The Inexpensive Starting Block Force Plate for Sprinters

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Abstract: - The focus of this study was to develop a force measurement device capable of tracking forces, moments, and the center of pressure throughout a sprint start. Both of the beginning blocks' force plates are independently adjustable, and they have a pair of force sensors (Loadcell Type- SQB/SQB-A/-SS/-ASS). Currently, commercially available expensive block start force plate use to measure the force production of the block clearance. The two-cantilever type loadcells used to produce this equipment can measure a maximum of 2500N depending on the use of the equipment. Start Blocks incorporate a charging amplifier. The system's sensor component is paired with a signal processing subsystem. To process the signal using the Cool term software and using the Mega 2560 is a microcontroller board with two HX711 Amplifier Module connect to the pressure sensors. Get data output using (Python with C or C++) of Graphical Programming Language (Cool Term Calibration Process and Visualize Data from Sensors Using Arduino + Cool term) Programming. The method utilizes an HC-SR94 ultrasonic sensor and an Arduino Uno chip. Finally, all the cool term columns data can get from the Excel sheet as a Graphical Data. In this study starting bock clearance force production is not statistically significant (P > 0.05). It indicates that the force production performs at a somewhat lower level than the female side in terms of performance. Therefore, possible to identify the athlete force production effect to the Block clearance peak performance. This Force Plate is easy for coaches and athletes to identify force production effectiveness for athlete's block starts performances.

Keywords:- *Force Production, Block clarence, Centre of Pressure, Foot Pendle.*

I. INTRODUCTION

This The athlete's reaction to the gun and initial application of force against the starting blocks have a major impact on overall sprinting performance, particularly in races of 100m or less (Nagahara, 2020). The Olympic-standard sprint starting blocks have two force sensors and a charge amplifier built into a single, streamlined construction, and athletes may customize the blocks to their preferred starting position in training. Each leg's forces were recorded independently.

This allows the force components to be recorded independently for each leg, allowing the force vector or speed to be calculated (Pilianidis, 2011). The force plate data is analysed by software, which also determines key performance metrics and displays the results graphically. Athletes use a lower body technique during the block and early acceleration stages of sprinting that can seem ineffective to a casual spectator. This technique is primarily comprised of a mix of hip flexion on the rear (swing) side, hip extension on the front side, and knee flexion on the front side from the block until the mid-flight phase, forward pelvic rotation on the rear side, and upward pelvic list on the rear (swing) side (Debaere, 2013).

The use of starting blocks to improve the starts of sprint races as well as the overall results (Schrödter, 2016). In sprinting, a sprinter's speed is measured by a rapid succession of leg movements, which is why precise timing is so crucial to the sport. Power, reflex, and adaptability are all contributors to overall velocity (Y Hachana, 2013).

The information gathered by this tool can be useful in training and in analysing an athlete's force output. It may be used to make athletes more effective (Babić V., 2008). Methods for accurately measuring the force required to clear the starting block at the beginning of a sprint are the focus of this study.

An inexpensive Block start force plate has been designed and tested using cool term software package since commercially world available Block start force plates are very expensive. One of the major usages of starting force plate is to measure the power force production during block clearance phase for minimize athlete acceleration performance purposes. Although, this is probably good solution for whole world to identify sprinters block clearance force production using this an inexpensive Block start force plate (AWS Chandana, 2003).

II. MATERIALS AND METHODS

The method used in this research was Research and Development (R & D) cycle. As a consequence of this study, a microcontroller-based device for monitoring sprinter force generation was developed, demonstrating the utilization of research and development methodology.

The two center loading cells are set to the toe of both foot paddles. After the green rubber grips, the pressure sensors are folded. That outcome gets as the digital signal and convert through that in Arduino board, and all the accuracy of the force production can indicate on Excel Sheet.

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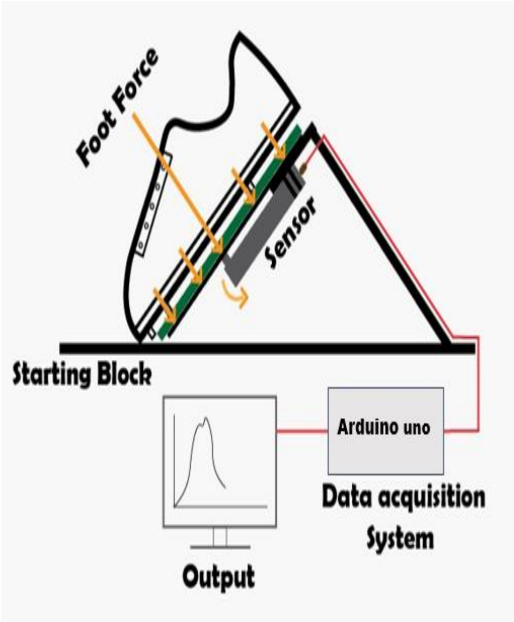

Fig. 1: Methodology Process for foot Pendle force plate design

A. *Materials*

The peak force output values of sprinters in the block clearance phase are the target of this instrument. The sprinter force gauge is a device that is used to measure the amount of force that a sprinter generates during the block clearance phase, which is the initial phase of a sprint race where the sprinter pushes off the starting blocks. It typically records the highest force generated in this phase, and is used to analyses the sprinter's technique and performance.

B. *Pressure sensor*

This apparatus has two primary Sensor components. Once the block paddle was securely fastened to the weight sensors, any movement of the paddle would be detected (up to 2500N). that all weight sensor values were first adjusted to equal 0 on the scale.

Fig. 2: Pressure Sensor (Loadcell Type- SQB/SQB-A/-SS/-ASS)

C. *Arduino Mega 2560*

If you want to power the Mega 2560 microcontroller board, you may plug it into a computer's USB port, use an AC-to-DC converter, or plug it into a 5V battery.

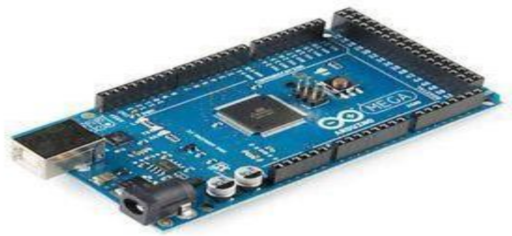

Fig. 3: Arduino Mega 2560

D. *HX711 Amplifier module and Connecter Cable (JUMPER Wires)*

Load Cell two Amplifier breakout board for the HX711 IC that makes it easy to measure weight with two load cells and Jumper wires are employed to connect the parts on the breadboard to a header connector on your Arduino.

Fig. 4: HX711 Amplifier module and Jumper Wires

E. *Testing Procedure*

Used the Cool Term Software to communicate serially with hardware connected to the computer through serial ports.

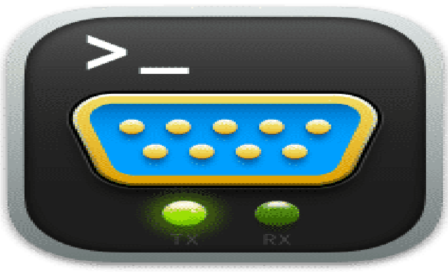

Fig. 5: Cool Term software logo

Visualize Data from Sensors Using Arduino + Cool term Programming Process and Using code similar to the Analog in Out Serial example in the Arduino.Obsrver can read serial data from one sensor. After programming Arduino and connecting it to a computer via USB, open Cool Term and click OPTIONS. Make sure the Baud Rate is set to 57600.Then Start Recording & Saving for Begin to record the data: Click Connection --> Capture to Text File --> Start. Finally, Graph the Data.

III. RESULTS AND DISCUSSION

In this research, the test result average force values using specific force plate for sprint (start block equipped with microcontroller). The Test-retest method was used in this study to measure reliability.

A. Technical Parameter

Special features of this equipment are as follows in Table 1.

Rated Capacities (Emax)	0.25,0.3,0.5,0.75,1,1.25,2,2.25,3,5,7.5,10t
Sensitivity	3.0±0.003m V/V(0.5~10t); 2.0 ± 0.002mV/V (0.25~0.3t)
Accuracy class	C2~C5
Zero Balance	±1% F.S
TC ZERO	±0.02% F.S/10°C
TC SPAN	±0.02% F.S/10°C
Input resistance	400±20Ω
Output resistance	352±3Ω
Insulation Resistance	≥5000M Ω
Temperature Range, Compensated	-10°C~+40°C
Temperature Range, Operating	-30°C~+70°C
Maximum Safe Overload	150% F.S
Excitation, Recommended	10~12V DC
Construction	Alloy Steel Stainless Steel

Table 1: Force sensors specifications (Loadcell Type- SQB/SQB-A/-SS/-ASS)

B. Statistical Validity and Reliability

Validity test in the study compared whole-body reaction test to test using specific reaction time measuring instrument for sprint (start block equipped with microcontroller). In this study, the Test-retest method was used to find the correlation between the score on the first measurement and the score on the second measurement for a reaction time test using a microcontroller-based starting block. This was done to find out how reliable the results were.

All variables that were assessed underwent descriptive statistics. to evaluate the consistency between the two test sessions for tests 1 and test 2. Apply the data in force production results to the Sri Lankan National Sprint Athletes and check the validity of the data.

Table 2. Male and Female Block start Force Production and Reliability for separate legs. Study population has considered all 100m National Sprint athletes in Sri Lanka. Mainly because this study focuses towards 100m event and mainly the starting block clearance techniques including Block Phase (Push Phase). Using Elongated Starting Position (Male n= 4) (Female n= 4). All the average values were included)

Male Athletes				
Age	Height	Weight	BMI	Mean±SD (Front & Rear Leg)
22	172	57	21	1170.2± 1251.27

Female Athletes				
Age	Height	Weight	BMI	Mean±SD (Front & Rear Leg)
23	163	52.2	20.4	1074.4375± 1071.8575

Table 2: Male and Female Block start Force Production

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Male Athletes

t-Test: Two-Sample Assuming Equal Variances

	FRONT LEG	*REAR LEG*
Mean	1170.2	1251.27
Variance	23680.50667	8189.269733
Observations	4	4
Pooled Variance	15934.8882	
Hypothesized Mean Difference	0	
df	6	
t Stat	-0.908240074	
P(T<=t) one-tail	0.199380723	

Female Athletes

t-Test: Two-Sample Assuming Equal Variances

	FRONT LEG	*REAR LEG*
Mean	1074.4375	1071.8575
Variance	39163.96709	24644.16909
Observations	4	4
Pooled Variance	31904.06809	
Hypothesized Mean Difference	0	
df	6	
t Stat	0.020427333	
P(T<=t) one-tail	0.492182424	

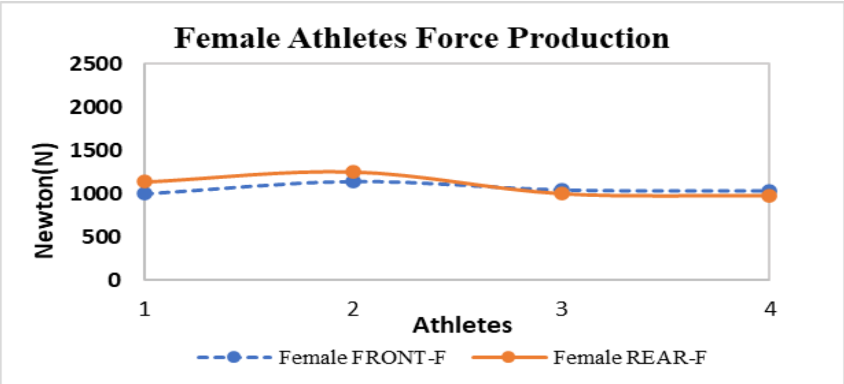

Fig. 6: Male athletes Block clearance Apply force

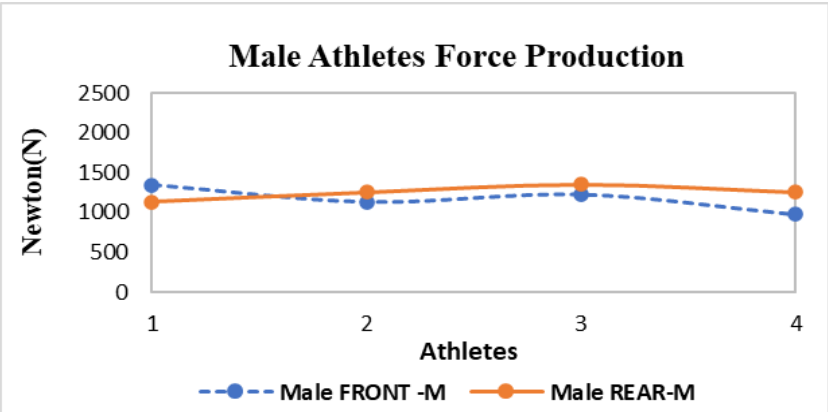

Fig. 7: Female athletes Block clearance Apply force

IV. CONCLUSIONS

One of the most important parts of winning a sprint race is how well preform block start. The speed with which the athlete leaves the blocks, the direction of force, the push-off, and reaction time are all important parts of a good start. The starting blocks that measure force separately for each leg. This lets the force vector be found and performance-related parameters be calculated. This gives the coach a good way to judge the athlete's technical and physical skills and makes training more effective. Sprint-specific reaction time measuring instrument (start block with microcontroller) has been able to do its job consistently, so it is reliable. As this can be made at affordable cost, it can be used any training conditions. With the current situation in the world, this can be introduced as an inexpensive tool to less money. This shows that the development of a sprinter reaction time measuring instrument based on a microcontroller can be used to measure sprinter reaction time well.

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