically from various angles. While the practice of martial arts is deeply intuitive and typically learned through a mentor-student relationship, proper technique is determinable and often formulaic.

This study analyzed data captured by photographing the skilled execution of a **Mauy Thai roundhouse kick** to find change in **position, velocity,** and **acceleration** over **time**. Researchers modeled the behavior of the tip of the subject's foot in three axes in order to look closely at the qualities of its motion.

The process was repeated for multiple executions of the kick to establish what they had in common. It was found that each execution had nearly identical confluence of change for position, velocity, and acceleration in each axis when considered independently. Furthermore, the relationships between critical points of change in each axis were strikingly similar for every recoded execution of the kick.

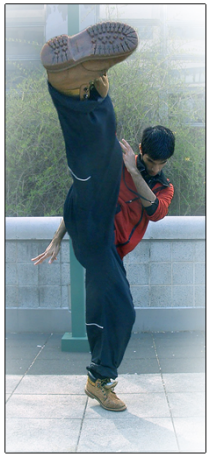
Method

The research uses data that we have collected based off video recording of the Kick itself from different angles and positions. The Mauy Thai Roundhouse kick is used in various levels such as low, middle, & high to inflict damage to different parts of the opponents body. A total of 4 students were involved in the data collection.

The Data was obtained by using 2 still video cameras to record the time at which the kick was delivered at each impact. We recorded various attempts in order to pin point a certain answer from different view points of the kick.

We used two Panasonic PV-GS300 Cameras to capture the footage. Each camera was fourteen feet from the subject. Frame rate was 30 fps, and shutterspeed was 1/8000th of a second.

The data modeling was achieved with **Microsoft Excel Algorithms,** the motion was tracked using **Adobe AfterEffects**, and the study also required graphical output and analysis with **Apple Grapher** and the online Desmos graphing tool available at **Desmos.com.**



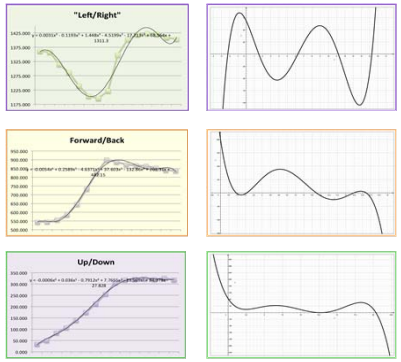
Front View

The resulting data for one execution is shown below. The **green column represents left/right position** of the tip of the shoe in the **front view video**. **Blue represents up/down motion** in the **front view video**. **Yellow** and **red** columns represent **left/right** and **up/down** motion in the **side view video**. The **purple column** is an average of the **up/down** data from **both videos**. The **white columns** represent the **frame *number* (Fr)**. The subject's foot left the ground at frame 47, and impact occurred at frame 58. This means that the kicking action lasted about 1/3 of a second.

(Fr)	Front View		(Fr)	Side View		(Fr)	
47	1361.370	443.000	47	543.786	450.366	47	33.317
48	1358.370	432.000	48	545.246	428.116	48	49.942
49	1315.000	389.000	49	555.774	402.863	49	84.069
50	1286.000	372.000	50	585.207	373.613	50	107.194
51	1240.000	341.000	51	644.500	340.554	51	139.223
52	1203.000	313.000	52	732.786	298.304	52	174.348
53	1196.000	278.000	53	828.536	256.882	53	212.559
54	1222.000	232.000	54	900.036	217.132	54	255.434
55	1348.000	174.000	55	887.036	175.132	55	305.434
56	1402.000	154.000	56	872.379	169.894	56	318.053
57	1419.000	151.000	57	867.379	165.894	57	321.553
58	1423.000	151.000	58	864.379	162.894	58	323.053
59	1421.000	156.000	59	853.379	162.894	59	320.553
60	1409.000	151.000	60	840.379	156.894	60	326.053
61	1403.000	156.000	61	836.379	166.894	61	318.553

Data Chart

The motion is graphed for each axis in the graphs below. The left column of graphs are plots of the data with 6th degree polynomial approximations superimposed on each. The column on the right shows the first derivative of each model.



The graph above superimposes the second derivative of each degree six equation modeling the data. The purple curve represents change in left/right acceleration over time; the orange curve represents change in forward/back acceleration; the green curve represents change in up/down acceleration.

Conclusions

There are several traits that give the Mauy Thai Roundhouse kick its potency. Unlike a conventional snap-kick, the Mauy Thai involves a **pivot of the leg and hips**. When the hips are rotated into the motion, a burst of **momentum** results, increasing the force at impact. This is only possible through a miracle of control and timing. .

For each execution of the kick for which data was recorded and analyzed, the motion included several common features:

1. Change in **rate** of forward/back acceleration from positive to negative preceding change in **rate** of up/down acceleration from positive to negative during the early rising action by 1/75th to 3/75th of a second.
2. Change in **rate** of left/right acceleration from negative to positive preceding change in **rate** of forward/back acceleration from positive to negative during the swinging of the hips by 1/120th to 3/120th of a second.
3. Change in up/down acceleration (**rate** of velocity) from positive to negative coinciding closely with change in **rate** of left/right acceleration from positive to negative at between 17/100th to 23/100th of a second into the kick. It appears that the hips begin to pivot at this point.

Because the cameras collect two fields of information for each 1/30th of a second, and since this study discarded the information from the earlier field in order to establish a single string of data from each recording, the motion was effectively sampled 30 time a second. Since the kick lasts for about 1/3rd of a second, study with high speed cameras will likely shed further light on the nature of the motion in a Mauy Thai roundhouse kick. .

Calculations

Front View (Left/Right)	Side View (Front/Back)	Top Down View (Up/Down)
$w(x) = 0.0031x^6 - 0.1193x^5 + 1.448x^4 - 4.5199x^3 - 17.713x^2 + 68.564x + 1311.3$	$d(x) = -0.0054x^6 + 0.2589x^5 - 4.6371x^4 + 37.603x^3 - 132.86x^2 + 201.31x + 442.15$	$h(x) = -0.0006x^6 + 0.036x^5 - 0.7912x^4 + 7.7655x^3 - 33.569x^2 + 84.978x - 27.828$
$w'(x) = 0.0186x^5 - 0.5965x^4 + 5.792x^3 - 13.5597x^2 - 35.426x + 68.564$	$d'(x) = -0.0324x^5 + 1.2945x^4 - 18.5484x^3 + 112.809x^2 - 265.72x + 201.31$	$h'(x) = -0.0036x^5 + 0.18x^4 - 3.1648x^3 + 23.2965x^2 - 67.138x + 84.978$
$w''(x) = 0.093x^4 - 2.386x^3 + 17.376x^2 - 27.1194x - 35.426$	$d''(x) = -0.162x^4 + 5.178x^3 - 55.6452x^2 + 225.618x - 265.72$	$h''(x) = -0.018x^4 + 0.72x^3 - 9.4944x^2 + 46.593x - 67.138$

Acknowledgments

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