



The 3rd HSSPF

IMU-Based Stroke Analysis in Table Tennis

Yi-shiuan Lin

Motivation:

- Traditional coaching in table tennis often relies on visual observation, which is subjective and at times inaccurate.
- IMU-based sensors provide objective, real-time motion data.
- In sports(e.g., swimming, golfing), IMU has been shown to enhance athletes' performance.

Goal:

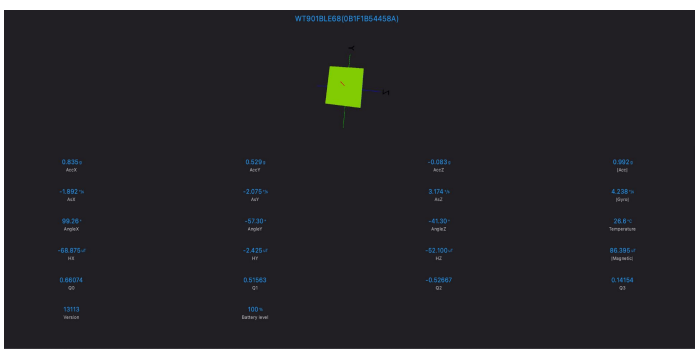
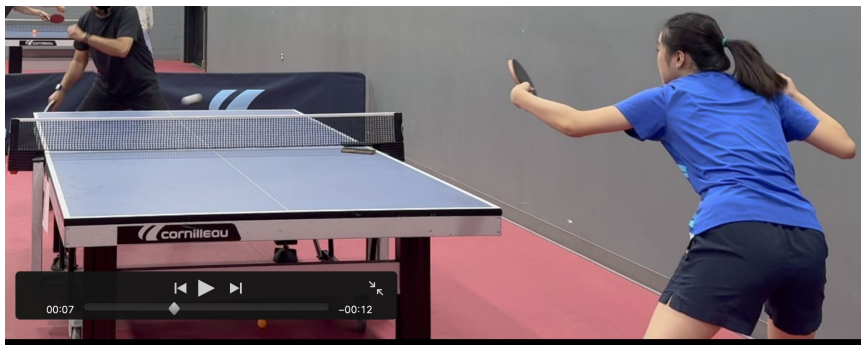
This project aims to use IMU to analyze the characteristics of forehand and backhand strokes for table tennis players, extracting information on movement patterns and consistencies for self-coaching purposes.

Procedure:

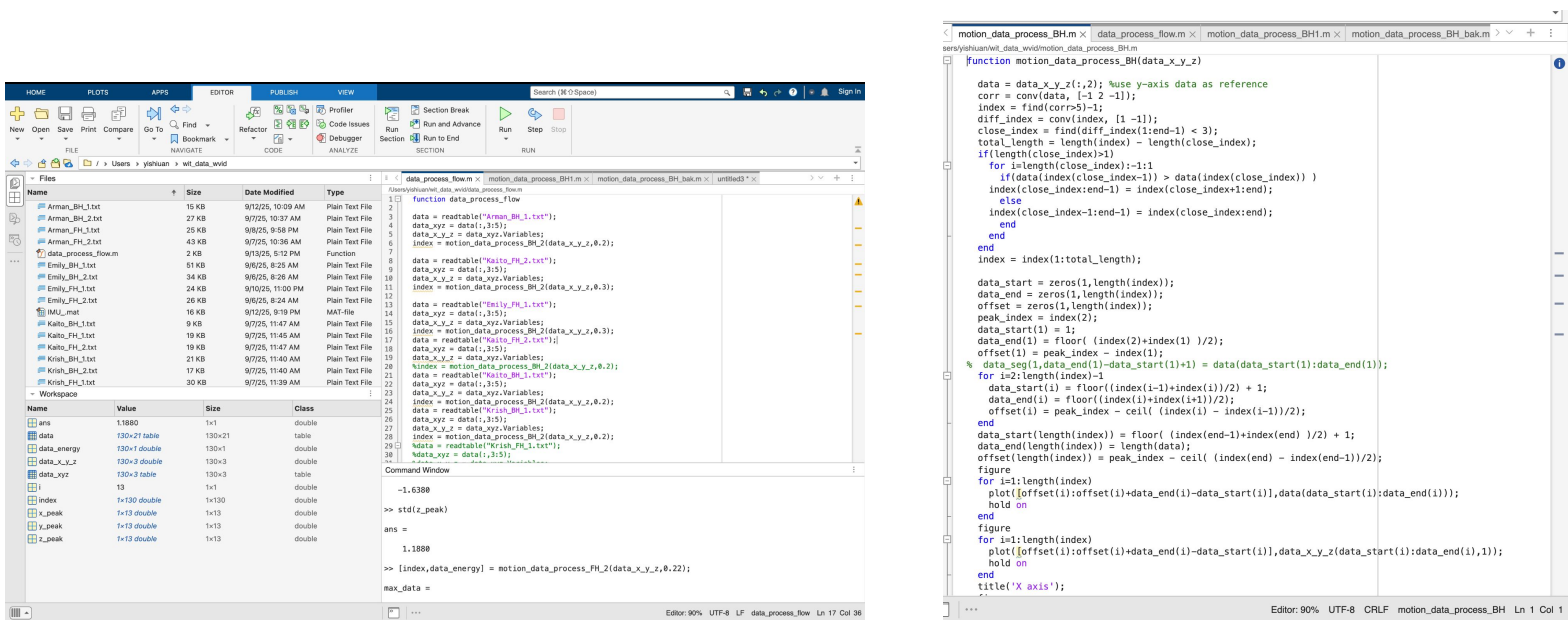
- ◆ Tie the IMU sensor around wrist



- ◆ Connect the sensor with a device to collect data:
 - Timestamp
 - 3D acceleration.
 - video-recording.



- ◆ Motion data import to MATLAB for analysis

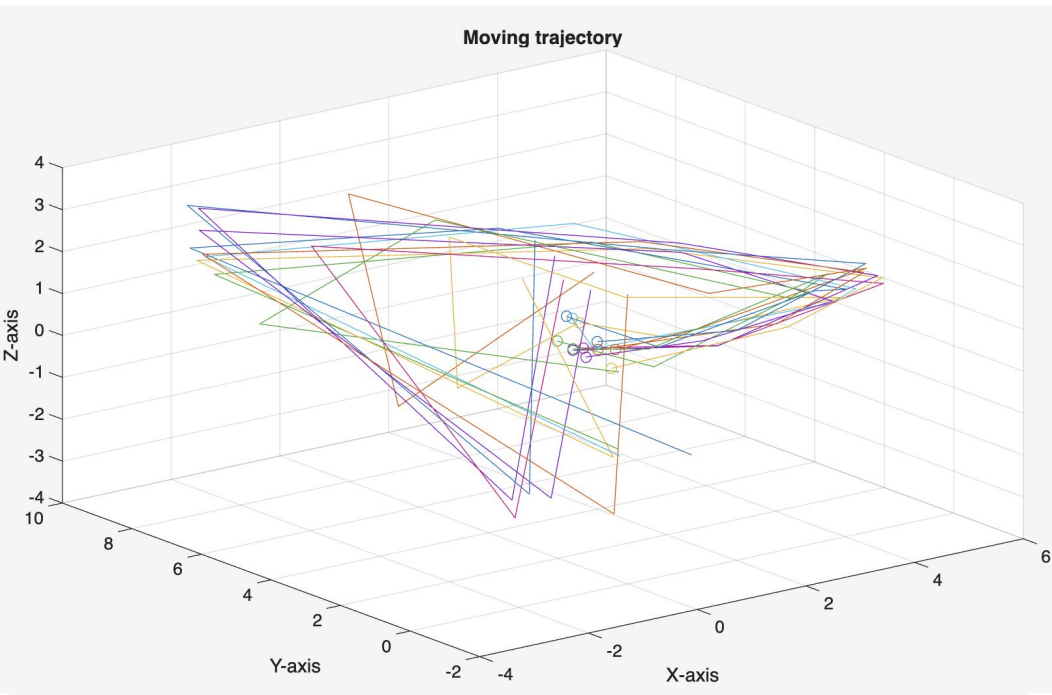


- ◆ Segmenting the rallies into individual stroke segments.

- ◆ Overlaying the stroke segments in 2D and 3D graphs to obtain characteristics

Result: The measurement of acceleration is in g and time is in millisecond

Example: Participant Forehand Analysis

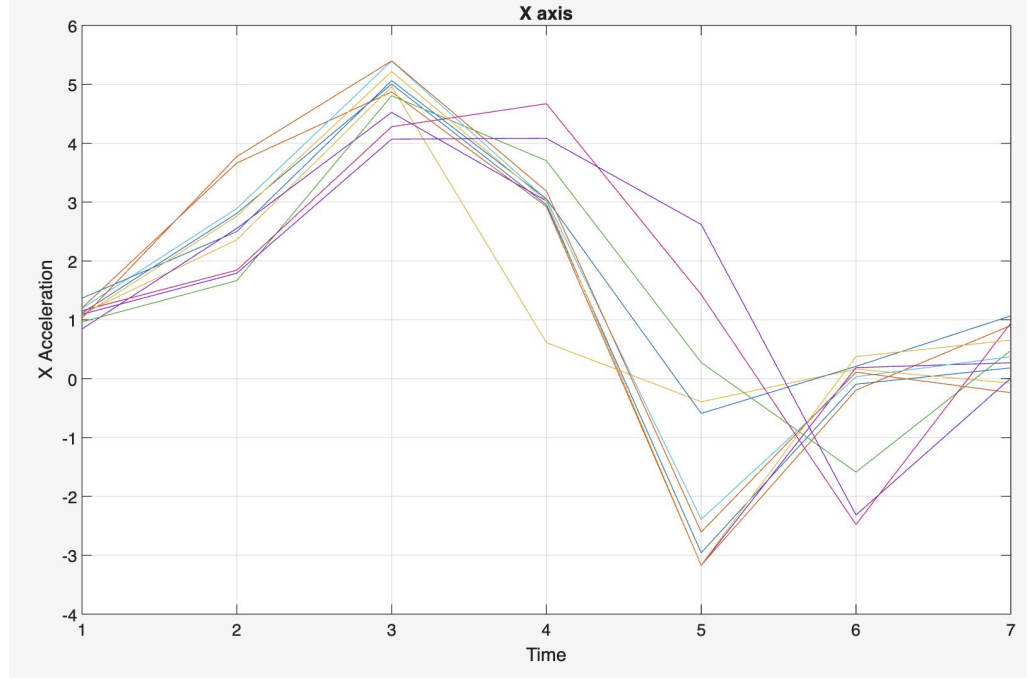


This is a 3D graph, and the lines represent the acceleration of each strokes.

- The graph is tracing a clear pattern, most lines align, indicating overall forehand consistency.
- There are a few outliers in the graph, mainly due to differences in the participant's hitting times.
- The circle marks the start of each stroke
- The motion sequence:
 - Accelerates forward and slightly upward
 - Continues forward-upward, moving toward left side of body
 - Shifts backward and downward, closer to right side
 - Extends outward away from body

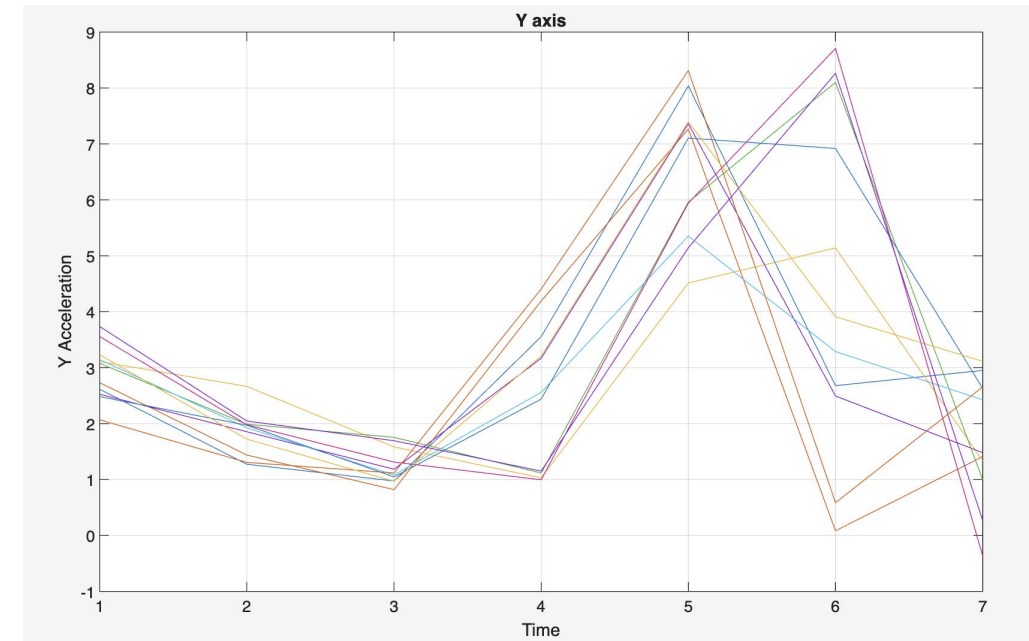
X-axis shows the forward(+) and backward (-) acceleration.

- Has greater forward acceleration than backward acceleration –her forehand moves more forward.
- Peak, at around t=3:
 - standard deviation: 0.3591 g/ms
 - average: 4.8893 g/ms
- The participant is consistent in forward movement, with a small standard deviation.



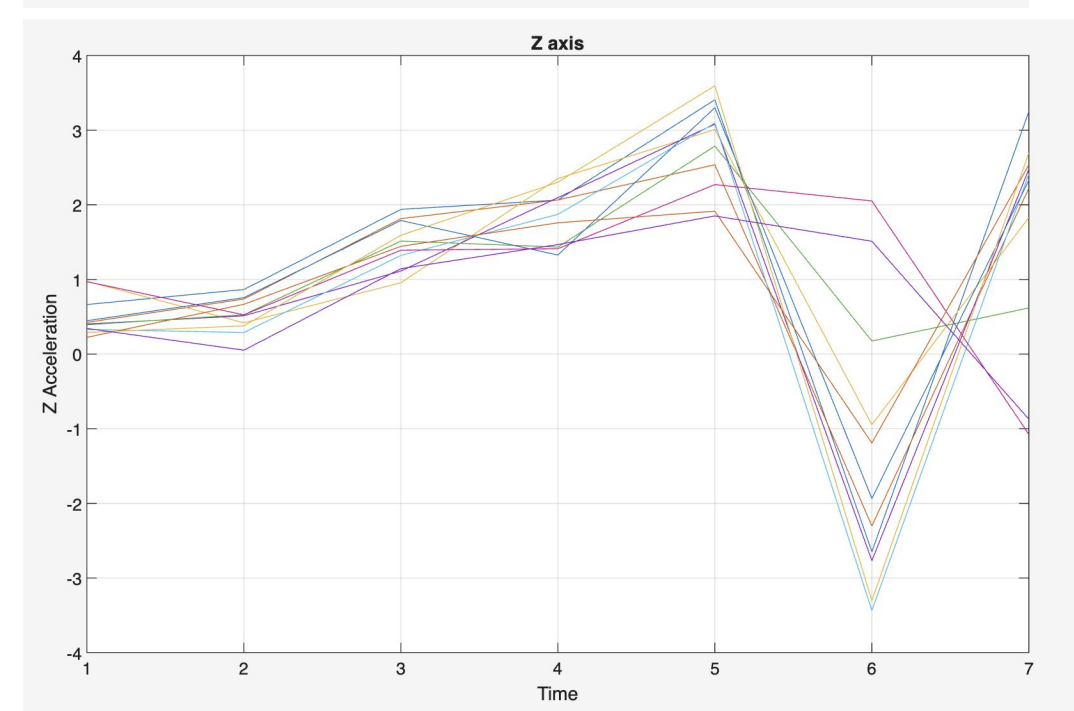
Y-axis shows closer to body(+) and far away from body(-) acceleration.

- Has greater acceleration toward body.
- Peak, at around t=5-6:
 - standard deviation: 1.5558 g/ms
 - average: 7.5512 g/ms
- Although the standard deviation is still relatively small, on this axis, the timing varied; it peaks from t=5 to t=6.
- Since there isn't a great negative number, indicating participant didn't use stretch arm to reach for the ball because most of the participant's arm is close to body (always in position to hit the ball).



Z-axis shows the up(+) and down(-) acceleration.

- Has roughly the same upward and downward movement.
- Peak at t=5:
 - standard deviation: 1.1880
 - average: 1.6380
- Participant accelerates upward slowly, then downward quickly.
- Not much acceleration from this axis, showing that participant has less up and down movement.



Bio:

- Yi-shiuan Lin is a Senior at Lexington High School
- Junior Table Tennis National Team Member
- Represented USA at:
 - 2023 Pan American Youth Table Tennis Championships, West Virginia, USA(two gold, one silver, and one bronze)
 - 2023 ITTF World Youth Table Tennis Championships, Nova Gorica, Slovenia
 - 2023 ITTF World Table Tennis Championships Finals, Durban, South Africa
 - 2022 ITTF World Team Championships Finals, Chengdu, China

Acknowledgments:



CEISMC
Georgia Tech Center for Education Integrating
Science, Mathematics, and Computing

