CALIBRATING A BALANCE BOARD FOR EXERGAMES WITH EQUITY BETWEEN PLAYERS

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Introduction

Cerebral Palsy (CP), occurs in 2.11 per 1000 live births [1,2]. Impairment of balance can significantly impact the mobility of people with CP.

Physiotherapy focusing on maintaining motor control, can be beneficial for CP patients.

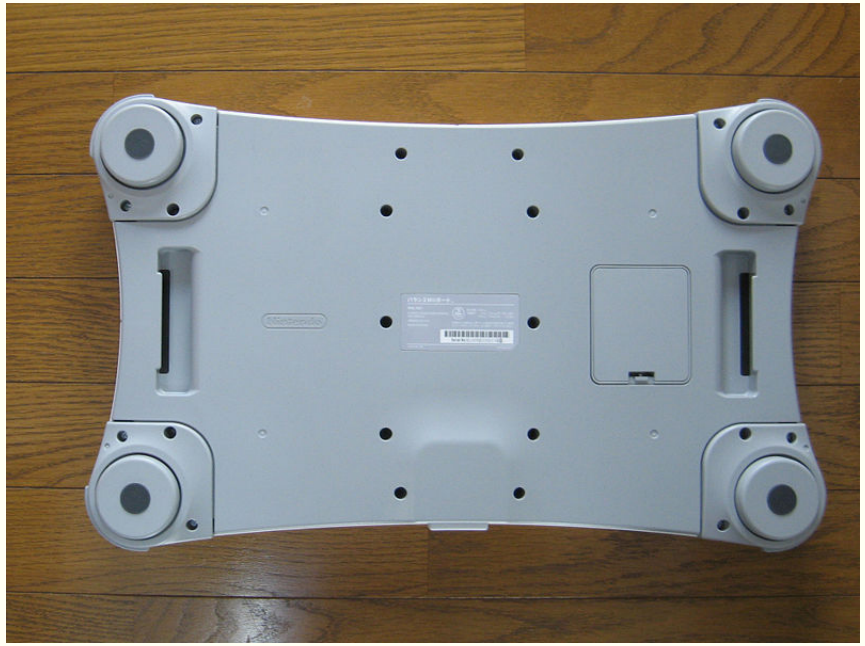
Comparative studies show significant improvements reported, when therapy is conducted with a form Exergame. [3,4]

Balance Boards measure changes in the distribution of a user's weight. This data forms the controller method. [5]

1. M. Oskoui, F. Coutinho, J. Dykeman, N. Jetté, and T. Pringsheim, "An update on the prevalence of cerebral palsy: A systematic review and meta-analysis," Developmental Medicine and Child Neurology, vol. 55, no. 6, pp. 509–519, 2013.
2. C. Cans, "Surveillance of cerebral palsy in Europe: A collaboration of cerebral palsy surveys and registers," Developmental Medicine and Child Neurology, vol. 42, no. 12, pp. 816–824, 2000.
3. A. A. AlSaif and S. Alsenany, "Effects of interactive games on motor performance in children with spastic cerebral palsy," Journal of Physical Therapy Science, vol. 27, no. 6, pp. 2001–2003, 2015.
4. D. Tarakci, B. Ersoz Huseyinsinoglu, E. Tarakci, and A. Razak Ozdincler, "Effects of Nintendo Wii-Fit video games on balance in children with mild cerebral palsy," ediatrics International, vol. 58, no. 10, pp. 1042–1050, 2016.
5. T. B. Weaver, C. Ma, and A. C. Laing, "Use of the Nintendo Wii Balance Board for studying standing static balance control: Technical considerations, force-plate ongruency, and the effect of battery life," Journal of Applied Biomechanics, vol. 33, no. 1, pp. 48–55, 2017.

Balance Board

1. Top Side - https://commons.wikimedia.org/wiki/File:Wii_Balance_Board-Rooooo.jpg



2. Bottom Side - https://commons.wikimedia.org/wiki/File:Wii_Balance_Board_2.JPG

Novel Contributions

People are unique. So is their posture and motor control ability.

1. Calibrate the Balance Board for a personalised game experience.
2. Translate the users motion into game input, with equity.

Overview of the Pipeline

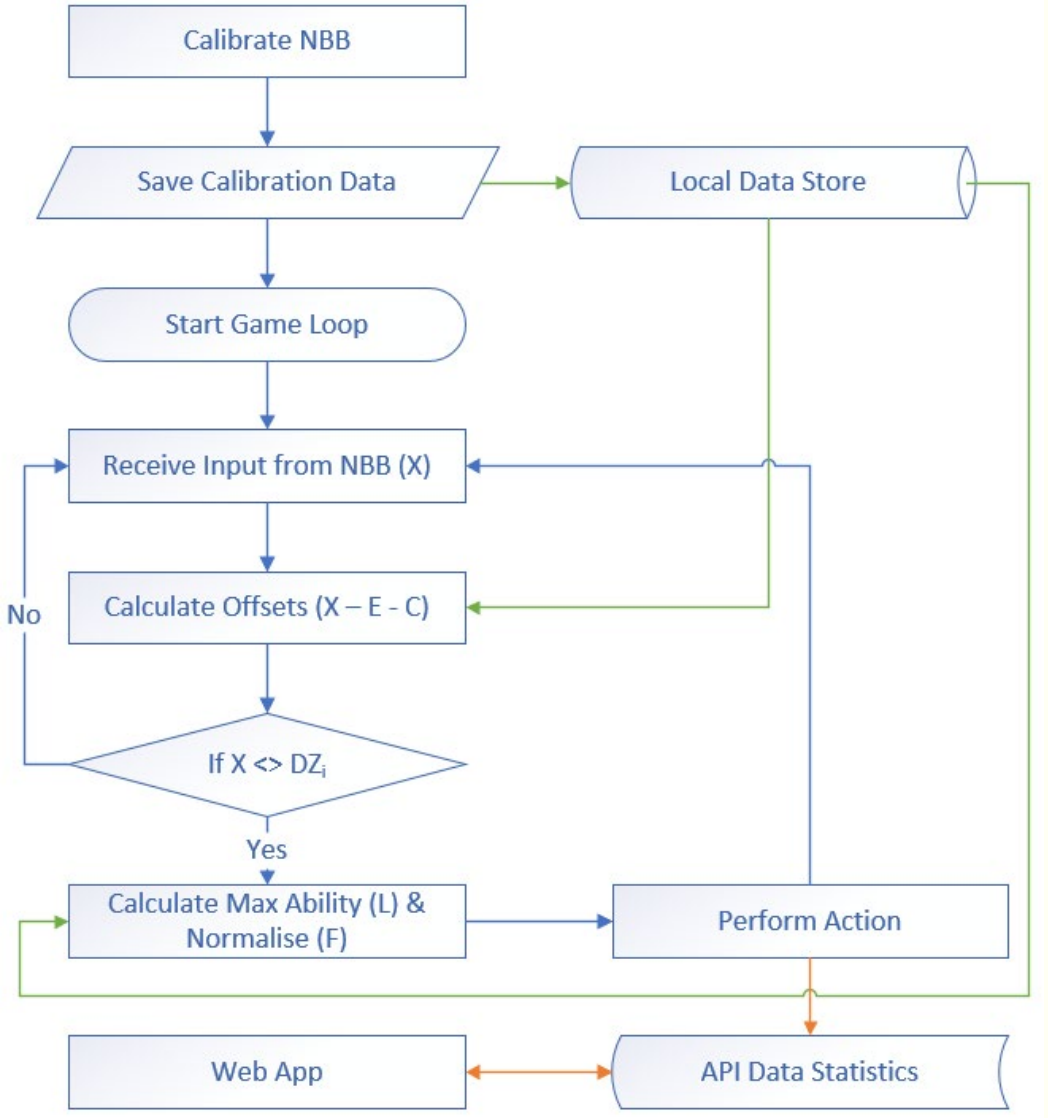
Calibration of the Balance Board is a three step process.

Results are stored locally to be used within the game loop.

Offsets are calculated against the current input.

If movement is detected, it is processed using the users unique lean ability.

The value is translated into in-game movement.



Calibration Process (Empty)

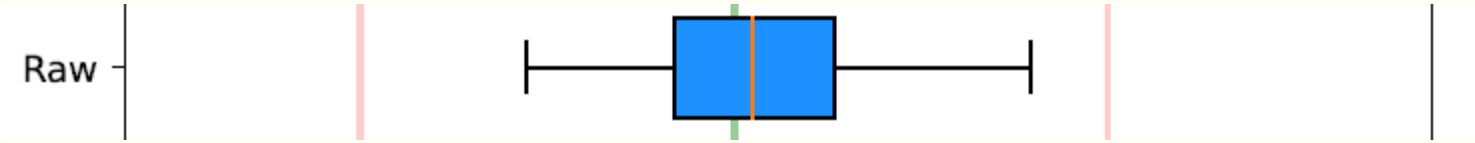
The first step to begin to make the data relevant, is to set an empty Balance Board to zero.

$$E = \frac{\sum_i^n (X_i)}{n}$$

$X = (x, y)$ and corresponds to the current data received from the Balance Board

n corresponds to each time frame

1. https://commons.wikimedia.org/wiki/File:Bathroom_Scale.jpg

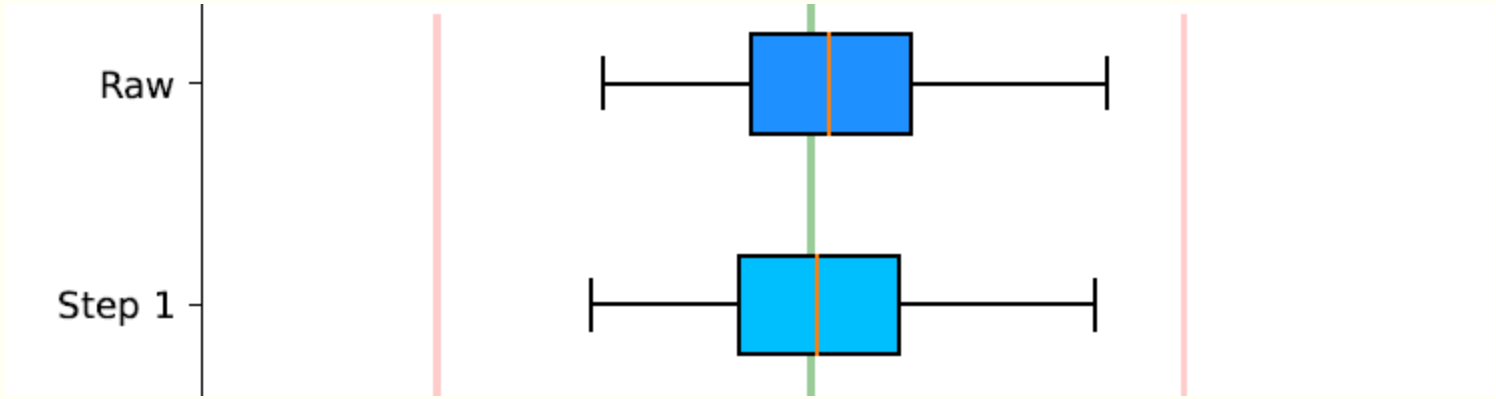


Calibration Process (Standing)

The next step is to calculate the user's unique standing posture.

$$C = \frac{\sum_j^m (X_j)}{m} - E$$

m corresponds to each time frame



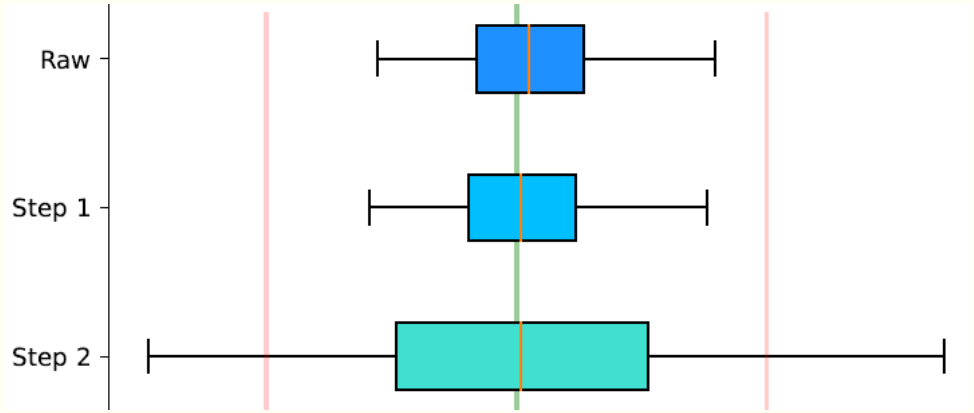
Calibration Process (Leaning)

The final step of calibration, is to take into account the user's maximum lean ability.

Users should lean to a comfortable distance.

$$L_d = \frac{1}{|\sum_k^p (x_k) - E - C|}$$

d is the direction the user is leaning



1. https://www.pinterest.co.uk/pin/41025046582517796/

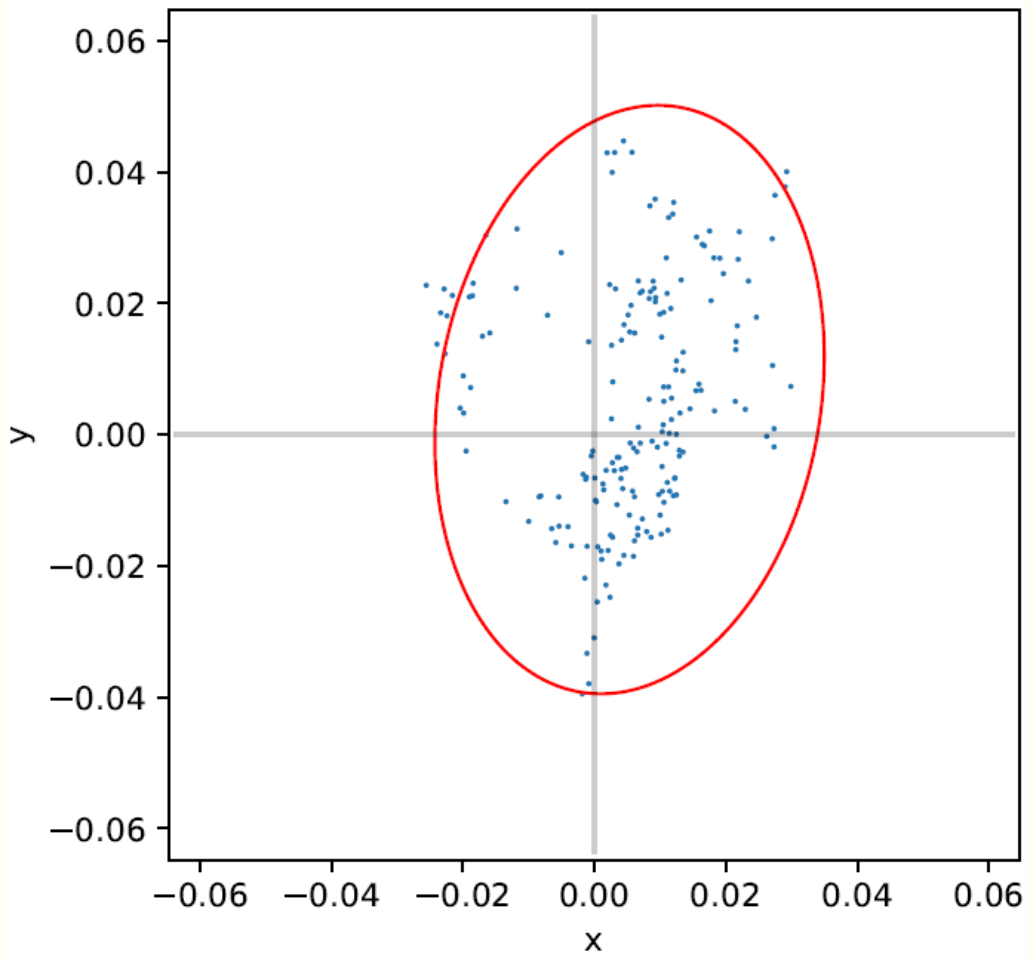
Game Loop

During the standing calibration stage, we can calculate a Dead-Zone (DZ) based on the user's unique body sway.

Every frame, we get new value from the Balance Board, this can be compared against the DZ before movement is translated.

$$f = (X - E - C) * L$$

$$F = \begin{cases} 1, & \text{if } f > 1 \\ f & \\ -1, & \text{if } f < \text{-}1 \end{cases}$$



Results

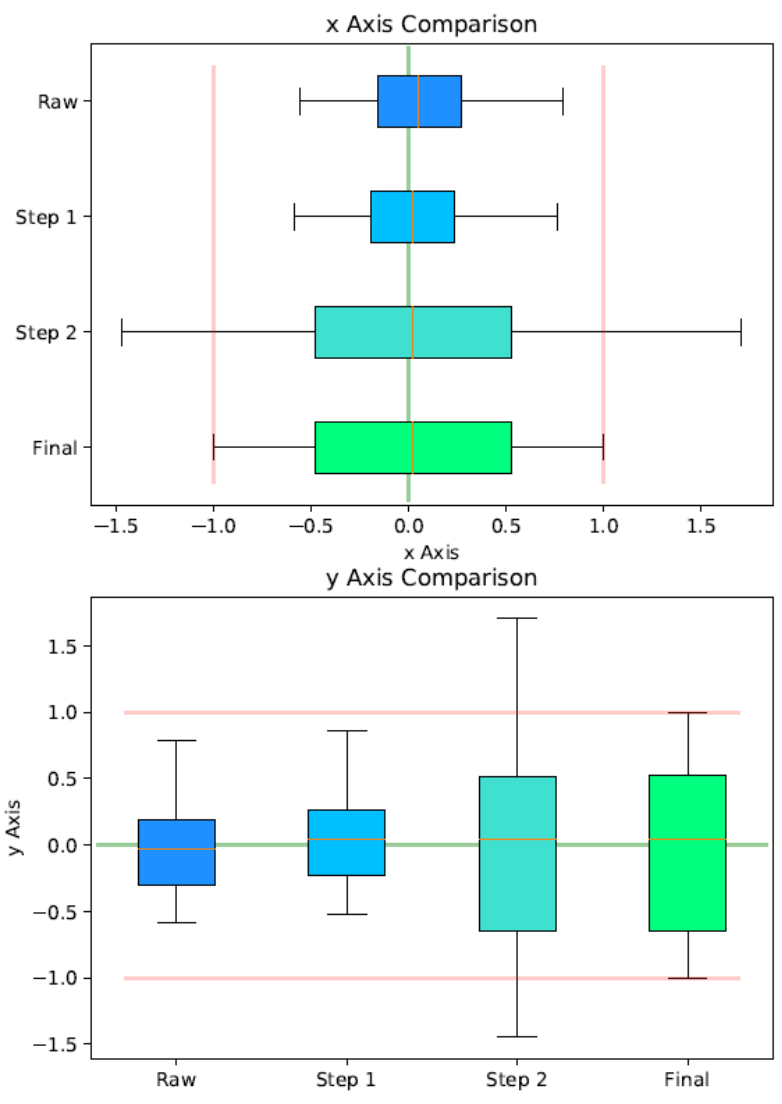


TABLE II
STORED CALIBRATION DATA

E	C	$L_x min$	$L_x max$
-1.253098	1.299769	1.835378	1.936547

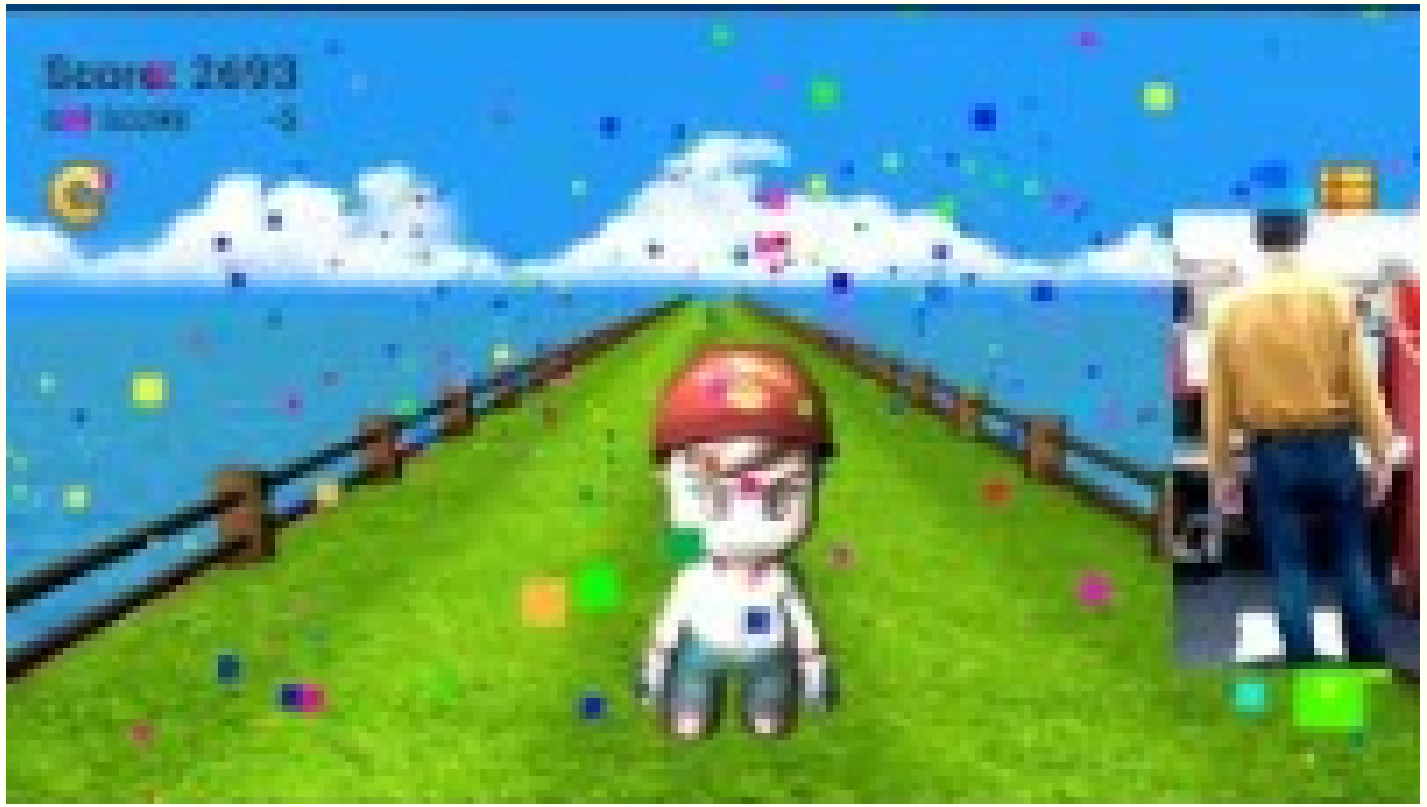
TABLE III
SAMPLE OF LIVE BOARD DATA

Description	Sample 1	Sample 2	Sample 3
Raw x	0.5953678	0.07703974	-0.3300814
Step 1 x	0.5486968	0.03036857	-0.3767526
Step 2 x	1.062577	0.03036857	-0.6914835
Final x	1.0	0.03	-0.69

Thank you for listening

You can follow our progress:

- https://ubitheraplay.com/



Future Plans:

We are teaming up with

- Orchard Hill College https://orchardhill.ac.uk/
- C-Potential https://cpotential.org.uk/

Any questions?