Literature Review

Artificial intelligence model for continuous, in-home, posture and health monitoring including user feedback and predictions of clinical assessment.

Topics

* Similar studies
* Machine Learning
* The application of ml in posture monitoring
* Clinical Assessment
* Sensor technology
* Mobile app development
* Similar studies (Smart sensing chair)

A Novel Smart Chair System for Posture Classification and Invisible ECG Monitoring - By Leonor Pereira

* ML was trained and tested using datasets composed by center of mass coordinates in the seat plane, computed from the weight measured by **load cells** fixed under the seat.
* ML was trained and evaluated in the classification of 5 and seven sitting patterns.
* For the ECG measurements, conductive nappa (connected to a single-lead sensor) was used. **DBSCAN** (clustering algorithm) showed satisfactory results for the ECG segmentation performance.
* Sitting Posture Monitoring Systems (SPMS) can be divided into 3 categories, computer-based vision systems, wearable sensor systems, and sitting chairs [12]
* Sensory chair to monitor sitting posture was first coined by the Tan [16] back in 2001.
* K-NN model was used to evaluate the postures, which attained a classification accuracy of 98.5 % using 5 posture positions and around 85% using 7 positions.
* It was said that the addition of posture positions reduced classification accuracy.

Future works

* Experimentation with different sensors such as infrared distance sensors
* Ability to wirelessly charge the smart chair.
* Development of a web application to provide user feedback on the user’s sitting posture and cardiovascular health.

Issues found or areas that could be improved.

* The addition of more posture positions

A Real-time Posture Monitoring System Towards Bad Posture Detection

* This paper proposes the use of a smart belt equipped with inertial sensors. The sensors collect the posture information and send them to a cloud server via Wi-Fi connection. The cloud then processes the posture data and subsequently sends the results to a mobile phone via Wi-Fi.
* The mobile applications allow the user to monitor his posture over time and receive in Real-time a sound and a visual notification in case of a bad posture detection.
* There are 2 types of systems used to deal with back problems which are systems based on visual information using cameras and systems based on sensing information using different types of sensors.
  + System 1 – Based on visual information
    - Utilizes cameras to record subjects in different positions and use an analyzer algorithm to determine if the detected subject in the image is aligned in a straight position to determine good/bad postures.
    - Main downside is the user’s privacy.
    - Expensive to implement.
  + System 2 – Based on sensing information
    - Takes advantage of different variations of sensors to determine postures.
    - Main advantage is that it’s quite affordable compared to system 1.
    - Doesn’t invade on the user’s privacy.
* This paper uses flex sensors (flexible force sensors) to measure posture.
* The main information needed for the posture monitoring is the angle fexion of the trunk.
* The best sensor types used for posture monitoring are pressure sensors, flexion sensors, optical sensors, inductor sensors and inertial sensors.
* [22] detailed the different sensing methods for pressure sensing.
* The main drawback of pressure sensors is that they are not portable and depends on the environment and the platform implementation.
* Main downside with flex sensors is that they are at times incapable of detecting small bend leading to further inaccuracies.
* According to this paper, based on their literature review, it was said that inertial sensors are the best wearable devices to measure the spine curvature.
* They used sensors which were capable of wirelessly streaming the sensor data to a data store (firebase db). Subsequently, the data was sent to a (iOs/Android) app which contained a realtime graph presenting the angle flexion and receives a visual and sound notification in case of a bad posture.

Gaps

* There’s no use of AI in the detection of bad postures.
* Bad posture is simply defined when the bent angle of the sitting person exceeds 30degree and the position is maintained for more than five minutes.
* There’s no sort of classification of bad postures.

The role of wearables in spinal posture analysis: a systematic review

Lauren Simpson Monish M. Maharaj and Ralph J Mobbs

There is a need for real-time postural monitoring and correction as sustained poor spinal posture is associated with the development and worsening of many musculoskeletal disorders.

Poor spinal posture, as defined by Hansraj et al. [6], relates to the relative position whereby the head and upper trunk is in a forward’s flexed position.

the predicted burden of back pain in the United States alone as estimated by Shekelle et al. [8] is an annual net cost of $60 billion.

* It was said that most studies uses IMU sensors in their posture detection system. Due to frequent inaccuracies, they are usually paired up with other sensors
* It was seen that most studies were done over a very small sample size under a very short time. In order to validate their use for long-term postural monitoring and improvement, larger and longer duration validation studies are required.
* Improvements regarding practicality are required before commercialization and mass uptake can be considered.

Smart Chair for Monitoring of Sitting Behavior

Mengjie Huang1\*, Ian Gibson2, and Rui Yang3

* This paper focused on the development of a smart chair system for classification of **8** static standardized sitting postures using artificial neural network (ANN)
* Sensors used: pressure sensor array, 52 by 44 piezo-resistive sensor array
* In the literature review, it has been suggested that poor sitting behaviour can cause a threat to the human body by linking to various pains and other complications.
* Also Previous studies have showed that some common sitting postures of human body can lead to lumbar flexion and higher compressive forces in lumbar joints [2, 3].
* In this paper, they were able to achieve an overall classification accuracy of **92.2%**

Gaps:

* Limited number of subjects involved in the experiment.
* The number of posture classification was limited to 8.
* This study was entirely focused on the detection/classification of postures; there was no alert system that was implemented.

A Smart Chair to Monitor Sitting Posture by Capacitive Textile Sensors

Marc Martínez-Estrada 1, Tiina Vuohijoki, Anja Poberznik 3, Asif Shaikh 2 , Johanna Virkki Ignacio Gil and Raúl Fernández-García

* Capacitive textile sensors were chosen as the sensors for the feedback system
* They integrated 10 ten interdigitated capacitive embroidered sensors into the chair
* The sensor were custom-made using conductive yarn and fitted with Velcro for detachability.
* 8 sitting positions were considered in the evaluation.

Gaps:

Only Five people were involved in the testing bit.

More testing needs to know its usefulness in real-life setting.

There was wasn’t any proper evaluation done to determine the accuracy of the readings that were found.

No informative feedback to the user

[6] A Smart System for Sitting Posture Detection Based on Force Sensors and Mobile Application

**Slavomir Matuska , Martin Paralic, and Robert Hudec**

They developed a multiple smart sensing chair, each equipped with **6 flexible force sensors.**

It was an IOT-based system

It was also equipped with a network-attached module (QNAP) that sends data via a MQTT to a centralized server. Node-RED was used to facilitate all the logic and MongoDB was used as the data storage.

The process is as follows:

* The person chooses a free chair in the office and sits down. The Arduino hardware will wake up from sleep at this point and connect to the cloud.
* The person turns on the mobile application and logs into the chair. Each smart chair has an identification number to login. The information about the sitting posture with additional data is displayed in the smartphone application.
* After finishing the work, the person logs out from the chair. Finally, you can view the daily report.

Sensor type: Single-zone Force Sensing Resistors FSR402

* For the posture classification, they defined 9 unique sitting postures
* 12 subjects participated in their experiment.
* They specified a set of threshold values (based on experiments) for each posture.

GAPS

Limited number participants

Development of a Smart Chair Sensors System and Classification of Sitting Postures with Deep Learning Algorithms

Taraneh Aminosharieh Najafi 1, Antonio Abramo 1, Kyandoghere Kyamakya and Antonio Affanni

* 8 resistive pressure sensor was used
* A total of 40 subjects were involved in the experimentation.
* The classification involved 8 different postures which was tested among 7 different deep learning models.
* The Echo Memory network (EMN) produced the highest accuracy percentage with about 91.68%
* They computed the average accuracy by means of the k-fold cross-validation
* method