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Injury Prevention for Javelin Athletes using Sensors and IOT

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Abstract: ***The main idea of this dissertation was to understand the inter-relationships among Biomechanical parameters which describes for javelin throwing execution and wounds continued by javelin throwers. One of the multi-joint, complex track and field throwing events is javelin throw, which needs great coordination on physiological and movement parameters. Current Javelin throwers mainly concentrate on muscular strength and the control to throw the javelin at long distance with high speed. But, it is essential for both men and women javelin throwers to effectively transfer run-up momentum and throwing arm action into great release speed and to control the release. A Great joint power was seen in spear hurlers were related with developments of the shoulder and elbow which is the system for lance tossing damage. These parameters may be modified to decrease injury risk without affecting the performance to achieve maximum throwing distance. Now a day technological advancements are increasing at a faster face, but the utilization of technologies in various sectors is very low. Considering the possible injuries to could occur, this system has been proposed for the welfare of javelin throwers. This indicates whenever the athletes commit a mistake while throwing the javelin which in-turn prevents further injuries through feedback mechanism using the sensor, IoT and Mobile App. The real-time monitoring of injury parameter and providing feedbacks become tremendous potentials for maximizing athlete's performances.***

Keywords: Injury parameters, Sensors, IoT, Athletes, and database.

I. INTRODUCTION

The origin of the javelin throw is obvious. Javelin means simply spear, javelin is a diminutive word of javelot. Initially, javelin is used for seeking food by primitive hunters and then used as a weapon by the Ancient Egyptian Military in the war-field but now a day's predominantly for sports. The weighs of javelin is lighter in sports when compared to wars. In older day, the javelin was made up of wood, now a day modern javelin is made up of aluminum or graphite.

The javelin weighs 800gm 600gm are used in the men's athletic event and women's athletic event respectively, for the age group of 19 to 49 and the weight of javelin depends on both the age group and gender. The rule of the javelin event is to throw the javelin for a maximum distance without touching a foul line. The maximum distance covered by the javelin depends up on 3 factors: release speed, release angle and the height at which javelin is thrown.

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The lift and drag force are minimized with correct release angle. Projectile of the javelin is also various with respect to height of the athlete.

In India, the game of javelin throw is a famous olympic style events rivalry delighted in by numerous spectator and competitors and performed at both national and global levels. It has picked up notoriety in the IAAF (International Association of Athletics Federation) acknowledge rivalries including the Olympic Games. Like competitors in all games, spear throwers are defenseless against wounds. javelin thrower experience a high inescapability of shoulder, elbow, lower back and knee wounds. The most widely recognized kind of damage was the average ulnar insurance tendon sprain, regularly known as javelin thrower elbow. The primary driver of wounds was poor tossing biomechanics that prompted compensatory development designs, bringing about community oriented muscle strength.

Javelin throw has been an over-arm tossing occasion in Olympic style events. Javelin throwers are prepared to toss the spear quite far. Despite the fact that being prepared to stay away from damage, Javelin throwers have a high rate of damage that essentially influences their presentation and personal satisfaction. Throwing procedures legitimately influence their presentation and might be related with wounds they continue. In spite of entangled systems for execution, and high damage rate, logical investigations that basically assess throwing procedure with 3D, biomechanical techniques are restricted. The general reason for examination, along these lines, was to decide the between connections among spear tossing system, lance tossing execution, and wounds continued by lance hurlers. The two most significant and controllable components are javelin release speed and release angle.

To defeat this, sensors can be utilized to scientifically compute the distance secured by the javelin throws. The sensors used are a MEMS sensor and a pair of pressure sensors which come in handy in determining the overall distance traveled by the javelin. Moreover, it indicates whenever the athlete commits mistakes while throwing the javelin and produce feedback to prevent athlete injuries. Javelin throwing technique may vary from athlete to athlete. In general, a spear tossing method comprises of seven segments such as carry, run-up, withdrawal, crossover, single support phase, delivery phase, and recovery phase. This is common for men's and women's javelin irrespective of left and right-hand thrower.

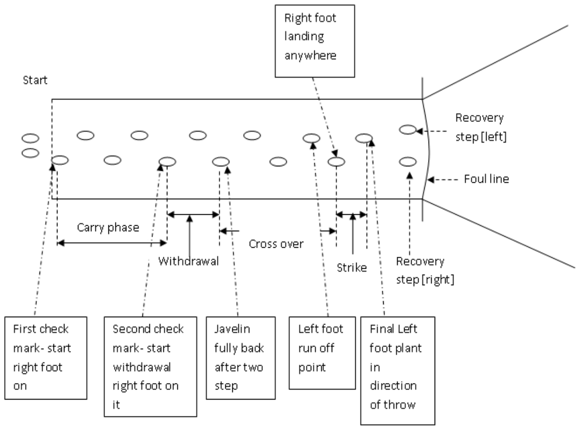


Fig.1. Javelin arena

Fig.2. Javelin release Position of an Athlete

II. EXISTING SYSTEM

In older days, traditional methods are used by the coach to analysis the performance of athletes and provide feedback manually to athletes to correct their mistakes. Furthermore, the coach could not give individual attention to every athlete in a large group. As a result, the athletes were prone to injuries which in turn affected their performance and overall results. Therefore, it was very difficult for a coach to select true athletes for further competitions.

In the last few years, a technological training was proposed by many researchers, Steve carried out a new technique in which a High Definition Cameras are used to record every player throwing the javelin frame by frame and it is analyzed by a data specialist mathematically and later a feedback is given to the player advising them to improve their performance.

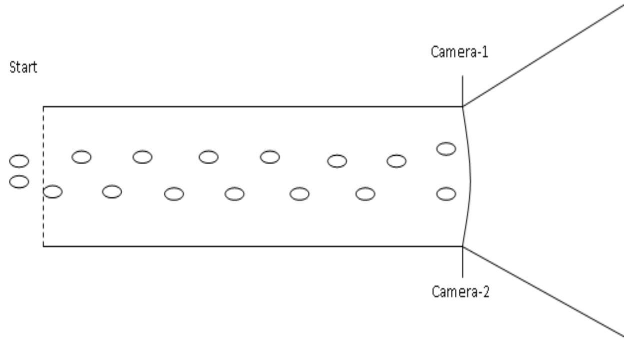


Fig.3. The positioning of two video camera in the javelin arena

But it suffers many disadvantages,

- Positioning the camera exactly in the javelin arena is very difficult
- We need two or more high definition camera to capture the video in different directions.
- In most of the researcher concentrate only on the analysis of thrower performance. But they do not concentrate on the following factors,

i. Day-wise Database maintenance of each athlete performance.
ii. Provide feedback about their performance.
iii. Attain maximum throwing distance without injuries.

In our research, we concentrate all those things with the help of a tiny sensor which is cost-effective when compared to cameras. The SQL database is used to maintain each athlete data's up to date and also throw mail we provide feedback about strength and weakness of athletes to improve their performance and also it is very useful to coach to analysis about athlete's performance at any time. Therefore they are doing their training without injuries

III. PROPOSED SYSTEM

Micro-electro mechanical systems (MEMS) are Freescale's empowering innovation for increasing speed and weight sensors. MEMS-based sensor items give an interface that can detect, process as well as control the encompassing condition. Here MEMS is an accelerometer and gyroscope sensor used to measure both angles of the elbow and released speed of javelin. Pressure sensors are used to measure how much pressure applied in hand and leg to pull the javelin in the throwing direction, with the help this avoid knee injuries. UART is used here communication device and all the data's are stored in the cloud with the help of IoT.

A. Proposed algorithm:

Step - 1 : Sensors are fixed in the corresponding places to sense the required value

Step - 2: Sensed values are send to Cloud using Wi-Fi device for further analysis

Step –3: From the data base , we analysis the injury parameter and provide feedback to correct the mistakes

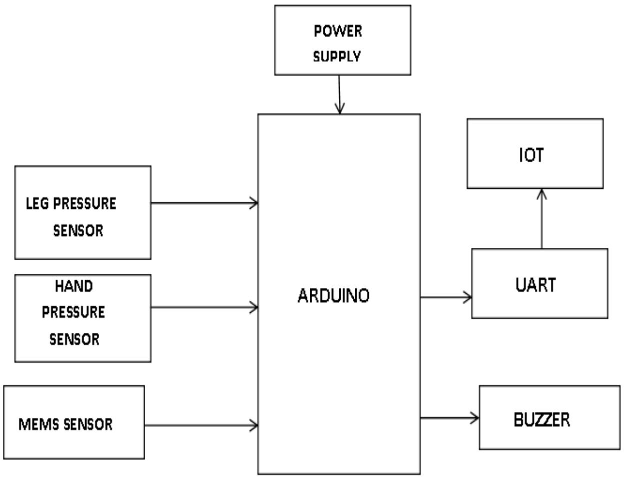


Fig .4. Functional Block Diagram of Proposed System

B. Hardware Setup

In this, we use an IoT based system which is used to determine the distance traveled by the javelin. Two pressure sensors are used, one is fabricated in the athletes right/left shoe and the other one fabricated to the athletes right/left glove which determines the pressure applied on the javelin as well as the pressure exerted on the foot and hand. A MEM sensor is used to determine the take-off angle at which javelin must be thrown. Approximately the take-off angle of javelin throw taken for analysis are **20°, 25°, 30°, 35°, 40°,** and **45°**.

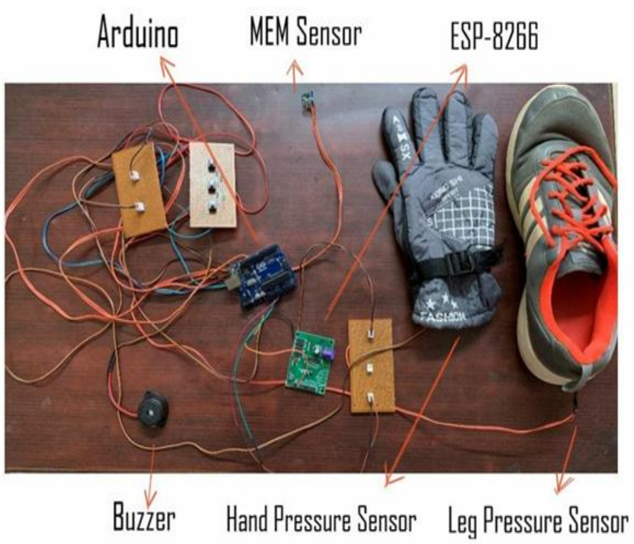
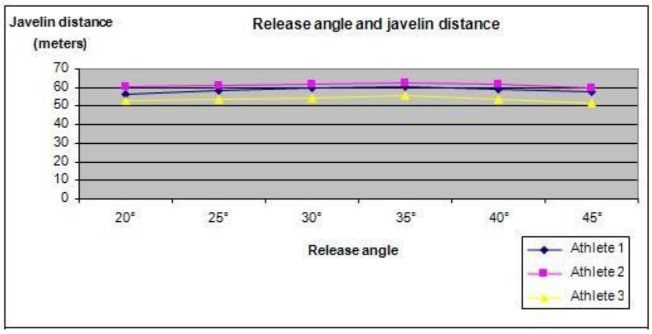


Fig .5. A prototype of the Proposed System

Arduino UNO is the main component used for this procedure in which both the values obtained by the pressure sensors and MEMS sensor are stored and updated with the help of a Wi-Fi module. Moreover, an IoT module (ESP8266) is used as a wireless medium which helps in transferring the values derived and stored in the Arduino to a cloud database which gets updated periodically. These values can be used to determine the javelin traveled distance and thereby monitoring the performance of the javelin throwers. Moreover, injuries can be prevented as the database will be alerted with a warning message indicating whenever the athlete commits mistakes while throwing the javelin.

Table.1 Angle Sensor outputs

Participant	Distance traveled by the javelin (meters)					
Angle	20°	25°	30°	35°	40°	45°
Athlete 1	56.7	58.2	59.7	60.5	59.4	57.5
Athlete 2	60.2	61.4	62.1	62.8	61.7	59.8
Athlete 3	52.7	53.4	54.7	55.5	53.6	51.8



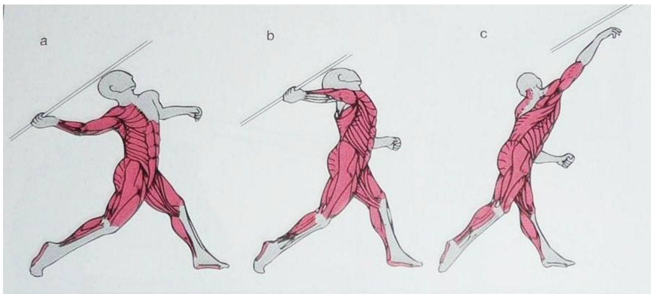


Fig.6. The release point of Javelin.

C. Experimental result

- First, go to the IoT icon in the Mobile App.
- Enter into this App through your login ID and password.
- After logging in, Click on the **Sensor** icon to access the IoT data are stored.

Fig .7. Sensor output of the proposed system via Mobile App

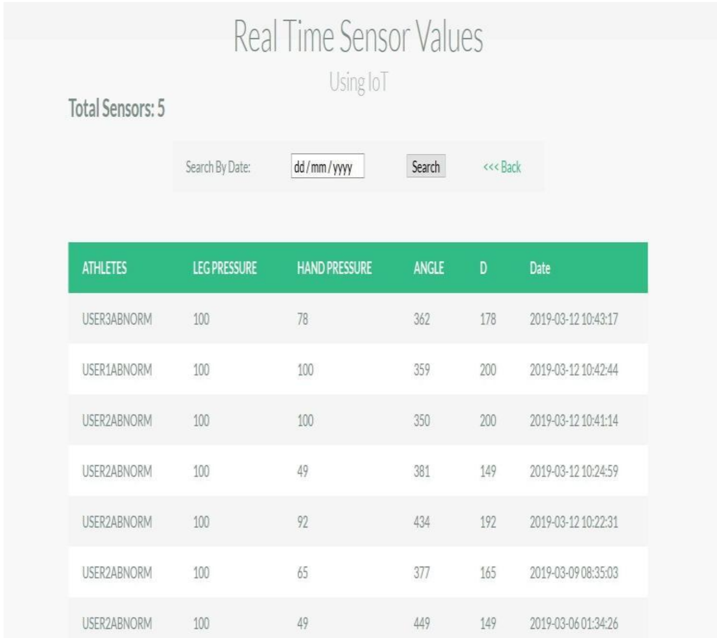


Fig .8. Sensor Values of different athletes

Table.2. Various Sensors output

ID	Player Name	Factor	D1			D2			D3			D4			D5			D6		
			T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
001	NISANT	RA	28	27	29	26	27	30	28	28	32	29	30	31	27	26	32	32	32	33
		RH	1.6	1.8	1.9	2	2	2	1.6	1.6	1.8	1.8	1.8	2	2	2	1.9	1.9	2	2
		RS	17	20	18	21	19	19	18	17	17	20	21	21	19	19	21	20	21	22
		HP	170	200	180	210	190	190	180	170	170	200	210	210	190	190	210	200	210	220
		LP	210	250	280	250	230	225	210	240	230	250	260	260	210	220	230	210	250	260
		D	27.1	36.2	31.1	39.1	33.3	35.0	30.1	27.1	29.1	37.6	41.8	42.8	33.3	32.6	43.3	39.5	43.4	47.9
002	SAM	RA	25	25	28	25	30	30	28	33	27	30	29	30	29	29	30	30	29	30
		RH	2	2	1.8	2.1	2.1	2.2	2	2.1	2	2.2	2	2	1.9	1.9	1.9	2.1	2.1	2.1
		RS	18	19	19	19	20	19	21	17	19	17	19	19	16	18	19	18	18	19
		HP	180	190	190	190	200	190	210	170	190	170	190	190	160	180	190	180	180	190
		LP	220	230	230	240	250	230	250	200	240	210	250	240	200	230	240	220	230	240
		D	29.0	31.9	33.6	32.1	38.6	35.3	40.7	29.8	33.3	28.8	34.5	35.0	25.2	31.1	34.9	31.9	31.4	35.2
003	VINAY	RA	28	33	29	30	33	25	25	27	29	32	29	33	30	28	33	29	33	26
		RH	1.6	2.1	1.9	2.2	2.1	2.1	2	1.8	1.8	1.8	1.9	2.1	2.2	1.6	2.1	1.9	2.1	2
		RS	17	17	18	17	17	17	18	20	20	17	18	17	17	18	17	18	17	19
		HP	170	170	180	170	170	170	180	200	200	170	180	170	170	180	170	180	170	190
		LP	210	200	230	210	220	210	230	250	250	200	230	200	210	240	200	230	210	260
		D	27.1	29.8	31.1	28.8	29.8	26.4	29.0	36.2	37.6	29.1	31.1	29.8	28.8	30.1	29.8	31.1	29.8	32.6
004	GURU	RA	33	30	27	25	30	28	26	25	27	26	27	30	27	26	27	27	30	30
		RH	2.1	2.2	2	2.1	2.2	1.6	2	1.7	2	2	2	1.8	1.8	2	1.8	2	2	1.8
		RS	17	17	19	17	17	17	19	19	19	19	19	21	20	19	20	19	19	21
		HP	170	170	190	170	170	170	190	190	190	190	190	210	200	190	200	190	190	210
		LP	200	210	230	200	210	200	250	240	250	240	250	260	250	240	250	240	250	260
		D	29.8	28.8	33.3	26.4	28.8	27.1	32.6	31.4	33.3	32.6	33.3	41.8	36.2	32.6	36.2	33.3	35.0	41.8
005	ANAND	RA	27	26	25	33	29	27	26	30	30	28	30	25	30	26	30	27	29	26
		RH	1.8	2	2.1	2.1	1.9	2	2	2.2	2.1	1.6	2	2.1	2	2	2.2	2	1.9	2
		RS	20	19	17	17	18	19	19	17	20	18	19	17	19	19	17	19	18	19
		HP	200	190	170	170	180	190	190	170	200	180	190	170	190	190	170	190	180	190
		LP	250	240	200	210	220	240	230	200	250	210	230	200	220	230	200	240	240	250
		D	36.2	32.6	26.4	29.8	31.1	33.3	32.6	28.8	38.6	30.1	35.0	26.4	35.0	32.6	28.8	33.3	31.1	32.6
006	Balaji	RA	27	28	29	27	32	30	33	28	32	29	27	30	30	28	30	28	32	33
		RH	2	1.6	1.9	1.8	1.9	2.1	2	2	2	1.9	2	2	1.8	2	2.1	2	2	2
		RS	19	17	18	20	20	20	22	21	21	18	19	19	21	21	20	21	21	22
		HP	190	170	180	200	200	200	220	210	210	180	190	190	210	210	200	210	210	220
		LP	240	200	210	250	260	250	260	250	260	230	240	240	260	260	250	260	270	270
		D	33.3	27.1	31.1	36.2	39.5	38.6	47.9	40.7	43.4	31.1	33.3	35.0	41.8	40.7	38.6	40.7	43.4	47.9

RA – Release Angle in degrees RH – Release Height in meters RS – Release Speed in m/s HP – Hand pressure in kpa

D – Days T – Throws D – Distance Travelled in meters LP – Leg pressure in kpa

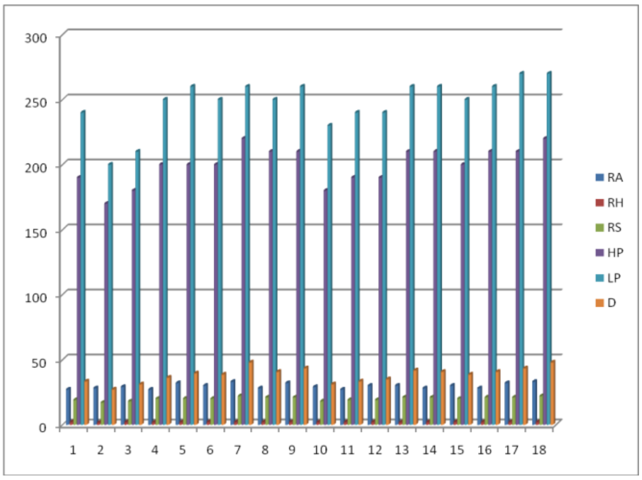


Fig .9. Best. Athlete performance graph for eighteen throws

IV. CONCLUSION

In this project, we have focused on the problems encountered by the javelin players during their practice and preventing the injuries encountered by them. A survey shows that there is nearly 60% chance of injuries to javelin throwers namely shoulder, neck and spinal cord injuries which greatly affect their performance, overall results, and severe life-threatening diseases. In order to prevent and overcome this, we have proposed a sensor-based IoT system which consists of a pair of pressure sensors and a MEM sensor which are fabricated along the wearers jacket or jersey which can mathematically analyses the pressure exerted by the javelin player on the javelin as well the force exerted on the leg and the take-off angle. These data's are stored in the Arduino which is later transferred to an IoT cloud database via an IoT module (ESP 8266). The results are then finally analyzed and proper feedback is given, and also these data's can be recorded and monitored by the trainer for multiple players. Thus, the trainer finds it easy to give proper suggestion to every player. Thus this cost-effective method would find a sweet spot in providing the players who have proven fit and can further include themselves in competitions representing their State. Athlete can improve their performance by themselves.

V. FUTURE SCOPE

We have proposed a system in which the components used here are interconnected to one another using a wired medium. As a result, these wires remain tangled to one another which when fabricated in an athlete's jersey may find it difficult and uncomfortable to practice with wires running all over his body. Moreover, exerting excess force to the sensors can possible to damage the components and cause miss failure, Weight is a major drawback since all the components are interfaced separately and connected using wires rather than all of the components imprinted on a single board. Hence, this system can be improved by eliminating wires and wireless sensors and components can be used. All the components could be fabricated in a single wearable device so that all of the above-mentioned flaws could be corrected. Moreover, Athletes find it is quite simple and easy to analyze their performance data's and moreover the weight of the components are drastically reduced. This is now tested for a right hand, male thrower only if it is more comfortable device than we use for any type of athletes just like left-hand thrower and female thrower and also used for a different sports event in future.

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