A NOVEL APPROACH FOR SITTING POSITION MONITORING USING SMART CHAIR

[1]Nitalaksheswara Rao Kolukula, [1]Sreekanth Puli, [2]James Stephen Meka

[1]Assistant Professor, Department of CSE, GITAM University, Visakhapatnam, Andhra Pradesh, India

[2]Ambedkar Chair Professor, Andhra University, Visakhapatnam, Andhra Pradesh, India

[1]kolukulanitla@gmail.com, [1]srikanthpuli66@gmail.com, [2]jamesstephenm@gmail.com

Received on: 2023-09-14 **Accepted on: 2023-10-26**

Keyword:
Blynk IOT, sitting position, smart chair, force sensors, Monitoring.

ABSTRACT

In our daily life, sitting is the most common behavior. People always work in front of the system for a long time, under pressure to meet deadlines. Wrong sitting posture for long hours leads to adverse effects. Health plays a crucial role these days. Employer's health is essential to the company to avoid losses because when an employer is sick or stressed, they may not do the work efficiently. Sitting in a bad posture on the office chair can lead to musculoskeletal disorders, myopia, cervical spine problem, and humpback. It can also decrease blood circulation in the brain leading to stress and anxiety. So, there is a need for sitting position monitoring, which notifies the user to sit in the correct position. We use force sensors to detect the force on the chair. We use Arduino to connect these sensors and make the chair function accordingly. To receive all these notifications, we develop a Mobile Application. This mobile app notifies the user about the sitting position. The mobile app is developed using Blynk IoT. We define simple rules for the correct sitting position.

Corresponding Author: Email: kolukulanitla@gmail.com

INTRODUCTION

With the significant impact of social media on personal and organizational reputation, understanding the sentiment of social media posts, comments, and interactions has become essential for individuals and businesses alike [1] . Sentiment analysis automatically determines the sentiment or emotional tone text or speech conveys. In social media, sentiment analysis can provide valuable insights into public perception, customer feedback, and brand reputation [2]. By analyzing the sentiments expressed in social media content, individuals and organizations can gauge the overall sentiment trends, identify potential issues, and take appropriate actions to maintain or enhance their online presence.Sitting is one of the most important and most commonly adopted postures of a human being. Today, modern life paved the way to a mechanical life and most of the people are spending a lot of time sitting in the same place for long working hours [1]. In recent days this sitting behavior analysis has become an important research topic in various domains like Biomedical engineering and public health care service. The researches have shown that poor sitting posture can cause serious threat to human beings which leads to various health issues [2]. This may have a significant impact on productivity and efficiency of work. Wrong sitting posture may also affect typing speed. A total of 50$ billion dollars on treatment of back pain are spent every year in the USA. There are many clinical views on "correct" and "incorrect" postures, many are trying to determine good sitting postures [3]. Some studies have shown that normal sitting positions of a human can lead to lumbar flexion. Not only sitting in the wrong position

leads to adverse effects on health but also excessive sitting will lead. Because of industrialization, and countries running behind to be economically strong. People are forced to sit for long hours, thus reducing the time of physical activity and regular exercise [4]. People have reduced their health. But, sitting is unavoidable these days. We can correct the posture of sitting and alert ourselves from time to time to have a physical activity. So, in order to avoid these effects caused by poor sitting behavior, a device for monitoring the sitting posture can be built. There are several ways this problem can be solved [5]. They are using computer image processing, using sensors in wearable clothing, measuring the load distribution on chair. Many research and papers are don't using computer image processing and applying various neural network algorithms [6]. But these are only used for static sitting positions. Also, they are limited to camera view systems and the user has to sit in a particular angle. They have conducted various experiments by using the pressure distribution measurement sheets which were placed on the seat pan and back rest of the chair for recognizing the correct actual posture [7]. Several analyses and investigations were done for the classification of posture based on the recognition.

Systems using wearable sensors were also built. These sensors are kept under clothing or on skin. They give user feedback through vibrations. The sensors are located on head and neck. But the user feels uncomfortable keeping sensors on body [8]. So, a better solution can be implemented by keeping the sensors on chair and monitoring the posture.An optimal and a low-cost solution can be developed with the help of sensors. A chair with sensors will be placed and a mobile app will be connected to the chair [9].

By using Blynk IoT Application the user will get the notifications about their sitting position. Blynk is an app and it will provide a platform for building mobile applications like Android and IOS and those applications will connect to the internet by using electronic devices and it will monitor remotely and these devices will be controlled [10]. The Blynk platform is used by the engineers for development boards and prototyping like Arduino,Raspberry Pi over Wi-Fi and Ethernet or the cellular to the Internet.

Arduino is an open source platform for electronics and it was easy to use for hardware and software development. It was easy for the beginners to use and it was flexible enough. The Arduino will run on Windows, Mac and Linux. Arduino boards are inexpensive when compared to the other microcontroller platforms [11]. Arduino boards will help us to read the inputs. By using a microcontroller, the Arduino board can do what we want by sending a set of instructions.We are using 4 force sensors, Two force sensors on the seat pad and two force sensors on the back. Force sensor resistor square of 38.1mm pressure sensor. The Force sensitive resistor(fsr) will vary the resistance and it will depend on how much pressure is being applied to the sensing area. If the force is harder than the resistance will be low]. If no pressure is applied to the fsr then its resistance will be larger than the 1 milliohm. For the force sensor there will be two pins on the bottom and with o.1" pitch making the breadboard friendly.

Breadboard is an electronic tool and it was used to test the electrical circuits. It consists of the metal strips inside and that will connect them and it will help to remove easily or move around when the circuit is being tested.Most of the studies were focused on the static postures. But, in real time we are not machines to sit in the same posture for long hours. Hence dynamic posture recognition is also important for the effectiveness of the device. The long-term goal of this paper is to develop a simple monitoring device which detects the person's sitting posture with the help of sensors placed onboth the seat pan and back. This is basically an interactive system which detects and notifies the person about his posture and helps him improve his sitting behavior.

LITERATURE REVIEW

Smart Healthy Chair, Smart Chair, designing a smart chair for monitoring sitting posture using convolutional neural networks, Intelligent Chair Sensor Classification of Sitting Posture, Design, and Implementation of a smart chair system for IoT, The Sitting Posture Monitoring Method Based on Notch Sensor are some of the existing papers.In smart healthy chairs, they use only one sensor, i.e., an ultrasonic sensor. It will continuously detect the sitting position by using an ultrasonic Sensor. If it finds the distance has been increasing, it will detect and indicate us to bend back by alarm sound. By using an Arduino board all the process is

coordinated.In the Designing of smart chair for monitoring of sitting posture using convolutional neural networks paper they have done by using the keywords likeThese keywords are used and the purpose of doing this paper Nowadays sitting in a chair is a modern act of the people and they are sitting in a wrong position and this may lead to the musculoskeletal disorders. so, to overcome these problems in that paper they think that there is a need to build a monitoring system for sitting position which makes us sit in the correct position and it was developed to classify the children's sitting position.In Intelligent Chair Sensor Classification of Sitting Posture paper, they build the chair and it has the capable of detection and correction of the sitting position by using the pressure maps and these maps are built with the eleven postures with standardized in the seat pad and backrest.to perform the posture classification automatically and in this paper, they used the Neural Networks and these are exported to Mobile by an app.

In smart office chairs with sensors, the paper aim is to provide an application for the smart technologies and sensors. And these smart technologies and sensors are installed in the chairs to reduce the health issues of users. And it will also detect the body pressure and contact pressure of the user bodies and it is connected between the chair's stool part and the user's body. And it will recognize the different positions of users while sitting. It acts as a prevention of health care. It will also check if the heart rate is proper and beats per minute.In Design and Implementation of a smart chair system for iot paper they have to design and implement the chair with smart Iot and it will combine the Iot device which was embedded and the chair was prepared with separate seating pads. In this paper they use an application to visualize the user's posture and help to correct the unbalanced posture. They use iBeacon and Bluetooth to communicate and transfer the data with low power consumption and they use six sensors, Arduino, Bluetooth, a mobile app to detect the different user positions.

In The Sitting Posture Monitoring Method Based on Notch Sensor paper they have done the paper to classify the sitting position through the medical research that if user sitting in a bad posture more than an hour they may lead to the serious injury to the humans like myopia, spinal diseases and humpback etc. In this they have used the K-nearest neighbor Algorithm for monitoring the sitting position for the sedentary people. This paper identifies the poor sitting posture and basis for improving the sub health of the people because of sitting in a bad posture.In a Smart System for Sitting Posture Detection Based on Force Sensors and Mobile Application they have done the paper to overcome the employee's health issues and they think that the employee's health and well-being is an important thing in our updated world and they thought that if employees suffer from health problems they cannot work and the employers may lose money. The main problem is the spinal pain that occurs when they sit in the wrong posture or in a ba d posture on the office chair. This paper deals with the realization to detect people who are sitting in an incorrect position. The chair consists of 6 force sensors. They connect the systems based on the Internet of Things(IoT) node and it is based on Arduino. It will monitor the seating position of the user and if they sit in the wrong posture then it will give notifications to the user. They have developed a mobile app to receive notifications and the user gets feedback on the sitting position and the additional statistical data. The data from the chair will be obtained by the private cloud solution from the QNAP and these are stored in the MongoDB database. They use the Node-RED application for the whole logic and the implementation.
Android-Based Low-Cost Sitting Posture Monitoring System The purpose of doing this paper they thought that back pain is the most common problem and it may lead to the cause of the disability adjusted life and the main cause of the back pain is due to bad posture. In order to overcome sitting posture and the back pain including behavioral change there are several actions that are adopted proactively. Moreover, these are not so expensive and difficult to execute for prolonged periods. In this paper the sitting posture monitoring systems will continuously monitor/observe the sitting pattern of the user in real time and give the feedback like sitting in a bad posture was observed. Threshold sensor is used to sit in a good posture they will identify by measuring the ages and height of the people collected by the healthy volunteersThe mobile application will continuously monitor the bending degree and if the bending reaches the threshold of the bad posture or they may sit for a long time at one place then the android application provides a vibration. The feedback they receive will be received positively when they are in the terms of comfortability, effectiveness and satisfaction

levels. This device will monitor the sitting posture pattern to prevent so many health related problems one of the main causes is back pain within the affordable price.

Design and implementation of the sitting posture monitoring system in this paper they designed the paper to monitor the sitting posture and also in order to count the health data they remind the sedentary workers. They use the single chip called microcomputer. The microcomputer will collect the array data of the sensor and it uploads the data to the server by using Wifi. The software will display the user's sitting posture information. It will count the sitting posture data and the users posture in real time.Smart-chair-for-monitoring-of-sitting in this paper they identify that sitting is a common behavior for every human in their daily life. To avoid the poor sitting behavior, they have developed a smart chair and it was highly practical design. This chair will monitor how our sitting position of the human body accurately.In this paper they will observe after doing experiments the results showed that it can recognize the eight standardized sitting postures of the human with high accuracy. The developed smart chair with sitting posture monitoring will helps us to promote the peoples to maintain and achieve healthy sitting behavior and it will also reduce and prevent the disease like chronic and it was caused by sitting in bad posture. These results in the system are feasible for sitting behavior monitoring and where it can find applications like healthcare services, human computer interactions and intelligent environment.

PROBLEM IDENTIFICATION & OBJECTIVES

As we have seen various papers done on our problem in literature review. Most of the papers used artificial intelligence algorithms and neural networks like CNN and ANN. Some papers used sensors like ultrasonic and notch sensors. These all papers can be measured on a static basis. Some papers just recognize wrong posture and observe the user's posture. There is no such thing like informing the user about their posture. This is the main drawback that was found. Although there are devices which can detect the bad posture, it will be of more use when it tells the user to change their position. Also, if we use image processing the paper is limited to users who are sitting in front of the system all the time. They need to focus on the camera along with their work. Users cannot sit freely and do work and have to search for their posture on camera all the time. Moreover, systems based on sensors have several advantages. They are portable and can give results with accuracy closer to reality.Although sensors like ultrasonic sensors and notch sensors wouldn't cover all the use cases of a sitting position. They are limited to only some sitting postures as we cannot predict every individual's position. Hence we need to study more on the ergonomics in order to produce an efficient product. It gives us an idea before setting up the environment that best benefits the user.Coming to the main problem, most of the health issues today are caused by the lack of physical exercise which in turn affects the individual both physically and mentally. As most of us are habituated to sitting at the same place for a long time due to the current working scenarios which includes working continuously for long hours, there will be less physical activity which leads to chronic health problems later. These are observed in almost every single person today irrespective of their age group due to the current lifestyle. The other important point that needs to be considered is the sitting position. A good posture is really important to keep our spines healthy which saves us from a lot of back related issues. It also improves the blood flow which is really important for a lot of muscular activities in the human body. We are ignoring these points while concentrating more on the work, which will lead to severe health problems later. Hence we really need to take good care about the sitting posture as it is the most adopted human action in today's lifestyle.

PROPOSED RESEARCH METHOD

This research paper introduces a novel approach to address the ubiquitous issue of incorrect sitting postures by proposing a smart chair equipped with sensors for real-time monitoring. In the contemporary context where individuals spend prolonged hours working in sedentary positions, the adverse effects on health are a growing concern. The paper highlights the significance of monitoring sitting behavior and reviews existing literature, pointing out limitations in current solutions. Emphasizing the need for user notifications and the drawbacks of

image processing, the research outlines clear objectives and a detailed methodology. The proposed implementation involves integrating force sensors into the chair and utilizing the Blynk IoT platform for mobile notifications. The research aims to bridge gaps in current understanding, offering a practical solution to enhance individuals' sitting habits and promote overall well-being.

Algorithm: Smart Chair Sitting Position Monitoring

1. Introduce the importance of monitoring sitting posture for health.
2. Summarize existing research on sitting posture monitoring technologies.
3. Identify limitations in current solutions, emphasizing the need for user notifications.
4. Define research objectives for addressing identified problems.
5. Specify the methodology, including experiments, data collection, and analysis.
6. Describe the implementation of a smart chair with sensors and Blynk IoT.
7. Conclude by summarizing key findings and suggesting areas for further research.

IMPLEMENTATION

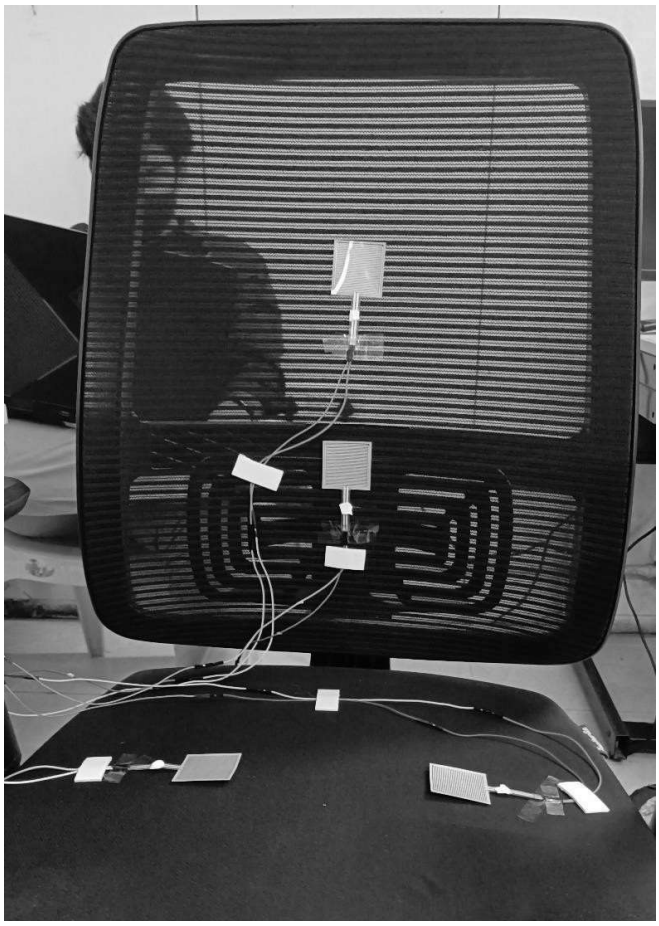


Figure 6.1 Implemented Model Sitting Chair

The above figure 6.1 shows that chair is arranged with two sensors on seat and two sensors on back connected to Arduino.We used Arduino IDE and Blynk IoT software development platform to make the chairfunctioning.

Arduino Code:

Used Blynk IoT library in Arduino for development of sensors on chair with the app.

Used four variables to store the data from four sensors and send them to four virtual pins inBlynk IoT to send notifications.

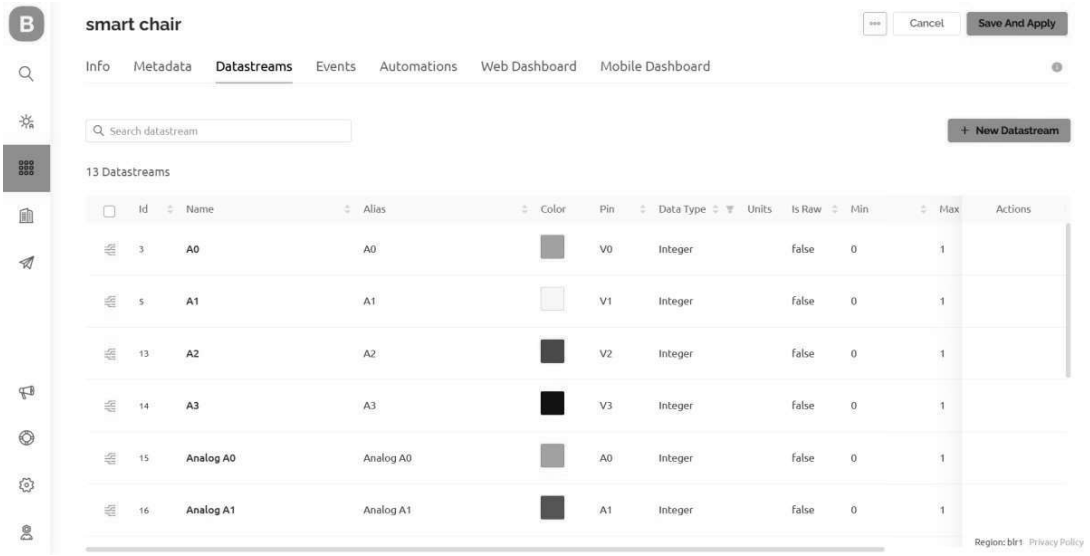
```
#include <BlynkSimpleStream.h>

// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut
icon).char auth[] = "xxx";
```

```
BlynkTimer timer;
int sensorVal1;
int sensorVal2;
int sensorVal3;
int sensorVal4;
void myTimer() {
  Blynk.virtualWrite(V0, sensorVal1);
  Blynk.virtualWrite(V1, sensorVal2);
}

void setup()
{
  // Debug console
  DebugSerial.begin(9600);

  // Blynk will work through Serial
  // Do not read or write this serial manually in your sketch
  Serial.begin(9600);
  Blynk.begin(Serial, auth);
  timer.setInterval(1000L, myTimer);
}
BLYNK_WRITE(V5) // Executes when the value of virtual pin 5 changes
{
  if(param.asInt() == 1)
  {
    Blynk.virtualWrite(V2, sensorVal3);
    Blynk.virtualWrite(V3, sensorVal4);
  }
}
void loop()
{
  sensorVal1 = analogRead(A0);
  sensorVal2 = analogRead(A1);
  sensorVal3 = analogRead(A2);
  sensorVal4 = analogRead(A3);
  Blynk.run();
  timer.run();

}
```

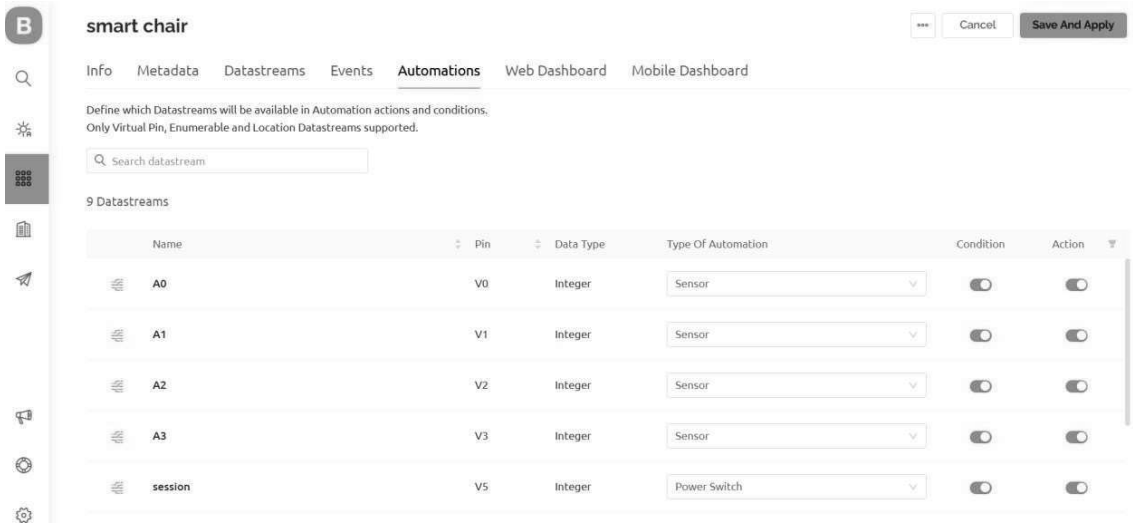
Blynk IoT

DataStream’

s:



Automations



CONCLUSION & FUTURE SCOPE

This research presents an IoT-based smart device for monitoring the sitting posture of a person with the help of sensors and a mobile application. Four flexible force sensors will be used in this paper, where two sensors were placed on the bottom seat and two were placed on the backrest of the chair. The sensors will sense the force and send notifications accordingly, which was set in automation in Blynk IoT. The main idea is to create simple rules to correctly detect the posture. The sensors are placed ergonomically. In future we can add features like calculate

the time the user is sitting and gives him an alert if he is sitting for a long time. We can also add giving the calories to be burnt based on the total sitting time. We tried building the app using free version of Blynk IoT, when we develop on a enterprise level necessary changes can be made and the level of the app working can be increased.

REFERENCES

1. H. Scott and K. Williams, "Impact of seating posture on user comfort and typing performance for people with chronic low back pain," International Journal of Industrial Ergonomics, vol. 38, no. Issue 1, pp. 35–46, 2008.
2. F. Tlili, R. Haddad, Y. Ouakrim, R. Bouallegue, andN. Mezghani, "A Survey on Sitting Posture Monitoring Systems," in Proceedings of the 2018 9th International Symposium On Signal, Image, Video And Communications(ISIVC), pp. 185–190, Rabat, Morocco, November 2018.
3. S. SathyanarayanaR. K. Satzoda et al., "Vision-based patient monitoring: a comprehensive review of algorithms and technologies," Journal of Ambient Intelligence and Humanized Computing, vol. 9, no. 2, pp. 225–251, 2018.
4. S. Sathyanarayana et al., "Accuracy and Robustness of Kinect ˇ Pose Estimation in the Context of Coaching of Elderly Population," in Proceedings of the 2012 Annual International Conference Of the IEEE Engineering In Medicine and Biology Society, pp. 1188–1193, San Diego, CA, USA, August 2012.
5. Mahanthi, B. L., Sesetti, A., & Manjeti, V. B. FACE EXPRESSION RECOGNITION USING OPEN CV AND CONVOLUTIONAL NEURAL NETWORK. The Journal of Computational Science and Engineering. pp. 16-22,September 2023.
6. Y.-L. Kuo, E. A. Tully, and M. P. Galea, "Video analysis of sagittal spinal posture in healthy young and older adults," Journal of Manipulative and Physiological .erapeutics, vol. 32, no. 3, pp. 210–215, 2009.
7. R. C. Ailneni, K. R. Syamala, Kartheek, I.-S. Kim, and J. Hwang, "Influence of the wearable posture correction sensor on head and neck posture: Sitting and standing workstations," Work, vol. 62, pp. 27–35, 2019.
8. J. Devlin, M.-W. Chang, K. Lee, and K. Toutanova, "BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding." 2019.
9. Potharaju, S. P., Sreedevi, M., & Amiripalli, S. S. (2019). An ensemble feature selection framework of sonar targets using symmetrical uncertainty and multi-layer perceptron (su-mlp). In Cognitive Informatics and Soft Computing: Proceeding of CISC 2017 (pp. 247-256). Springer Singapore.
10. Raju, r. k., & Lakshmi, v. a novel implementation of pedestrain detection using hogd and svm algorithms. The Journal of Computational Science and Engineering. pp. 1-7,September 2023.
11. Sumathi, A., Kumar, B. S., & Vishnubhatla, S. Advancements in Energy-Efficient Virtual Machine Placement Survey for Cloud Computing. The Journal of Computational Science and Engineering. pp. 9-15, September 2023.