Development of a Mobile Application to Reduce the Rate of People with Text Neck Syndrome

Rosa Perez-Siguas, Hernan Matta-Solis, Eduardo Matta-Solis, Hernan Matta-Perez, Luis Perez-Siguas, Randall Seminario Unzueta , Victoria Tacas-Yarcuri
TIC Research Center: eHealth & eEducation, Instituto Peruano de Salud Familiar, Lima-Peru

***Abstract*—Now-a-days, it is no surprise that mobile devices have become a very useful tool in the daily tasks of many people worldwide. This is thanks to their various features such as portability, connectivity, entertainment, work tool, etc. However, due to the bad posture that users have when using them, a syndrome called "Text Neck" is produced. This is caused by prolonged use of the devices looking down and tilting the head at different angles. The degree of inclination of the head causes a detrimental effect on the neck joints, so that the greater the degree of inclination the effect of the weight of the head on the neck increases detrimentally. However, currently mobile devices have sensors that help in monitoring the activities of users, in this sense, there is the gyroscope that allows the completion of the position and the accelerometer that tells us the amount of movement of the device. In this sense, a mobile application has been developed that by monitoring the information of the angle of inclination of the device and the time it remains in the same, allows notifying users to adopt a proper position. The aim is to reduce the number of people affected by text neck syndrome.**

***Keywords*—Accelerometer; android; firebase; gyroscope; mobile devices; sensors; text neck**

I. INTRODUCTION

Today, we find that mobile devices such as cell phones, tablets or e-books have become essential attachments in the daily lives of millions of people worldwide [1]–[6]. According to statistical data collected in 2021, the number of mobile device users will exceed 3.8 million, representing 48.53% of the world's population [1]. This popularity in the massive use of mobile devices is due to the various activities that can be performed with them, in this sense, users can exchange information, access the Internet, play in mobile applications, and other types of activities [5], [7], [8] They also allow for fluid communication between users through the use of text messages and social networks [1]–[3], [8]

However, beyond the popularity that mobile devices have achieved, due to prolonged use and poor posture of users, health-related problems have been identified [1]–[10]. The problem is now known as "Text Neck" syndrome, a term coined by American chiropractor Dr. Dean L. Fishman [1], [3], [6]–[8]. However, this syndrome is produced due to the downward inclination of the users' neck and the excessive forward bending when using mobile devices [1], [3]–[7], [10]. In this sense, the greater the angle of inclination, the greater the weight that falls on the neck joints, being 12 kg at an angle of 15 degrees, 18 kg at an angle of 30 degrees, 22 kg at an angle of 45 degrees, and 27 kg at an angle of 60 degrees [1], [2], [5], [6], [9], [10]. As a result, the user may experience many ailments ranging from neck pain, neck stiffness, reduced mobility, headaches, postural disturbances, rounded shoulders [1], [6], [7], [10].

On the other hand, nowadays cellular devices have a wide range of sensors that allow the detection and monitoring of many activities [11]–[13]. In this sense, the accelerometer and the gyroscope can be found as complementary sensors in the measurement of certain activities [11], [14]–[17]. Therefore, due to the precision that cell phones possess [13], [18], activities such as swaying in the elderly can be monitored [19], establish the frequency of the footprint [14], detection of abnormal behaviors [11], determine the degree of sedentary lifestyle of the users [17] and video stabilization through the use of the gyroscope [20]. Now, these sensors can be used to detect the time that a person has been using the cell phone and the position in which it is used. This information can be provided by the accelerometer and gyroscope, then through an application developed in Android can be analyzed for the purposes of the case [11], [12], [14], [15], [19], [20].

Therefore, taking into account the information that can be obtained through the sensors of mobile devices, we developed a mobile application that allows the monitoring of the position in which it is used by users through the gyroscope; the time the user uses the device in a specific position taking into account the viewing angles. The purpose of our research is the development of a mobile application to notify users of the excessive use of mobile devices and the position in which it is used, with the aim of reducing the rate of people suffering from text neck syndrome.

Next, the activities carried out within the present research project are detailed, in this sense, in Section II we specify the methodology that has been used to obtain the main objective of our project, in Section III we show the results obtained after implementing our application, in Section IV we made a comparison of the contributions obtained with those of other authors, and finally in Section V we show the conclusions that we have reached after having carried out the present research project.

II. METHODOLOGY

A. Determination of Angle of Inclination

Text neck syndrome is characterized by the angle of inclination generated in the user's neck when tilting the head forward to view mobile devices [1], [5], [7], [9], [10], [21] Thus, as shown in Table I, as the degree of inclination of the user's neck increases, there is a direct effect on the weight exerted on the spine [1].

TABLE I. HEAD WEIGHT ACCORDING TO THE ANGLE OF INCLINATION

Angle of inclination of the neck	Force exerted on the neck
0°	4,54 – 5,44 kg
15°	12,25 kg
30°	18,14 kg
45°	22,23 kg
60°	27,22 kg

Likewise, Fig. 1 shows graphically the angle of inclination of the neck forward and the weight effect equivalent to each one for the reader's better understanding.

Taking into account that the sensors are located inside the mobile devices, the detection of the information of the users' neck inclination angles must be related to the inclination angles of the devices where our device is running. Consequently, the calculation of the tilt angles taken by the mobile devices in relation to the users' neck tilt angles was performed.

In that sense, the users' neck inclination angles vary in an incremental range of 15°. Likewise, the initial angle is 0° and the maximum angle of inclination is 60°, where it is possible to identify the inclusion of four increments to get from the minimum to the maximum angle of inclination.

Tilt interval range = 15°

Now, before continuing with the calculations, it was taken into account that users seek the best position of the mobile device for viewing the various desired contents. Therefore, after performing an analysis of the way in which mobile devices are held by users, a correlation was found between the angle of inclination and the angle at which the mobile device is held.

In effect, the mobile devices when held cover different angles of a quadrant. Taking into account the aforementioned, the calculation of the range of degree intervals that the devices have in the different positions was carried out, resulting in 22.5°.

Cell interval range = 22.5

The angles of inclination that the mobile device can take can be seen more clearly in Fig. 2, taking 90° as the starting point, which are traveled in intervals of 22.5° until reaching 180°. On the other hand, Table II shows the equivalence of each of the degree intervals in both the inclination of the user's neck and the angle at which the mobile device is held.

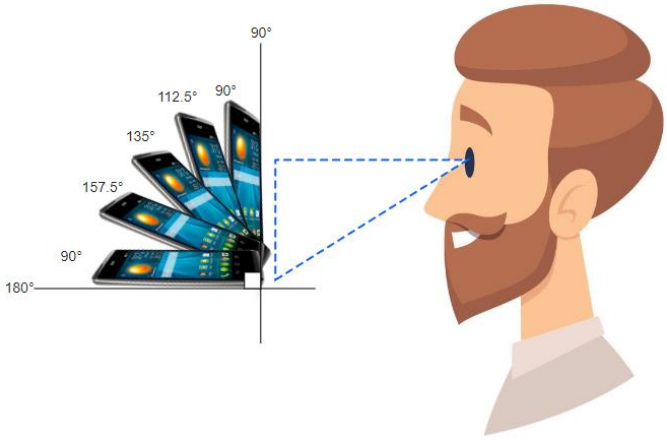

Fig. 1. Tilt angles of the mobile devices

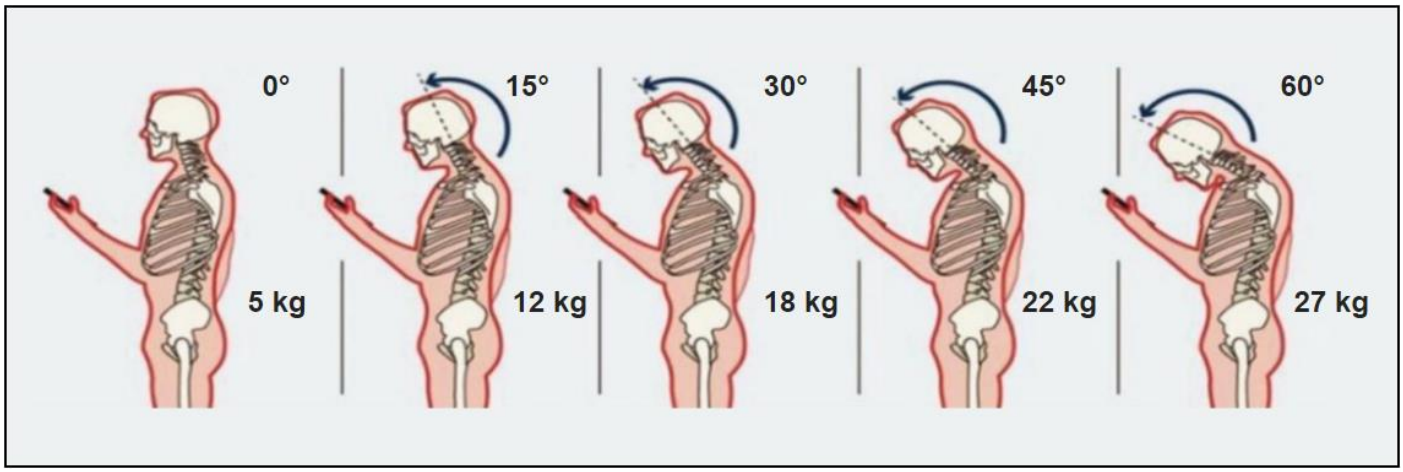

Fig. 2. Angle of inclination of the neck and the equivalent weight effect on the spine

TABLE II. EQUIVALENCE OF USER ANGLES AND MOBILE DEVICES

Angle of inclination of the neck	Tilt angle of the mobile device
0° < 15°	4,54 – 5,44 kg
15° < 30°	12,25 kg
30° < 45°	18,14 kg
45° < 60°	22,23 kg
60°	27,22 kg

B. Flowchart

In this section, as can be seen in Fig. 3, the actions that are evaluated within the application are detailed, as well as the path that must be followed for the evaluated actions. This diagram gives a clearer idea of the actions that must be programmed within our application, as well as determining the evaluation criteria at the time of the application's decision-making process. In this sense, the application is started when the cell phone is unlocked by the user; then the angle of inclination of the mobile device is determined by analyzing the gyroscope information; then the amount of inertia that the device carries in the position carried by the user is determined; then the application proceeds to keep track of the time in which the device is used in an inappropriate position; and finally the device makes a notification for the user to take the necessary measures to avoid the use of the device in that position.

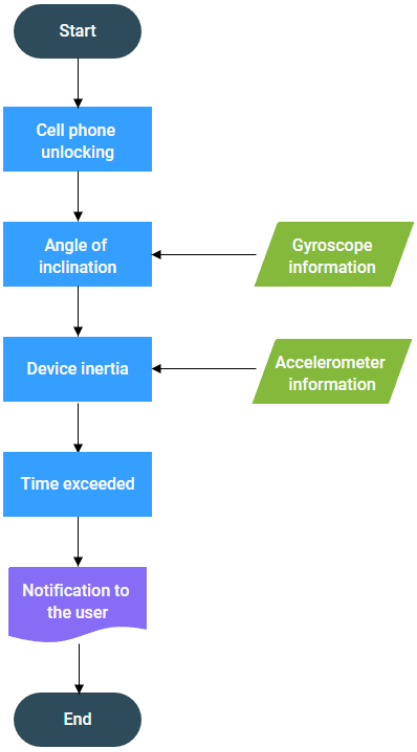

Fig. 3. System flow diagram

C. Prototyping of the Application

In this section, the respective prototyping of the different phases that are part of this application was carried out. In this sense, a detailed analysis of the actions that are framed in its workflow was carried out, resulting in the necessary modules for the correct fulfillment of the objectives of this research project.

Now, our project was developed keeping a user-friendly design through the use of colors that allow the understanding of the messages. In this sense, the modules were developed:

1) Welcome and login: As part of the development of this module, we took into account the need to keep track of those users who make use of our application. Therefore, as can be seen in Fig. 4(A) where the Welcome module is shown, the application icon has been placed at the beginning; then a phrase that allows users to identify the purpose of the application; the login button that allows access to the login form; and finally a couple of options that ask the user about the possession of an account. Also, in Fig. 4(B) login module we include as title the name of the application; as in the previous model, the icon of the application is shown; then the data required to complete this form are shown, which are the username and password; likewise, the options to remind the user and the login button are shown; finally, the user is given the possibility to access our application through the use of their social networks such as Facebook, Google, Twitter, and Linkedin, since they are the most used social networks today [22].

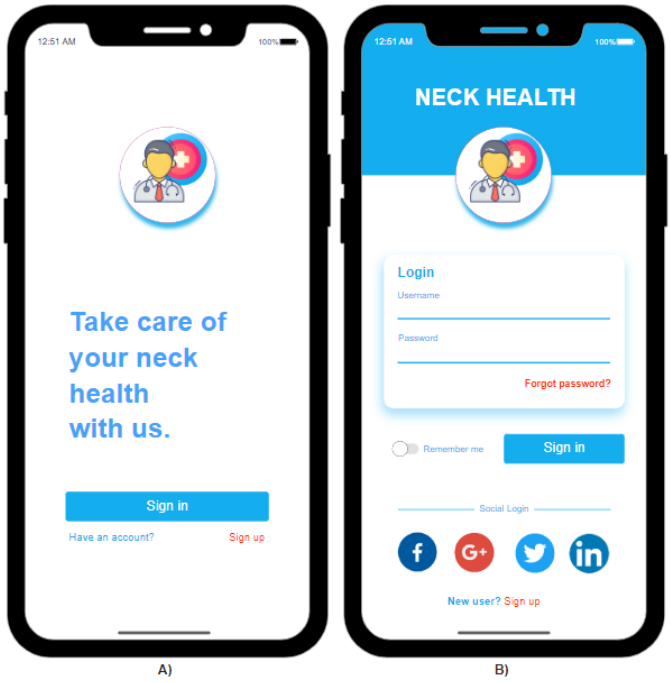

Fig. 4. A) Welcome module. B) System login module

2) Main menu: For the development of this module we took into account the functions to which the user requires access within our application. In this sense, as can be seen in Fig. 5 of the main menu, a couple of buttons have been implemented, the first one gives the user the possibility to access the current tilt status, and the second button allows the user to access the statistics of the use of the cell phone.

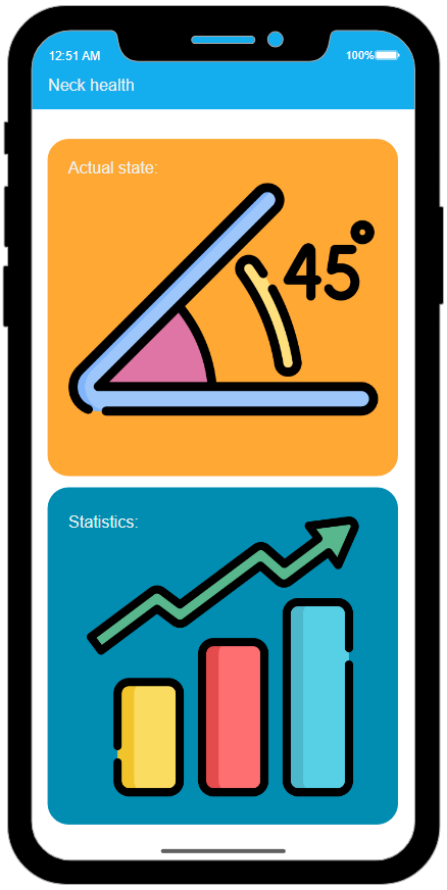

Fig. 5. Módulo de menú principal

D. Hardware

As part of the development of our research project, the hardware technologies necessary for the project to meet the previously stated objective were determined.

1) Accelerometer: This sensor allows us to obtain information on the acceleration of the device during the time it is used by the user, which makes it possible to determine the amount of inertia and other daily activities[11], [15]–[17] .

2) Gyroscope: This sensor has the ability to detect the tilt angles in which the devices that have it implemented [15], [18], [20], this is of utmost importance since it is very much in line with the main objective of our research project.

3) Smartphone: Mobile devices that have a great acceptance by the general public, surpassing 80% of North American users [13]. Thus, these mobile devices have several sensors, among which are included the accelerometer and the gyroscope, both being complementary in the detection of movement and determination of activities by the users of these mobile devices [11], [12], [15], [23], [24]. Taking into account the characteristics and the utilization rate of these devices, it has been determined as the ideal device for the implementation of our research project.

E. Software

Within the development of this project, the following software technologies were selected due to their characteristics and features.

1) Android: It is an operating system that is used in a large number of mobile devices which allows you to run a large number of applications according to the needs of users [25]. It also allows the implementation of many functions for the management of user data [26]. Taking into account these characteristics, this operating system was used for the deployment of our mobile application.

2) Android studio: This IDE has a large number of features that allow the correct development of mobile applications for the solution of the diverse needs that users have [25]. In this sense, this IDE allowed us to carry out the correct development of the software infrastructure necessary to achieve the objective of our research project.

3) Firebase: This allows us to handle a large amount of unstructured data or commonly known by the name of NO-SQL [26]. This technology allows us to handle a large amount of data in real time and other features that are easy to implement in Android applications [27]–[29]. Therefore, this technology was used for the storage of user account data and usage data of their mobile devices.

III. Results

Once the development of our mobile application has been completed, we will analyze the results obtained after its implementation.

A. Implementation of the Application

Initially, the application was installed on a mobile device with the Android operating system. Fig. 6 shows how the application has been deployed by means of an icon that has been added to the main screen, through the use of this icon the user can access the application system.

B. Current status of the Device

After the user has successfully authenticated, the system will allow the user to enter the main menu of the system. At this point, the application, when used for the first time, will require the user's authorization to access certain features and data of his mobile device. Then, the user will be able to access the main menu of our application where you can see the options to which the user has access.

Now, among the options shown in the main menu is the Actual State option. This option collects the gyroscope information that is integrated inside the mobile device. Fig. 7 shows the result of the information obtained from the gyroscope sensor by means of which the angle of inclination that the device has at that moment and its equivalent angle of inclination in the user's neck can be given as a result.

Fig. 6. The application shows the angle of inclination and the equivalent weight

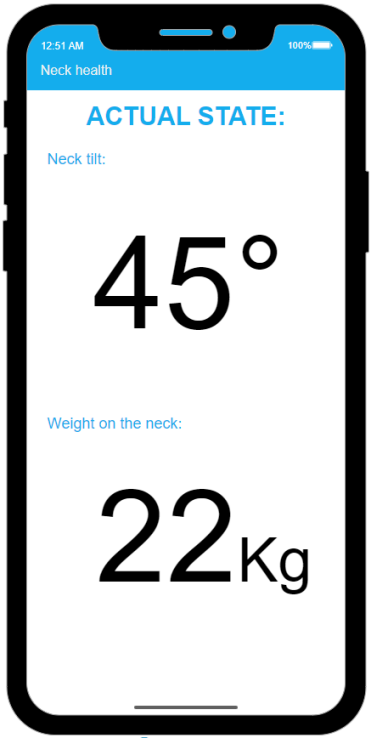

Fig. 7. Application deployment on a mobile device

This module allows the user to have immediate access to information on the tilt angles of both their device and the equivalent angle their neck is taking in relation to the tilt of the mobile device. This allows users to correct their neck position and change the way they are using their mobile devices by adapting better positions that safeguard their health.

C. Device Usage Statistics

As part of the options implemented within the application, we find the statistics option. As shown in Fig. 8, this module presents the statistics options according to the day, week, month and year; in each of the above-mentioned cases a statistical table is presented where the frequency of incidence in the angles of inclination can be appreciated; likewise, in the lower part of the module the application shows which is the largest angle registered according to the statistical option that has been selected by the user.

This module allows users to keep track of the angles at which the mobile device is used, in this sense, in view of the data shown by the application, the user has the possibility to keep track of the change in their habits in the use of mobile devices. Therefore, the application is an extremely important tool to keep track of the angles of inclination that users have with respect to the use of mobile devices.

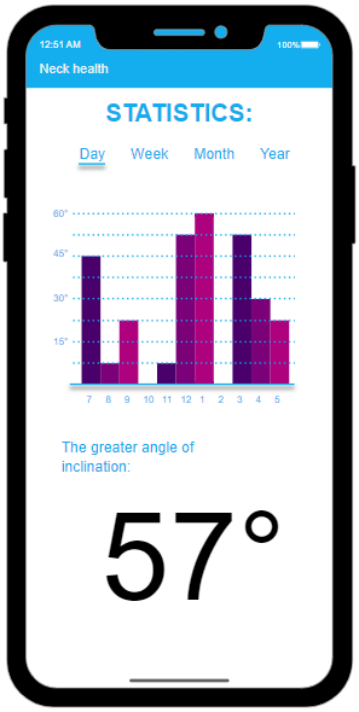

Fig. 8. Module for statistics of the device's tilt angles

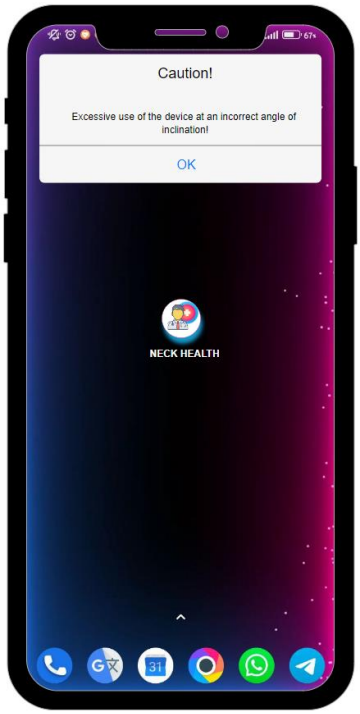

Fig. 9. Notification to the user about excessive use of the cell phone at an improper tilt angle

D. Notification of Tilt Angle

In this module, after the system detects an inadequate angle of inclination of the device and an excessive use of time, a notification is made. In Fig. 9 it can be seen that the application notifies the user of the excessive use of the device by means of a message: "Excessive use of the device with an incorrect angle of inclination", by means of this notification the user can become aware that he is taking a bad position of the mobile device allowing him to change it to safeguard his health.

IV. Discussions

In this section, we show the differences of our research work in the various topics that coincide in those works that have been used as a basis for the development of the same.

In this section, we show the differences of our research work in the various topics that coincide in those works that have been used as a basis for the development of the same [1], [2], [4]–[8]. Indeed, several research studies have collected data on the use of various methodologies and recommendations to counteract the effects caused by this syndrome on users [1], [3], [9], [10]. However, the development of a system that allows the user to become aware of the moment in which the position adopted when using a mobile device is detrimental to their health is not performed. Therefore, this research project implements a system that allows the user to become aware of these bad postures when using mobile devices.

At present, mobile devices such as cell phones have become very popular, reaching 81% of acceptance by Americans [13]. They are also used to monitor the physical activities of their users through the use of various sensors [11], [12], [14], [19]. Among the sensors most commonly used in activity monitoring are the gyroscope and the accelerometer because they provide accurate information [11], [14]–[16], [18], [20]. In this sense, the information provided by these sensors can be used to determine where the device is being used, in addition to knowing precisely how long the user is in that position.

V. Conclusions

In conclusion, it is possible to use the information of the tilt angle of the mobile devices through the use of the gyroscope and accelerometer sensors of the mobile devices. This information allowed the system to show the user the current tilt angle of the device. It is of utmost importance that the user is aware of the misuse of the device, since this allows the user to change position quickly in order to avoid falling into the text neck syndrome. Also, having a record of the activity that has taken place over time, greatly helps the user to keep track of their progress. Finally, the notifications provided by the system allow the user to have a timelier knowledge of their incorrect position during the use of the device, allowing it to make an immediate change in its position.

References

[1] M. T. Ansari and S. Ghosh, "CONCEPT OF TEXT NECK SYNDROME AND ITS MANAGEMENT THROUGH AYURVEDA," International Ayurvedic Medical Journal, vol. 9, no. 2, pp. 447–452, Feb. 2021, doi: 10.46607/iamj2009022021.

[2] M. A. Kulkarni, N. Lakhwani, N. Prajapati, D. Prajapati, B. Modi, and P. Muni, "Effect of providing awareness regarding the text neck syndrome in young adults," Int J Community Med Public Health, vol. 9, no. 2, p. 831, Jan. 2022, doi: 10.18203/2394-6040.ijcmph20220247.

[3] D. Jain, S. Jawade, and N. Chitale, "Effectiveness of Progressive Resisted Exercise along with Conventional Exercise and Conventional Exercise Program alone in Subjects with Text Neck Syndrome," J Pharm Res Int, pp. 536–542, Dec. 2021, doi: 10.9734/jpri/2021/v33i59b34412.

[4] A. Kaur and S. Makker, "A Study to Assess the Prevalence of Text Neck Syndrome and Quality of Sleep among Smartphone Users in Selected Colleges of District Ludhiana, Punjab," Int J Health Sci Res, vol. 11, no. 9, pp. 49–54, Sep. 2021, doi: 10.52403/ijhsr.20210907.

[5] S. Kumari, R. Kumar, and D. Sharma, "Text Neck Syndrome: The Pain of Modern Era," Int J Health Sci Res, vol. 11, no. 11, pp. 161–165, Nov. 2021, doi: 10.52403/ijhsr.20211121.

[6] M. Kamalakannan, R. Rakshana, and R. Padma Priya, "Estimation and prevention of text neck syndrome among smart phone users," Biomedicine (India), vol. 40, no. 3, 2020, doi: 10.51248/.v40i3.30.

[7] M. Gałczyk, W. Kułak, and A. Zalewska, "Is the use of mobile phones good for your neck? Text neck syndrome as an awareness of the existing threat – literature review," Medycyna Ogólna i Nauki o Zdrowiu, vol. 26, no. 3, pp. 240–243, Sep. 2020, doi: 10.26444/monz/126848.

[8] P. P. Samani, N. A. Athavale, A. Shyam, and P. K. Sancheti, "Awareness of text neck syndrome in young-adult population," Int J Community Med Public Health, vol. 5, no. 8, p. 3335, Jul. 2018, doi: 10.18203/2394-6040.ijcmph20183057.

[9] D. David, C. Giannini, F. Chiarelli, and A. Mohn, "Text neck syndrome in children and adolescents," Int J Environ Res Public Health, vol. 18, no. 4, 2021, doi: 10.3390/ijerph18041565.

[10] O. Soyer and Z. Ü. Akarırmak, "The Effect of Postural Correction and Exercise on Neck Pains in Cell Phone Users," Turk Osteoporoz Dergisi, vol. 26, no. 2, pp. 81–91, Aug. 2020, doi: 10.4274/tod.galenos.2019.76094.

[11] A. Prasad, A. K. Tyagi, M. M. Althobaiti, A. Almulihi, R. F. Mansour, and A. M. Mahmoud, "Human activity recognition using cell phone-based accelerometer and convolutional neural network," Applied Sciences (Switzerland), vol. 11, no. 24, Dec. 2021, doi: 10.3390/app112412099.

[12] M. Y. Esas and F. Latifoğlu, "Motion Type Verification Studies Using Accelerometer Sensor Data With Local Mean Decomposition," Academic Perspective Procedia, vol. 2, no. 3, pp. 1051–1057, Nov. 2019, doi: 10.33793/acperpro.02.03.117.

[13] M. A. Emberson, A. Lalande, D. Wang, D. J. Mcdonough, W. Liu, and Z. Gao, "Effectiveness of Smartphone-Based Physical Activity Interventions on Individuals' Health Outcomes: A Systematic Review," BioMed Research International, vol. 2021. Hindawi Limited, 2021. doi: 10.1155/2021/6296896.

[14] A. J. Casson, A. Vazquez Galvez, and D. Jarchi, "Gyroscope vs. accelerometer measurements of motion from wrist PPG during physical exercise," ICT Express, vol. 2, no. 4, pp. 175–179, Dec. 2016, doi: 10.1016/j.icte.2016.11.003.

[15] A. Ciecko, G. Grunwald, K. Kowalski, D. Tanajewski, and M. Dobek, "Analysis of the Accuracy and Usefulness of MEMS Chipsets Embedded in Popular Mobile Phones in Inertial Navigation," in IOP Conference Series: Earth and Environmental Science, Mar. 2019, vol. 221, no. 1. doi: 10.1088/1755-1315/221/1/012070.

[16] A. Pranav, "International Research Fibrillation Detection using Accelerometer and Gyroscope of a Smartphone," 2018. [Online]. Available: www.ijtsrd.com

[17] C. Fennell, E. L. Glickman, A. Lepp, J. D. Kingsley, and J. E. Barkley, "The Relationship between Cell Phone Use, Physical Activity, and Sedentary Behavior in United States Adults above College-age," International Journal of Human Movement and Sports Sciences, vol. 6, no. 4, pp. 63–70, Dec. 2018, doi: 10.13189/saj.2018.060401.

[18] V. v. Soshenko et al., "Nuclear Spin Gyroscope based on the Nitrogen Vacancy Center in Diamond," Phys Rev Lett, vol. 126, no. 19, May 2021, doi: 10.1103/PhysRevLett.126.197702.

[19] M. Cimera and A. Voloshin, "Validation of smartphone sway analysis for fall prevention," Applied Sciences (Switzerland), vol. 11, no. 22, Nov. 2021, doi: 10.3390/app112210577.

[20] C. Jia and B. L. Evans, "Online camera-gyroscope autocalibration for cell phones," IEEE Transactions on Image Processing, vol. 23, no. 12, pp. 5070–5081, Dec. 2014, doi: 10.1109/TIP.2014.2360120.

[21] S. Sanchana, A. P. Manjari, and B. N. Jyothi, "Application Development for Real-Time Location Tracking for Underwater Vehicles Using Low-Cost GPS with GSM," in 2021 International Conference on Wireless Communications, Signal Processing and Networking, WiSPNET 2021, Mar. 2021, pp. 108–112. doi: 10.1109/WiSPNET51692.2021.9419421.

[22] U. Can and B. Alatas, "A new direction in social network analysis: Online social network analysis problems and applications," Physica A: Statistical Mechanics and its Applications, vol. 535. 2019. doi: 10.1016/j.physa.2019.122372.

[23] S. Biroğul and H. B. Gültekin, "Importance of Business Intelligence Solution on Decision-Making Process of Companies," International Journal of Applied Mathematics, Electronics and Computers, pp. 86–86, 2016, doi: 10.18100/ijamec.266141.

[24] A. E. Mogrovejo-lazo, Celio Froilán Andrade-Cordero, and Héctor Alejandro Espinoza-Pillaga, "Inteligencia de Negocios con enfoque estratégico en el sector comercial de la ciudad de Cuenca-Ecuador," REVISTA CIENTIFICA DOMINIO DE LAS CIENCIAS, vol. 7, no. 3, 2021.

[25] A. Nasution, B. Efendi, and I. Kamil Siregar, "PELATIHAN MEMBUAT APLIKASI ANDROID DENGAN ANDROID STUDIO PADA SMP NEGERI 1 TINGGI RAJA," Jurdimas (Jurnal Pengabdian Kepada Masyarakat) Royal, vol. 2, no. 1, 2019, doi: 10.33330/jurdimas.v2i1.321.

[26] C. Khawas and P. Shah, "Application of Firebase in Android App Development-A Study," Int J Comput Appl, vol. 179, no. 46, 2018, doi: 10.5120/ijca2018917200.

[27] A. V. B. Dr.Amita Goel and Nidhi Sengar, "Android Based Instant Messaging Tool Using Firebase as Backend," International Journal for Modern Trends in Science and Technology, vol. 6, no. 12, pp. 198–201, Dec. 2020, doi: 10.46501/ijmtst061238.

[28] E. A. W. Sanad, "Pemanfaatan Realtime Database di Platform Firebase Pada Aplikasi E-Tourism Kabupaten Nabire," Jurnal Penelitian Enjiniring, vol. 22, no. 1, 2019, doi: 10.25042/jpe.052018.04.

[29] R. Mallik, A. P. Hazarika, S. Ghosh Dastidar, D. Sing, and R. Bandyopadhyay, "Development of An Android Application for Viewing Covid-19 Containment Zones and Monitoring Violators Who are Trespassing into It Using Firebase and Geofencing," Transactions of the Indian National Academy of Engineering, vol. 5, no. 2, 2020, doi: 10.1007/s41403-020-00137-3.