

A Fuzzy Inferencing System for Stress Management of University Students in COVID-19 for Pakistan

Sahiba Karim

Department of Computer Systems
Engineering
Balochistan University of Engineering
and Technology Khuzdar, Pakistan
email: 16cs04@buetk.edu.pk

Shabbar Naqvi

Department of Computer Systems
Engineering
Balochistan University of Engineering
and Technology Khuzdar, Pakistan
email: shabbar@buetk.edu.pk

Sohrab Khan

Department of Computer Systems
Engineering
Balochistan University of Engineering
and Technology Khuzdar, Pakistan
email: sohrab@buetk.edu.pk

Aasia Razzaq

Department of Computer Systems
Engineering
Balochistan University of Engineering
and Technology Khuzdar, Pakistan
email: 16cs09@buetk.edu.pk

Abdul Jalil

Department of Computer Systems
Engineering
Balochistan University of Engineering
and Technology Khuzdar, Pakistan
email: 16cs12@buetk.edu.pk

Muhammad Ishaq

Department of Computer Systems
Engineering
Balochistan University of Engineering
and Technology Khuzdar, Pakistan
email: 16cs32@buetk.edu.pk

Muhammad Amir Khan

Department of Computer Systems
Engineering
Balochistan University of Engineering
and Technology Khuzdar, Pakistan
email: 16cs18@buetk.edu.pk

Abstract—COVID-19 has caught the whole world by surprise in general. It has affected all activities around the globe including higher education. The world moved to online education in a bid to continue imparting quality education. Higher Education Commission (HEC) also advised all Universities of Pakistan to start online education. In this research work, we have made an effort to explore the area of stress management for students of Pakistan with the help of Artificial Intelligence using fuzzy inferencing. After doing detailed literature review on stress, its causes, impact of stress on online education globally and more specifically in Pakistan and Balochistan, an online Survey was done using social media, WhatsApp for the students. On the basis of the analysis of the results of the survey, stress factors were identified, and fuzzy inferencing systems were developed. The initial results have shown that fuzzy inferencing provides a way forward to deal with stress management of students encapsulating ambiguities of stress. In future, more empirical data will be used, and advanced Artificial Intelligence based techniques will be used to find out automated solutions for managing stress of students during any pandemic situation.

Keywords—Covid19, Stress, online education, fuzzy inferencing

I. INTRODUCTION

The term coronavirus comes from the Latin origin. The word corona means crown or halo. If virus is carefully looked under an electron microscope, then the shape of the virus would seem like it is surrounded by a solar corona hence the name is given as Coronavirus. The disease caused by the novel corona virus first identified in Wuhan, China. The name can be broken into pieces for better understanding in which 'CO' stands for corona, 'VI' for virus, and 'D' for disease. Formerly, this disease is called '2019 novel coronavirus' or '2019-nCoV.' The COVID-19 virus is a new virus linked to the same family of viruses as Severe Acute Respiratory Syndrome (SARS) and some types of common cold [1]. Because of its worldwide spread across the globe,

COVID-19 was called pandemic by the World Health Organization. Corona Virus spread in the world disturbing the day to day life including the education sector. Corona pandemic started in Pakistan in February and early March 2020. For the precautionary measures, Govt of Pakistan suspended educational activities across Pakistan including higher education activities. Higher Education Commission (HEC) asked HEI (Higher Educational Institutes) of Pakistan to start Online Classes and issued various guidelines in this regard [2]. The online classes caused many difficulties for the students also resulted in stress among students. It is very essential that University authorities address the stress issue of students because of Covid-19 to have better management of online classes

Fears about COVID-19 can take an emotional roll, especially for students of far-flung areas of Pakistan like the HEIs of Balochistan because of lack of facilities. The results of stress can be catastrophic, therefore, there is need to develop methods based on technology to facilitate Stress management.

In this work, we have investigated the use of fuzzy logic for development of a stress management system during online classes for Universities with a focus on remote areas of Balochistan. The rest of the paper is divided in such way that Section-II provides background of the work done and literature review, Section-III describes the Methodology regarding design of fuzzy inferencing system (FIS), Section-IV discusses the results and lastly Section-V is the conclusion and future work.

II. BACKGROUND

A. Online Education in Pakistan

Due to the COVID-19, educational activities across the country including University level education were suspended for a long period of time. The HEC directed all HEIs of Pakistan to initiate Online Classes for students in minimal

time. The HEC in this regard issued several guidelines on safety measures and regarding software availability, training programs to facilitate online education. However, this scheme had various issues due to lack of facilities for students across Pakistan especially in remote areas [2].

B. Lack of Facilities in Pakistan

According to data from the PTA website, 31.19 % of Pakistanis have access to the internet. It indicates that vast majority of Pakistan's population does not have internet access, therefore, online education is hard to carry out as internet is backbone of online education [3]. In additions to that, low-income households in Pakistan do not have computer hardware. Out of the 78% population that has mobile subscriptions, 35.9% is online. Children and students from families that make up the 42% not using 3G/4G or the 22% that do not have mobile subscriptions which results in limited learning opportunities. Other than that, poverty, electricity issues, remoteness of areas are overall other general concerns which are a major obstacle for quality online education.

Balochistan is the largest province of Pakistan area wise and scarcity of population exists. As the province lacks facilities, amenities and optimum internet infrastructure are among major factors that may result in huge problems for online education. According to the latest stats released by Pakistan Telecommunication Authority (PTA), however, 3G/4G users have crossed the 65 million mark in Pakistan; but the province of Balochistan still lacks the efficient Internet and Mobile Communication Infrastructure. The Tele density or the number of telephone connections for every 100 users in an area increased to 75.15% from 74.23% in Pakistan, but Balochistan still hovers near least in the country. Alongside that, broadband users also reached 63,773,916 million by the end of December 2019, yet the largest province comes last in the list of the broadband subscribers due to the weaknesses in the infrastructure in the interior districts of Balochistan [4].

Furthermore, Pakistan's mobile internet users as a percentage of the population have recorded at 21 per cent at the end of January 2019, according to a Global Digital report. The internet penetration stood at 22 % (44.6 million users) of the population at the end of the aforementioned period which is considered very inadequate for the proper commencement of online classes and examination in Pakistan in general, and in Balochistan in particular. Because of important security issues, some area of Balochistan do not have internet access which also causes problems for online education [4]. Similarly, areas of Balochistan have weak or no 3G or internet access including Chagai, Pishin, Panjgoor, Killa Abdullah and a few other areas as well [5].

All of the above-mentioned facts have resulted in Stress for students taking online classes. Now we discuss the significance of Stress.

C. Stress

If we look at the definition of Stress then it generally refers to two things: the psychological perception of pressure, on the one hand, and the body's response to it, on the other, which involves multiple systems, from metabolism to muscles to memory. It is not that Stress is always bad. Some stress is necessary for all living systems;

it is the means by which they encounter and respond to the challenges and uncertainties of existence. The perception of danger sets off an automatic response system, known as the fight-or-flight response that, activated through hormonal signals prepares an animal to meet a threat or to flee from it. But Stress can also cause diseases [6]. There are both physical and psychological ways to deal with blunt stress. Physical activities include meditation, yoga, and exercise. Psychological strategies include more serious cases of falling in love or seeing mental health professionals. Studies show that people are protected from the harmful effects of stress rather than being asked to help see certain experiences, such as the final exam, while still having positive effects, such as focusing and faster information processing. Changing the stress mindset not only reduces the damage of stress, studies show, but also increases efficiency and productivity [7].

D. High Stress in Students in COVID-19

The COVID-19 outbreak changed the education experience abruptly and radically. Campuses began to close, unemployment rose, and within a few weeks social distance became a norm. According to a new survey from Best Colleges, 78% of households with a high school or college student have experienced COVID-19 barriers. These barriers have a worrying side effect on students' mental health. Among students under the influence of COVID-19, an overwhelming majority (81%) agreed that they were experiencing increasing stress. The survey, conducted by the government, included 745 people who reported some educational effects from COVID-19. Of those, 290 reported academic disruptions as students, and 516 reported that someone in their household had their education disrupted. The results showed that the global epidemic and its aftermath are exacerbating pre-existing concerns about the mental health of students in college. Campus closures and changes to online education may be a variable that has increased student anxiety. About 35% of respondents said that the shift was having a negative effect on students. Meanwhile, a survey of the best colleges showed that the majority (69%) of students facing barriers believed that schools are providing significant support throughout the transition process. Most of the stress reported by survey respondents may be related to other adverse effects caused by the spread of the corona virus. Among other variables, housing, travel, employment, and income are caused by either epidemic diseases at the student or household level. A survey by the American Psychological Association found that, regardless of whether they sought treatment, 52% of college students expressed feelings of hopelessness and 39% reported severe depression [8].

Raja et al have performed a study to determine the stress level of students at dental colleges and institutes of Pakistan under Pakistan Medical and Dental Council (PMDC). They prepared a questionnaire to determine the stress level of students during COVID-19. Results indicated that out of 706 students who responded to the survey, 53.5 % students were going through high stress and 43.4 % from moderate stress. It indicates that Pakistani students are having generally high stress in COVID-19. The response percentage of Balochistan students in the survey was only 0.5%. The authors concluded that there is need to address the issues of stress among

students of Pakistan and to develop methods to deal with the stress [9].

In another study of undergraduate medical students of Pakistan, a questionnaire was distributed among 450 students via WhatsApp and respondents were mainly female students. In the study it was found that 77.84% female students were having stress in during COVID-19. The authors stressed the need to find methods to cope with stress by institutes [10].

To deal with the online education in Pakistan efficiently, in a research article, a comprehensive strategy has been proposed. In that strategy the concept of virtual student characteristics has been defined. They include Dedicated Space at Home, Space Management, SOPs, Availability Management, Speed and Connectivity Required, Fast Speed Internet, Computer System, 24/7 Help & Contact Center, 24/7 Complaint Management Unit, Technical Support Required, Live Technical Support Department, Uploading/Transferring Data, and Downloading/Receiving Data. It can be seen that for students living in Balochistan and also for a remote University of Balochistan, it is going to be hard to achieve them in short span of time. It also reveals that unavailability of these necessary online teaching aids, the stress level of students of Balochistan will remain high [11].

To address the problem of Stress management of students, we have considered fuzzy logic as part of Artificial Intelligence based technique. In the next section, we describe the fuzzy logic and parts of fuzzy inferencing system.

III. STRESS AND FUZZY LOGIC

Fuzzy logic is described as a multivalued logic where degree of membership lies in between 0 and 1. It was introduced by Zadeh in 1965. The advantage of fuzzy logic over traditional crisp logic or Boolean logic is that as values can be in between 0 and 1, therefore, it facilitates in dealing with ambiguities involved in data. As the real world problems have different level of complexities, this logic provides a good option to deal with the complexities of the data and provide rational solutions. Fuzzy inference system (FIS) is also called Fuzzy Expert System (FES) and Fuzzy Logic Controller (FLC) depending upon the area of its application. It is a rule-based system that uses fuzzy logic, rather than Boolean logic, to reason about data [12].

In the literature, fuzzy logic has been used for finding solutions for stress related management in various scenarios. In [13], authors have described a fuzzy logic-based system for tutoring students and their evaluation. It was discussed that in traditional evaluation systems, difficulty of questions and efforts put by students is not considered. The developed fuzzy based system considered difficulty of questions and efforts put by students. They used student t-test and results showed encouragement which was an indication that fuzzy based system can be used in academic problems related with students.

Ghosh et al [14], used fuzzy logic to analyse student's lifestyle. They used fuzzy logic in conjunction with Global Positioning System (GPS). The parameters included health, leisure, social work and others. They also argued that locality of University and other factors mentioned above can play a significant role in the lifestyle of a student in a University. The future work was directed towards using fuzzy weights and scores for a better system.

In [15], authors have analyzed that in the rapidly changing environment, college students are under stress because of family pressures, and society and there is a need to find solution of this important problem. They have designed a system based on ECG parameter to determine the emotional stage of the college student. The system uses a feature extraction mechanism from ECG and then applies it to a fuzzy logic-based Support Vector Machine (SVM) for final emotions detection. Public data set S. Koelstra et al was used. The results showed improvement towards determining the emotional understanding of the students.

Pua et al [16], used fuzzy Delphi method to identify mental health elements among technical university students of Malaysia. Authors reviewed that a student with good mental health with less stress can deal with day to day life well as well as it increases productivity and academic performance. Fuzzy Delphi Technique is a fuzzy based process which has six basic steps, namely, selection of experts, linguistic scale selection, compute the average value, calculate the threshold value, determine the consensus of experts and lastly defuzzification process. The results indicated that stress was among the top four disturbing things for a student. They suggested that steps are required to be taken to deal with stress.

In another work, prediction of student's dropout was done with the help of fuzzy logic. A sample size of 300 students was used for the system. The steps included data collection, data cleansing, feature selection, classification of samples and dropout prediction. IF THEN rules were developed to predict the drop out of students. Results indicated that fuzzy logic and logistic regression were able to high percentage accuracy regarding prediction of drop out of students [17].

The above review shows that fuzzy logic has been used in academic problems related with student's stress and others. Therefore, we have selected this method for our research as we want to address the ambiguities found in real data and to deal with them using fuzzy logic.

IV. METHODOLOGY

Fig.1 shows the schematic diagram of the research work carried out. It can be seen from the figure that after doing detailed literature review, we created the questions for the online survey. For the stress assessment questionnaires, we have made 37 questions. Some questions are taken from literature review and some are taken according the local scenario of Balochistan to address the problems faced by HEIs of remote areas.

These forms were distributed among students of Balochistan University of Engineering and Technology Khuzdar (BUETK) by Google forms using email, social media with complete anonymity and confidentiality. The obtained results were analyzed and based on the results, three types of factors including Controllable factors (CF), Intermediate factors (IF) and Uncontrollable factors (UCF) were identified as shown in Table-I.

Controllable factors are those factors which can be controlled by University mainly on its own providing better stress management for students. Intermediate factors are those which require a joint effort by the University as well as higher authorities of the province and the country and Uncontrollable factors are those which mainly belong to

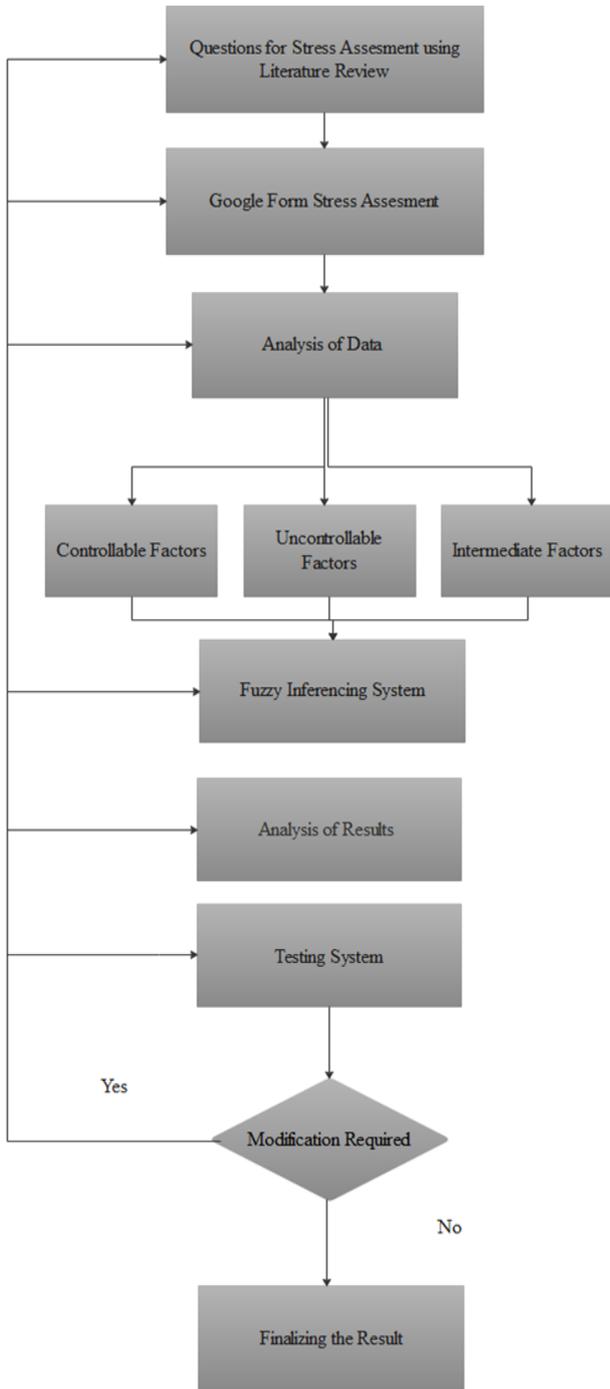


Fig.1: Schematic Diagram of Research

country level policies to deal with stress management of students. These factors were then given as input to fuzzy system and results were obtained and analyzed. On the basis of the three factors mentioned in Table-I, functions have been defined as shown in Table-II.

Three fuzzy inferencing systems have been developed one for each type of factor. Mamdani type FIS were developed using Matlab Fuzzy logic Toolbox. Each system has three input variables and for each input variable three membership. It can be seen from the Table-II that low indicates lower level stress for that particular input variable and high indicates high stress for the particular variable. For example, in case of variable NALM, lower values reflect that more learning material available thus causing lower stress in

TABLE I. STRESS FACTORS DURING ONLINE EDUCATION

Controllable Factors (CF)	Intermediate Factors (IF)	Uncontrollable Factors (UCF)
Non- availability of learning materials [NALM]	Poor skills to use computer [PSUC]	No Broadband and internet coverage Access [NBIA]
Difficulty in reading textbooks in soft [DIRTB]	no resources to take online classes [NRTOC]	No Laptop [N-lap]
no Command on learning software[NCLS]	no confidence in online examination[NCOE]	Non availability of Separate space at home[NASSH]

TABLE II. EXAMPLE OF INPUT VARIABLES MEMBERSHIP FUNCTIONS

S.No	Membership function	Type
1	Low	Triangular
2	Medium	Triangular
3	High	Triangular

students whereas high level of non-availability of learning material is going to cause more stress.

The input variables have a range from 0 to 1, where 0 indicates lower level of stress whereas 1 indicates higher level of stress. The three FIS for CF, IF and UCF are shown in Figs 2-4 respectively. An example of membership function consisting of three membership functions is shown in Fig. 5. The output variables for three membership functions are called Result-CF, Result-IF and Result-UCF respectively. All output variables have three membership functions called low-stress, Moderate-Stress and Extreme-Stress respectively. For the ruleset, 27 rules have been developed. For decision of stress level, majority vote has been chosen.

IF (majority membership functions are low) THEN Result is Low-Stress

IF (majority membership functions are Medium) THEN Result is Moderate Stress

IF (majority membership functions are High) THEN Result is Extreme-Stress

The cases where majority vote is not possible to bring a result have been excluded and this is current limitation of this work. All rules have equal weight in the system. The surface view of the system is shown in Fig. 6.

It can be seen from Fig. 6 that as an example, increase in membership values for the input variables NLAP and NBIA which are indicators of students having no laptop and not having broad band or internet access results in increase in stress. The spike in 3rd dimension which is the result is due to the unavailability of these two important inputs.

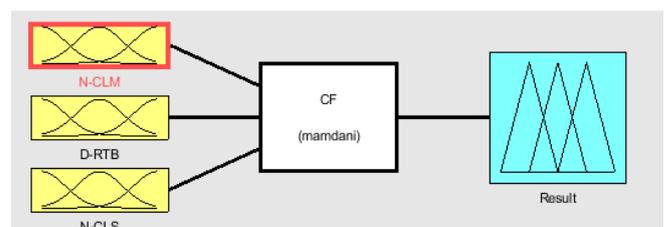


Fig 2: FIS-1 of Controllable factors (CF)

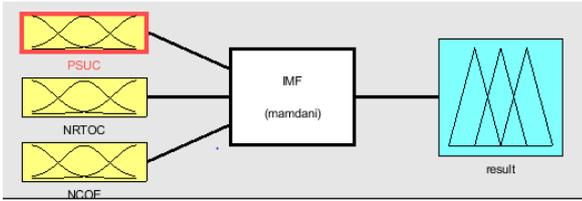


Fig 3: FIS-2 of Inermediate factors (IF)

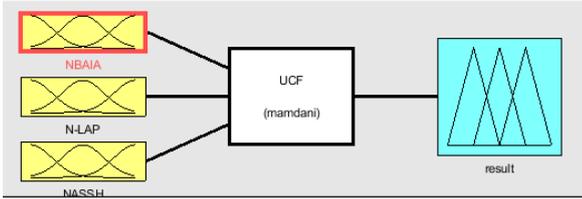


Fig 4: FIS-3 of Uncotrollable factors (UCF)

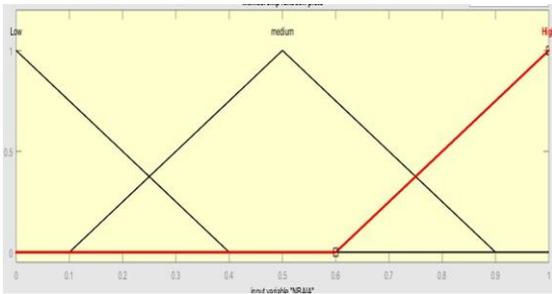


Fig 5: Example of Membership Functions of UCF

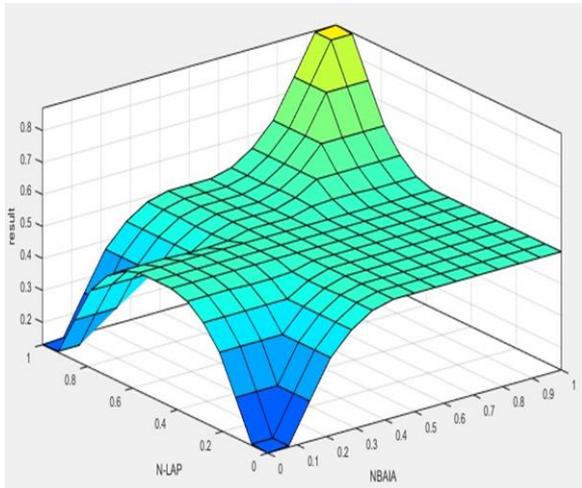


Fig 6: 3D plot of Surface View

V. RESULTS

The system was executed on synthetic data for testing having Gaussian distribution. For each FIS, based on the Questionnaire and selected parameters, stress management conclusions were drawn. They are mentioned in Table-III.

It can be seen from the Table-III that results of three FIS provide a classification of stress level of students. Results are divided into three categories for low, intermediate and extreme stress management. After cohort analysis, the stress management options against each level of stress have been provided. For all three FIS, these three categories identify

the steps that can be initiated for better stress management. Lower level management generally involves counselling sessions in the relevant areas. In intermediate management, specialized sessions are encouraged, In Extreme stress condition, one to one sessions, limited provision of hardware equipment is suggested. In case of extreme stress caused by uncontrollable factors, contacting regional authorities to country level authorities has been suggested. Our initial results have indicated that FIS may provide a better way of finding intelligent solutions with respect to stress management of students of Pakistan especially in context of far flung areas of Pakistan like remote areas of Balochistan.

VI. CONCLUSION AND FUTURE WORK

Stress management for students during COVID-19 pandemic is an important area of research. In this work we have developed a prototype framework for stress management. Three types of Stress factors based on a sample Questionnaire have been derived. On the basis of these factors, three FIS have been developed. The results of the FIS have helped to provide a sample guideline to deal with stress management especially in context of Balochistan. In future, we aim at combining the results of three independent FIS to find a unique stress management scheme. More empirical data will be obtained, and different scenario tests will be performed. We shall also be investigating the use of type-2 fuzzy logic for the development of stress management system for students of Pakistan with a focus on Covid19.

TABLE III. STRESS MANAGEMENT SCHEME

FIS Type	Result-Stress	Management Scheme
Controllable Factors (CF)	Low-Stress	Occasional Training Sessions for Students
	Moderate-Stress	More student counselling More training sessions on online methods
	Extreme-Stress	One to one training sessions with targeted outcome More information on Online Resources added to repository
Intermediate Factors (IF)	Low-Stress	Dedicated sessions on Software for online teaching
	Moderate-Stress	Student counselling sessions Limited access to use on campus facilities where possible
	Extreme-Stress	Limited provision of hardware, laptop, Smart Phone Counselling on Confidence building
Uncontrollable Factors (UCF)	Low-Stress	Contacting district level authorities for provision of internet, broad band, laptops for students
	Moderate-Stress	Contacting provincial authorities for funding regarding facilities for online education
	Extreme-Stress	Contacting at country level and also with HEC for dedicated specialized funding for student facilitation including financial support for laptops, smart phones, broadband devices etc

REFERENCES

- [1] Unicef, "Unicef Website," 2020. [Online]. Available: <http://www.unicef.org>. [Accessed: 10- Oct- 2020].
- [2] HEC, "HEC Pakistan Website," 2020. [Online]. Available: <http://www.hec.gov.pk>. [Accessed: 10- Oct- 2020].
- [3] PTA, "PTA Website," 2020. [Online]. Available: <http://www.pta.gov.pk>. [Accessed: 10- Oct- 2020].
- [4] Websource, "Internet Restrictions and Online Classes in Balochistan," 2020. [Online]. Available: <http://www.voiceofbalochistan.pk>. [Accessed: 10- Oct- 2020].
- [5] Tribune, "Tribune Website," 2020. [Online]. Available: <http://www.tribune.com.pk>. [Accessed: 10- Oct- 2020].
- [6] Medcrave, "Medcrave Online Website," 2020. [Online]. Available: <http://www.medcraveonline.com>. [Accessed: 10- Oct- 2020].
- [7] S. Psychology, "Stress Psychology Today Website," 2020. [Online]. Available: <http://www.psychologytoday.com>. [Accessed: 10- Oct- 2020].
- [8] S. Writers, "Students Stressed Out Due to Coronavirus," 2020. [Online]. Available: <http://www.bestcolleges.com>. [Accessed: 10- Oct- 2020].
- [9] H. Z. Raja et al., "Perceived Stress Levels in Pakistani Dental Students During COVID-19 Lockdown," *Eur. J. Dent. Oral Heal.*, vol. 1, no. 4, pp. 1–7, 2020, doi: 10.24018/ejdent.2020.1.4.14.
- [10] M. Waseem, N. Aziz, M. U. Arif, A. Noor, M. Mustafa, and Z. Khalid, "Impact of post-traumatic stress of covid-19 on mental wellbeing of undergraduate medical students in Pakistan," *Pak Armed Forces Med. J.*, vol. 70, no. 1, 2020.
- [11] W. Akram, S. Adeel, Y. Jiang, M. A. Chandio, and I. Yasmin, "Scenario Analysis and Proposed Plan for Pakistani Universities – COVID – 19: Application of Design Thinking Model," 2020.
- [12] S. Naqvi, "Modelling Spectral Data with Type-1 and Type-2 fuzzy sets for breast cancer grading," University of Nottingham, UK, 2014.
- [13] A. Krouska, C. Troussas, and C. Sgouropoulou, "Fuzzy Logic for Refining the Evaluation of Learners' Performance in Online Engineering Education," *Eur. J. Eng. Res. Sci.*, vol. 4, no. 6, pp. 50–56, 2019, doi: 10.24018/ejers.2019.4.6.1369.
- [14] S. Ghosh, S. Boob, N. Nikhil, N. R. Vysyaraju, and A. Kumar, "A Fuzzy Logic System to Analyze a Student's Lifestyle," in *International Conference on Advanced Computational Intelligence*, 2017, pp. 231–236.
- [15] Y. Ding, X. Chen, S. Zhong, and L. Liu, "Emotion Analysis of College Students Using a Fuzzy Support Vector Machine," *Math. Probl. Eng.*, vol. 2020, p. 8931486, 2020, doi: 10.1155/2020/8931486.
- [16] P. K. Pua, C. S. Lai, and M. F. Lee, "Identifying Mental Health Elements among Technical University Students Using Fuzzy Delphi Method," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 226, no. 1, 2017, doi: 10.1088/1757-899X/226/1/012189.
- [17] A. Saranya and J. Rajeswari, "Enhanced prediction of student dropouts using fuzzy inference system and logistic regression," in *ICTACT Journal on Soft Computing*, 2016.