A SYSTEMATIC REVIEW ON LUMBAR ALIGNMENT DEVICE'S MECHANISM USING SENSOR FUSION TECHNOLOGY

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Abstract: Good posture reflects a proper state of mind which let anyone get away with anything but people nowadays, is experiencing loads of work burden that are resulting in a bad posture. In this work the role of sensors in posture corrector devices are reviewed. Multiple techniques with different applications are used to detect, identify, and classify the lower lumbar spine movement. In the review multiple sensors employed in posture correctors are reviewed. Each sensor has a different working principle, its own advantages and disadvantages in this review, each paper had different methods and sensors. They are used in the devices according to their functions to get the exact expected output.

Keywords: Lumbar spine movement, multiple sensors.

INTRODUCTION:

In this fast-moving technological world between staring at computers and hunching over mobile phones great numbers of people are working as hard as possible without even worrying about the health in first place as money has become the status decider people started chasing for it where they end up with back pain and poor posture.

Postural dysfunction (or) poor posture is one of the common problems among all age groups in recent years. Prolonged hunching while sitting and standing causes the muscles more strained and stressed this reduce the blood flow and numbness and results in lower back pain. The devices that are used could be contributing to awkward positioning and bad posture. There are few devices that are used to detect the lumbar spine movements and correct the posture. They give live biofeedback of the spinal movements. Some of the visible symptoms of the poor postures are shown in the Figure.1 below as follows,

FIGURE 1 VISIBLE SYMPTOMS OF THE POOR POSTURES
Spinal postures can be brought back to the normal state using different technological posture corrector devices. The direct and the indirect treatment for spinal posture correction is estimated more than $100 billion per year globally. While 80% of the population in the world experience back pain due to the improper posture and spinal movements. In common, when people suffer from back pain, they are suggested to undergo minimal invasive surgery like dynamic joint braces which brings the spine normal within 6 to 12 months. By and large, there are two advances for the posture identification that is non-wearable and wearable innovation. Vision-based innovation includes picture preparing through programming. Detecting innovation is the most embraced approach in the field of posture discovery. The issue in both the non-wearable and wearable methodology is that they are similarly expensive, secure, information reasonable and their reliance on enlightenment yet this will not make a major concern about a distinction with regards to remedying the posture. Sensors are planned in a way with the goal that they can undoubtedly discover and to distinguish certain credits or changes in the climate and to give criticism to the framework dependent on its recognition. The order of sensors depends on the reason, and various models.

**METHODOLOGY:**

An extensive survey was led with the assistance of Pub Med, drug line, EMBASE and Scopus Articles identified with wearable and non-wearable advancements. Key inquiry terms include: Wearable and non-wearable, Posture observing, act locator innovations. Different sensors were utilized in both wearable, non-wearable advances to identify and to dissect lower back development of subject's body. Engineering of wearable and non-wearable specialized framework can be isolated into five squares. They are,

![Figure 2 Architecture of Technical System](image)

This is the architecture of the technical system. This shows that when the input power is given the sensor particular respective sensor calibrates and the sends to the data to the core which then process the data and results in communication.

This article surveys the various advances that utilized various sensors to distinguish and address the lower lumbar spine in the corrector gadgets. Wearable advances and sensors utilized is various gadgets is classified and the explored distributions are the investigated distributions clarified utilizing existing innovation, segments utilized, sensors utilized, their input framework, point of the examination and the finish of the investigation. This shows a detailed study of the different devices.
| REFERENCE                     | EXISTING DEVICES                                   | EXISTING DEVICES                      | DEVICE TYPE                  |
|------------------------------|----------------------------------------------------|---------------------------------------|------------------------------|
| (Bell J, 2007)               | Fiber-Optic Goniometer System                      | Fiber Optic Sensor.                   | Wearable Device System       |
| (Charry E, 2011)             | Dorsavi’s Vimove                                   | IMU Sensors (One Tri-Axial Accelerometer, One Single Axis Gyroscope) | Wearable Device System       |
| (Dunne L, 2008;2(2))         | Plastic Fiber Optic System                         | Fiber Optic Sensor                    | Wearable Device System       |
| (Gleadhill S, 2016; 49(7))   | Spine Angler                                       | Accelerometer Sensor                  | Wearable Device System       |
| (Harms H, 2009.)             | Smash Accelerometers                               | Accelerometer Sensor                  | Wearable Device System       |
| (Kang S, 2017; 17(2560)      | Smart Garment                                      | IMU Sensors                           | Wearable Device System       |
| (Leung K, 2012)              | Limber                                             | Accelerometer, IMU                    | Wearable Device System       |
| (Nath N, 2017; 62)           | Mobile Sensors with IMU                            | Smartphone Sensors, IMU Sensors       | Wearable Device System       |
| (Plamondon A, 2007; 38       | Hybrid System                                      | IMU Sensors                           | Wearable Device System       |
| (Sardini E)                  | Inductive Sensor                                   | Inductive Sensor                      | Wearable Device System       |
| (Tsuchiya Y, 2015)           | Flex Sensor, Accelerometer                         | Accelerometers, Flex Sensors          | Wearable Device System       |
| (Yan X, 2017; 74)            | Yei 3-Space                                        | IMU Sensors                           | Wearable Device System       |

**TABLE 1** DIFFERENT TECHNOLOGIES THAT USED DIFFERENT SENSORS TO DETECT AND CORRECT THE LOWER LUMBAR SPINE IN THE CORRECTOR DEVICE
DISCUSSIONS:

(Bell J, 2007) - Development of a fiber optic goniometer system to measure lumbar and hip movement to detect activities and their lumbar postures - Utilizing fiber optic goniometers, lumbar postures were recognized. By connecting fiber optic goniometers in lumbar spine and hip for 8 min while being recorded utilizing a camcorder when sitting, standing, and walking. Spectator Software was utilized to code the video recording, empowering the sagittal development attributes of each FOG to be portrayed for singular exercises. This paper came about that the System announced as agreeable and inconspicuous; movement profiles precisely distinguished business-related exercises and evaluate lumbar postures.

(Charry E, 2011) Design, and validation of an ambulatory inertial system for 3-D measurements of low back movements - In this present Dorsavi's ViMove inertial sensors are utilized to scale lower back directions in 3 measurements when the simple inertial signs are prepared, with the help of OPTOTRAK framework positive outcomes were acquired.

(Dunne L, 2008;2(2)) Wearable monitoring of seated spinal posture - This work depicts the assessment of a wearable plastic optical fiber (POF) sensor for checking situated spinal posture, an article of clothing incorporated POF sensor was created and tried on nine sound subjects. The outcomes show that the wearable sensor approximates the exactness of master visual investigation and gives adequate precision of estimation to dependably screen situated spinal posture.

(Gleadhill S, 2016;49(7)) The development and validation of using, inertial sensors to monitor postural change in resistance exercise - In this technique inertial sensor were utilized to evaluate the postural changes during weight lighting and exercising. This research gives the establishment to the inertial sensors to be applied for subjective action acknowledgment of opposition exercise and safe lighting measure. This came about with error in yield.

(Harms H, 2009.) A Wearable therapist: sensing garments for supporting children improve posture - Smash is of accelerometer sensor. it is a wearable therapist. A detecting piece of clothing that helps in following the lower back postures and help in giving training input to address the postural brokenness exceptionally in kids.

(Kang S, 2017;17(2560)) The development of an IMU integrated clothes for postural monitoring using conductive yarn and interconnecting technology. Sensors - A smart wear, which is comprised of a conductive yarn, the metal fibers and IMU sensors set on the pieces of the body to quantify posture and contrast them and movement caught camera framework.

(Leung K, 2012): DIY wearables for reducing risk of office injury - Limber is a gadget with accelerometer, IMU sensor and strain scale. This is proposed to keep up great posture while sitting in the work place. as this is the profoundly captivating observing method. as like other technique this diminishes the terrible postures while in work.

(Nath N, 2017; 62:) Ergonomic analysis of construction worker’s body postures using wearable mobile sensors - Smartphone with inbuilt IMU sensors is chiefly intended to screen the development laborer's substantial developments and postures. This additionally recognize ergonomic dangers while working. This gadget can be likewise utilized for different experts like teacher, carpenter, etc..., by computing postures near the perceptions this distinguish postural dangers and trunk flexion.
(Plamondon A, 2007; 38:) Evaluation of a hybrid system for three-dimensional measurement of trunk posture in motion - In this paper half type framework is assessed with the help of inertial sensors. Along with accelerometers; spinner and magnetometers for estimating the back movement. This paper brought about measuring 3D trunk position moving.

(Sardini E), Daylong sitting posture measurement with a new wearable system for at home body movement monitoring - Instrumented shirt with inductive sensors to scale and recognize the posture development of the lower back while sitting/in the situated postures. This came about with the positive yield estimating postural developments and postures.

(Tsuchiya Y, 2015.) Calibration method for lumbosacral dimensions in wearable sensor system of lumbar alignment - The point of this paper is diminishing low back torment by a wearable sensor framework which can scale lumbosacral arrangement and lumbar burden by estimating the state of the lumbar skin when the lumbosacral arrangement changes by utilizing this strategy, lumbosacral arrangement and lumbar burden could be precisely assessed utilizing the wearable sensor system. This technique precisely assessed Lumbosacral arrangement and lumbar load.

(Yan X, 2017; 74:) Automation in construction wearable IMU-based. real-time motion warning system for construction workers’ musculoskeletal disorders prevention. - Yei 3-space is a wearable gadget with IMU sensors. This is created for a constant usage. Inertial sensors were utilized in head protectors and in belts to follow the continuous dangers and caution the user. This assist laborers with keeping themselves from the business-related musculoskeletal disorders. This came about as an effective notice framework.

Devices can easily track the respiratory, heartbeat rate and other postural movements and positions of the lower lumbar spine but some devices can only correct the position and the posture. Sensors play a major role in detecting treating and correcting the posture and the movement of the lower spine and slouches in the back. Some of the reviewed sensors are given below,

1. ULTRASONIC SENSOR

A Sensor that is utilized to scale the distance of an article by discharging ultrasonic waves and converts the reflected sound waves into an electrical sign is called as ultrasonic sensor. The distance between the spine and the seat can be estimated utilizing this sensor. [35]

2. FLEX SENSOR

Back slouches can be easily sensed used flex sensors. Flex resistance will be changed accordingly to bending of flex and simultaneously output will also be changed.

3. PRESSURE SENSOR

Pressure sensor determines the seating position according to the ergonomic pressure distribution.

4. X-RAY SENSORS

Utilizing X-ray sensors ebb and flow of the spine and incorrect posture in the human body is perceived through radiograph imaging which incorporates different procedures like PC tomography (CT)
and attractive reverberation imaging (MRI). This sensor helps in review the unmistakable and point by point spinal posture. Nonetheless, these frameworks can't screen spine during everyday exercises. This procedure is appropriate just for centers and medical clinics and not reasonable for individual and field use.

5. FIBER-OPTIC BEND SENSORS

Fiber optic bend sensors are the famous moving toward strategy for recognizing the arch of spine and off base posture. A light source, A plastic optical fiber with a rubbed area in the middle and a photosensitive identifier incorporates fiber optic bent sensors. At the point when Light is delivered into the optical fiber toward one side and next beam of light it is identified at the opposite end. The light force brings down as the optical fiber bents. At the point when a part of optical fiber is cut, cleaned, or raised, the deficiency of light is regularly expanded. According to the detecting guideline, single fiber-optical twist sensors are unipolar gadgets.[17]

6. ACCELEROMETER SENSOR

Static-Gravitational power and Dynamic-sensor development can be precisely estimated. Various directions of speed increase such as 3D spatial developments be valued with the improvement of triaxial accelerometers from the uniaxial models.[29]

7. VIBRATION SENSOR

Piezoelectric sensor is also called by the name vibration sensor. Piezoelectric effects are used while measuring the changes within acceleration, pressure, temperature.

8. MPU6050 SENSOR

Speed increase, Velocity, Orientation, Displacement, and numerous different movements related boundary of a framework is estimated with MPU6050 SENSOR. Count of deviation points of lower back in coronal plane for competitors and patients with lower back torment is determined from the information got from the sensor. [26]

9. GYROSCOPE SENSOR

Angular Rate Sensors is usually called as Gyro sensors. This aides in estimating the precise speed. As spinner is a kind of power sensor this identifies a couple of tomahawks of rakish movement. Angular Rate Sensors likewise scales and keeps up hub pivot and gives rotational and direction data. [35]

Sensor Fusion Technology in Healthcare,

A lot of growth and technological changes happening in the 21st century is leading and misleading both young and old generations. Less awareness and lack of knowledge about the postural dysfunction leads them to severe infections and disorders. In healthcare postural dysfunction is one of the most recent common situations faced by techies and adult’s improper unhealthy lifestyle makes them even more worsen. This kind of postural dysfunction can be treated or corrected only with the help of the devices using microelectromechanical system sensors. But, when in the worst conditions wearable devices should be strictly used.
RESULTS:

This paper provides a review on role of sensors in posture corrector devices, from the models of different corrector devices. In this review different sensors are explained. It is clearly visible that sensors play a major role in detecting and analyzing the lower lumbar spine movements and helps in correcting postural dysfunction. published literatures regarding multiple posture corrector devices were analyzed. Even though other hardware modules and devices used plays a vital role in calibrating and correcting This survey unmistakably uncovers that the posture of spinal can be estimated utilizing various sensors yet for moreover inside and out comprehension of their clinical appropriateness more examination into the precision and long-haul results of these gadgets is needed with furthermore improvisation.

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