IN THIS ISSUE

Instagram App on Speaking Accuracy

Economy Industrial Risk Transmission

Systematic Review of Smart Internet

Paradigm Shift in Medical Decision

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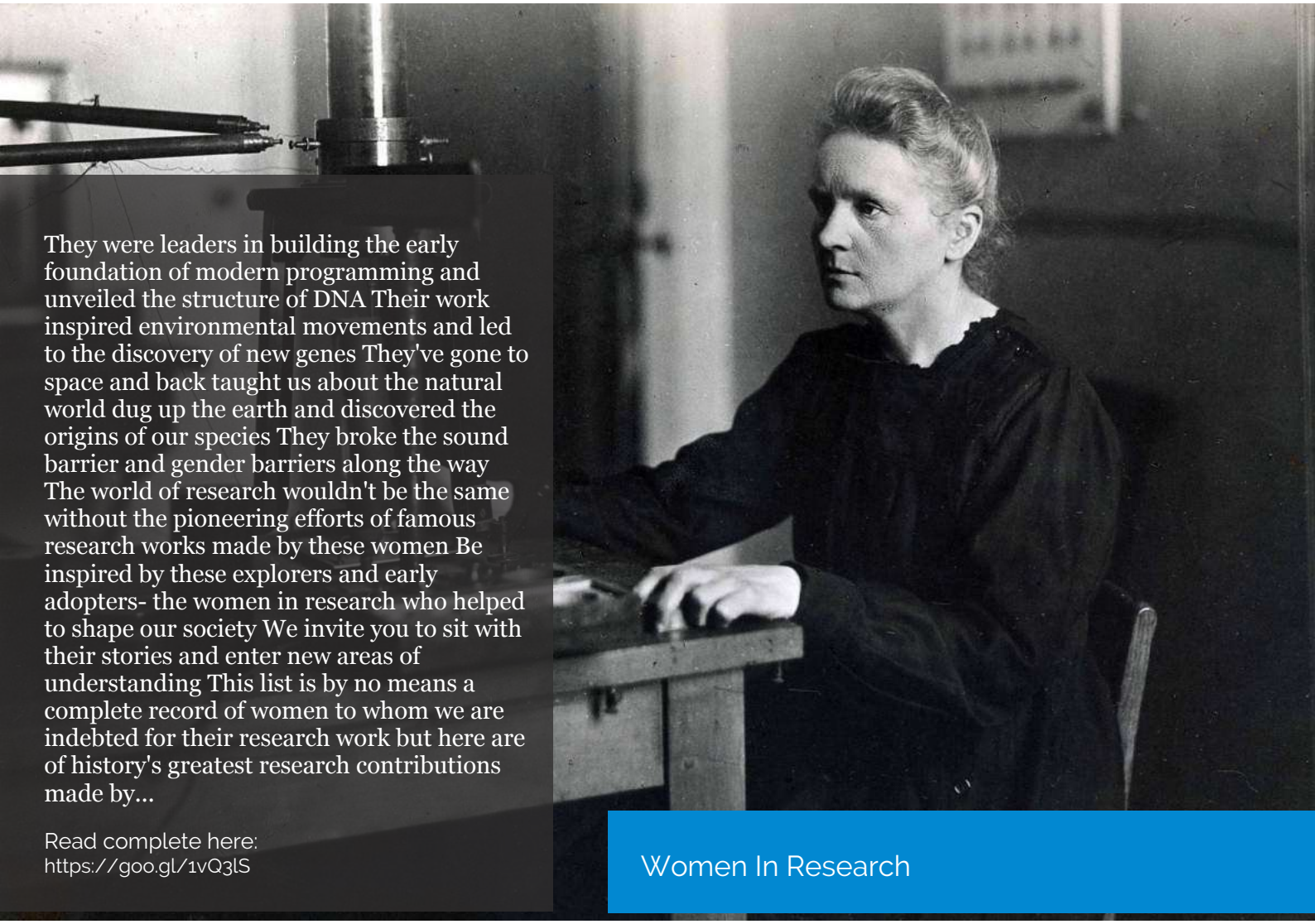

They were leaders in building the early foundation of modern programming and unveiled the structure of DNA Their work inspired environmental movements and led to the discovery of new genes They've gone to space and back taught us about the natural world dug up the earth and discovered the origins of our species They broke the sound barrier and gender barriers along the way The world of research wouldn't be the same without the pioneering efforts of famous research works made by these women Be inspired by these explorers and early adopters- the women in research who helped to shape our society We invite you to sit with their stories and enter new areas of understanding This list is by no means a complete record of women to whom we are indebted for their research work but here are of history's greatest research contributions made by...

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Journal Content
In this Issue

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i. Journal introduction and copyrights
ii. Featured blogs and online content
iii. Journal content
iv. Curated Editorial Board Members

1. A Systematic Review of Smart Internet of Things Wearable Devices in Healthcare. ***1-5***
2. Cascading Failure under the Digital Economy Industrial Risk Transmission. ***7-16***
3. Leveraging AI in Clinical Diagnosis: A Paradigm Shift in Medical Decision-Making. ***17-20***
4. Effect of Google Meet & AMP; Instagram App on Speaking Accuracy in Intermediate Level of EFL Learners in L2. ***21-32***
5. Visualization Tool for Data Structures in Real Time. ***33-44***

v. Great Britain Journals Press Membership

Editorial Board

Curated board members

Research papers and articles

Volume 23 | Issue 5 | Compilation 1.0

A Systematic Review of Smart Internet of Things Wearable Devices in Healthcare

Kamal Aldin Yousif Yaseen

University of Nizwa

ABSTRACT

Technological advancement has shown incremental growth in each and every field from communication to healthcare. It made our lives easier and comfortable. One of the outcomes of technology revolution that proved as a boon to mankind is Internet of Things enabled Wearables. IoT wearables are the smart Internet enabled devices that can send data recorded from the human body for proper health monitoring and analysis. Benefits of this connected device driven technology will serve the purpose of both doctors and patients. It becomes possible to get accurate diagnosis and right treatment at the right place without wasting time and efforts. This research paper will focus a light on various IoT wearable devices for healthcare discussed in literature and also study the working of Wearable devices with their weaknesses.

Keywords: internet of things (IoT), wearables, healthcare, health monitoring.

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A Systematic Review of Smart Internet of Things Wearable Devices in Healthcare

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ABSTRACT

Technological advancement has shown incremental growth in each and every field from communication to healthcare. It made our lives easier and comfortable. One of the outcomes of technology revolution that proved as a boon to mankind is Internet of Things enabled Wearables. IoT wearables are the smart Internet enabled devices that can send data recorded from the human body for proper health monitoring and analysis. Benefits of this connected device driven technology will serve the purpose of both doctors and patients. It becomes possible to get accurate diagnosis and right treatment at the right place without wasting time and efforts. This research paper will focus a light on various IoT wearable devices for healthcare discussed in literature and also study the working of Wearable devices with their weaknesses.

Keywords: internet of things (IoT), wearables, healthcare, health monitoring.

Author: Department of Information System, CEMIS College, University of Nizwa, Nizwa, Oman.

I. INTRODUCTION

Health is important for every human being. In case of illness, it is equally important to get prompt and appropriate treatment. In sudden critical situations or medical emergencies, it becomes impossible to take patients to hospital for diagnosis followed by course of treatment. Even the hospitalization cost is expensive.

Internet of Things enabled wearable devices are a much-needed solution to get health information remotely. The world is changing fast with the growth and evolution of IoT Technologies. With IoT, Medical Practitioners can continuously monitor the health condition of patients under their treatment and take necessary action whenever required.

Internet of Things are the hardware devices that communicate over the Internet through processors, sensors and actuators [1]. Healthcare applications are providing medical services at remote places with improved accessibility and reduced cost [2]. IoT based healthcare devices provide automated disease monitoring, predictions and treatment [3]. This automated interconnected system not only helps to get fast access to patient data but also to provide accurate diagnosis and treatment by medical practitioners.

In recent times, IoT sensors have shown their applications in early detection of illness based on physical factors such as blood pressure, heart rate, oxygen level etc. [4]. This paper reviews various existing IoT wearables used in healthcare, further it explains the working of connected devices for gathering data. This paper focuses light on future challenges for researchers who want to develop IoT devices for detection of illness not detected yet.

The structure of this paper is as follows: Section 2 highlights the review method, Section 3 emphasis on various IoT devices in healthcare and sensors used to detect and predict early stages of illness based on data gathered from the human body. Section 4 focuses on future challenges in development of patient specific customized IoT wearable devices. Finally, section 5 concludes the paper with conclusion.

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II. LITERATURE REVIEW METHODOLOGY

The method of systematic Literature review started with searching keywords: IoT, Wearable Technology, Healthcare, sensors, disease detection. The search strings used for finding related literature are "IoT wearable Technology", "IoT wearable devices in Healthcare", "Disease detection using Wearable sensors". For reliability of published content, the search was carried out using reliable sources like Google Scholar, Springer, IEEE Xplore, Science Direct. The journal articles and research papers published in the recent 4 years were considered for study. The relevance and applicability of content were the factors used for filtering publications. The process of filtering results in: published in 2019(4 papers), published in 2020 (3 papers), published in 2021(8 Papers) , published in 2022(1 paper).

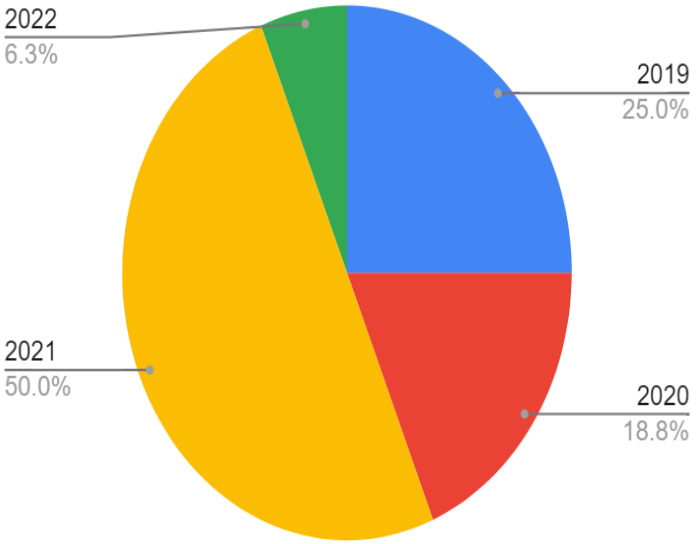

Fig. 1: Related Papers Reviewed between 2019-2022

III. STUDY OF IOT WEARABLE DEVICES AND SENSORS

3.1 Devices

The first wireless wearable device, a Webcam was invented by Steve Mann, a Canadian Researcher in 1994.Since 1994 a Technology revolution took place on a large scale which gave birth to Internet of Things enabled devices. This technology influenced many fields including healthcare. In the healthcare domain, wearable technology becomes a much-needed solution. Below part focused on various disease specific devices:

(i) Smart Heart Disease Prediction [5]: This paper proposed a smart Edge-Fog-Cloud integrated wearable device for accurately predicting chronic Heart Disease. Heart features were extracted through signals for continuous monitoring and detection.

(ii) Novel Smart Watch Care Up [6]: According to WHO about 46% of adults suffering from hypertension are unaware of disease conditions. This paper proposed a smart watch for calculating blood pressure in real time using Photoplethysmogram. Two Oximeters installed with the device take the signal to identify the time delay in pulse count.

(iii) Parkinson [7]: This paper suggested a system based on wearable sensors and Artificial Intelligence to avoid misdiagnosis of Parkinson disease. Movement data of individuals are recorded with sensors which helps in detecting neurodegenerative disorders accurately.

(iv) Blood Glucose Monitor [8]. This paper proposed an IoT enabled E-Healthcare system with wearable Technology. These devices can be worn or implanted in the body for remote monitoring of critical illness. This paper suggested

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a sensor based implantable device to be implanted in abdominal tissue for tracking blood glucose sugar.

(v) Elderly care [9]: This paper presents a review of different solutions used for elder care. With the growing age, old age people need more attention and care. In such situations IoT wearable devices are helpful to individuals as well as for caregivers. Paper focuses on effectiveness, accessibility and accuracy of devices.

(vi) Sweat Sensor [10][17]: The study presented in Literature states that sweat can be used as an alternative body fluid as its contents are similar to Blood, Urine and Saliva. Sweat was considered to be an important measure to detect electrolyte imbalance. An IoT enabled wearable device was used to study the composition and concentration of Sweat released from the human body during exercise.

Beside these chronic disease detections, there are many uses of IoT wearables in healthcare [11]. IoT healthcare applications use devices like Remote Patient Monitoring, Mood Monitoring, Connected contact lenses, Robotic surgery, sleep quality etc.

3.2 Sensors

This paper presented a review of past literature studied on IoT, E-health and healthcare. Two types of sensors highlighted were Wearable and Environmental. Various sensors studied in the *review are:*

1. Galvanic skin response (GSR) system: To detect physiological activities.
2. Smartphones and Wrist band: To collect real time data.
3. Portable ECG: To detect long term Electrocardiogram.
4. Wearable Body Area Network (WBAN): To measure body temperature and heartbeats.
5. Fog based sensors: For remote sensing
6. SPHERE- A smart home application: To monitor people at their living places.

3.3 Communication Technology [13]

The four commonly used communication Technologies for Sensors are ZigBee, LoRaWAN, WI-FI and Bluetooth. These are the most popular wireless communication protocols used for retrieving data from remote sensors. LoRaWAN is applicable in long range communication whereas ZigBee, Wi-Fi and Bluetooth are applicable in short range communication. Data transmission rate is higher in LoRaWAN as compared to other three technologies.

3.4 Overview of IoT Architecture [14]

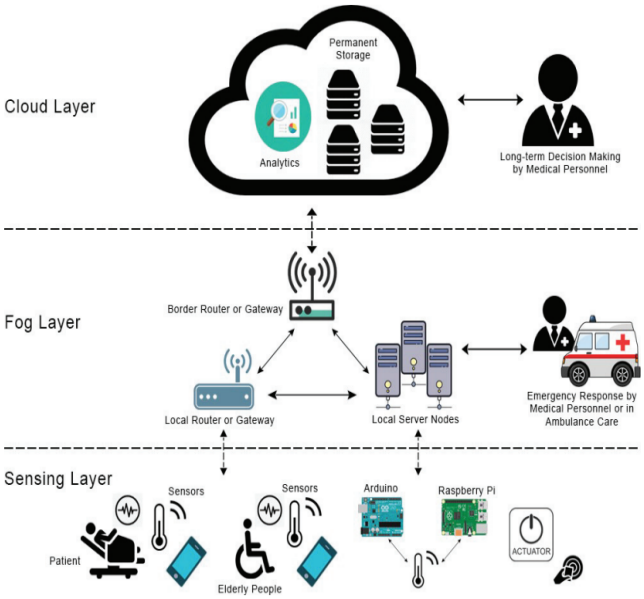

Fig 2: Architecture of IoT Wearables for Healthcare [14]

Above figure shows the layered architecture of IoT wearables discussed by many researchers in their work. The architecture consists of Sensors, communication technologies, Open-source platforms and Gateways. The sensing layer senses the data through Wearables. Data obtained from sensors is passed to the Fog/Edge system through gateways and routers. Analysis of data takes place at the cloud layer. The outcome of data analysis is sent to mobile applications which are used for remote sensing.

VI. CHALLENGES IN DEVELOPMENT OF IOT WEARABLES [15][16]

The rapid growth of Information and Communication Technology generates the scope for improvement in existing wearable technologies. Development of IoT based wearable devices specific to healthcare need to face challenges related to data sensing, data processing, data security and privacy.

The customization of Wearable devices is yet another challenge for future IoT development. There is a need to design more sensors that directly take crucial parameters from the human body. More accurate data collection and processing is required for healthcare specific to elderly care.

V. CONCLUSION

With this survey paper we found that IoT-enabled healthcare devices can improve the remote monitoring of patients, more specifically the elderly people and people receding in old age homes or day care facilities. For the growing population of senior citizens all over the world, IoT wearable devices are a very helpful solution. These sensor-based devices are beneficial for detection of severe illnesses like heart attack, asthma, Parkinson, diabetes, depression, blood pressure and so on. In Spite of many challenges, IoT researchers and developers will definitely find their path in the development of more accurate and customized sensor based IoT based healthcare devices.

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Cascading Failure under the Digital Economy Industrial Risk Transmission

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Huaqiao University

ABSTRACT

With the background of emergencies and the digital economy industry as the core, this paper collects the data of China's 2020 input-output table, uses network analysis technology to establish digital economy industrial networks, analyzes the structural characteristics of industrial networks, and analyzes the risk transmission characteristics of industrial networks under the impact of various emergencies by establishing cascade failure simulation models. The results show that the digital trading industry occupies a higher position than other digital economy industries in the industrial network and is an important intermediary industry in the economy. Sudden systemic financial risks cause the largest damage at the highest risk transmission speed.

Keywords: digital economy; industrial network; cascade failure; risk transmission; input-output.

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With the background of emergencies and the digital economy industry as the core, this paper collects the data of China's 2020 input-output table, uses network analysis technology to establish digital economy industrial networks, analyzes the structural characteristics of industrial networks, and analyzes the risk transmission characteristics of industrial networks under the impact of various emergencies by establishing cascade failure simulation models. The results show that the digital trading industry occupies a higher position than other digital economy industries in the industrial network and is an important intermediary industry in the economy. Sudden systemic financial risks cause the largest damage at the highest risk transmission speed.

Keywords: digital economy; industrial network; cascade failure; risk transmission; input-output.

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I. INTRODUCTION

At present, various emergencies occur frequently, which might seriously hinder the development of the global economy and have a huge impact on the economy and society of all countries in the world. In today's globalization and deep integration of industrial chain, China possesses a complete industrial chain and the operation of various industries has formed a complex and huge industrial network. However, because some industries still rely on imports of high-end parts, the huge economic volume makes it have a high demand for exotic energy. Moreover, it has relied on cost advantages to act for brands in developed countries to obtain profits, which fully exposes the weakness of China's economy. When certain emergencies occur, certain industries in the economy will be affected, and due to the transmission effect, it will have a huge impact on the overall economy.

Therefore, the analysis of the possible impact of emergencies on Chinese industries under various scenarios and how risks are transmitted in the industrial network is helpful for China to prevent and resolve its own economic risks in today's complex and changing world pattern.

II. LITERATURE REVIEW

Xu.et.al[1] study the input-output table of 41 major economies in 2009 and find that China's metal products and petroleum refining industry have important resource transmission capacity in the international trade system. At the same time, the public administration and defense sectors of the United States have a greater influence on the upstream industries and the huge defense expenditure has significantly boosted the development of the global upstream industries.

Huang.et.al[2] apply the network cascade failure model to the systemic risk of the financial network, studying the risk transmission process when the US banking industry hit by the financial crisis in 2007. They propose that the model could be used for the systemic risk stress test of the financial system.

Acemoglu.et.al [3] study macroeconomic fluctuations from the perspective of network structure and believe that industrial asymmetry is the root of economic crisis because seemingly weak shocks from marginal industries could completely cause large fluctuations of the entire economic system due to structural asymmetry.

Cerina.et.al[4] study several input-output tables of the world in the way of time series to dynamically observe the changing trend of international economic structure.

Sonis.et.al[5] provide a new idea of applying the network analysis method to the inter-regional input-output table from the perspective of mathematical reasoning to study the inter-regional transmission of economic shocks through the network system.

Li.et.al[6] apply the cascading failure network model to the material and energy exchange network in an industrial park and measure the destructive impact of a single node on the entire network when considering the cascading failure through simulation experiments including single node failure and edge failure.

Giammetti.et.al[7] analyze the impact of output damage in key industries under the epidemic on the overall supply chain structure in Italy, which is helpful to guide the government in designing lockdown or un-lockdown policies under the epidemic.

III. METHODOLOGY

Based on the input-output table data, the strongest path weighted network analysis method is used to analyze the network structure between the digital economy industry and other industries. On this basis, the industrial network cascade failure simulation model is used to analyze the impact of the dynamic process of economic risk caused by accidents.

3.1 Input-Output Network Description

3.1.1. Strongest Path (SP)

SP is used in input-output analysis to measure the path of investing the intermediate products produced by one industry and maximizing the production of another industry. Based on the direct consumption coefficient a, the strongest path coefficient is defined as q_{ij}, which means that the intermediate input of sector i enters the per-unit output of sector j through the strongest path:

$$q_{ij} = \prod_{i \neq k_1 \neq k_2 \neq \cdots \neq j} a_{ik_1} a_{k_1 k_2} \cdots\cdots a_{k_m j} \tag{1}$$

SP from sector i to j can be defined by the following equation:

$$p_{ij} = \{k_1, k_2, \cdots, k_m\} = i \to k_1 \to k_2 \to \cdots \to k_m \to j \tag{2}$$

where $i \neq k_1 \neq k_2 \neq \cdots \neq k_m \neq j$,Dijkstra algorithm is used to search the shortest path between two nodes and form the strongest path matrix Q.

3.1.2. SP Betweenness and Closeness

Industrial betweenness refers to the number of the shortest paths between any two industries, which is used to quantify the ability of an industry to act as a medium in the network. The industry betweenness definition based on matrix Q is as follows:

$$b_i = \sum_{s=1, s \neq i}^{n} \sum_{t=1, t \neq j}^{n} x_t q_{st} \tag{3}$$

where $i \subset p_{st}$. Similarly, the SP betweenness for a particular link i→j is:

$$b_{i \to j} = \sum_{s=1}^{n} \sum_{t=1}^{n} x_t q_{st} \tag{4}$$

where $i \to j \subset p_{st}$.

Closeness measures the proximity of a particular industry to other industries. Downstream closeness is the average value of all SPs starting from a particular sector i:

$$C_i^D = \frac{1}{n-1} \sum_{j=1}^{n} w_{ij} \tag{5}$$

Similarly, upstream closeness is defined as the average value of all SPs ending at a particular sector j:

$$C_i^U = \frac{1}{n-1} \sum_{i=1}^{n} w_{ij} \tag{6}$$

3.2 Industrial Network Risk Transmission Cascade Failure Process

Due to the failure of an industry in the economic network, the failure of other adjacent nodes based on the coupling relationship, leads to the phenomenon of cascade failure, and then leads to the large-scale industrial collapse in the economic network, which can be divided into the supply side and demand side are affected by the risk contagion effects.

3.2.1 Input-Output Network Risk Transmission Path Under the Supply Shocks

The normal production and operation of an industry depends on the supply of products from its upstream industry. If the upstream industry cannot produce normally, the supply will decline or be interrupted, and due to the stickiness of the supply chain and the high conversion cost, it will decrease or the industry will stop production. This process can be characterized by the network cascade failure model. When node i is affected by the supply, the supply of the adjacent node j can be used for production decreases,γ_j^t represents the ratio of the available production supply of node j to the production supply of the previous period:

$$\gamma_j^t = \frac{\sum_{i=1}^{n} w_{ij}^t}{\sum_{i=1}^{n} w_{ij}^{t-1}} \tag{7}$$

Assuming that there is a threshold of P_c, β_i^t represents the impact intensity, when the ratio of the supply of production materials and the initial situation in the current period is lower than the threshold, the industry is determined to be suspended, and the demand for production means and the supply of products in the industry are reduced to 0:

$$\beta_j^t = \{\gamma_j^t, \quad \gamma_{0j}^t \geq P_c\, 0, \quad \gamma_{0j}^t < P_c \tag{8}$$

Due to the decline in the supply of production materials, the industry will provide the supply of products to other industries to decrease in the next phase. The formula is:

$$w_{ij}^{t+1} = w_{ij}^t \beta_i^t \tag{9}$$

3.2.2 Input-Output Network Risk Transmission Path Under the Demand Shocks

Similarly, when the industry is affected and the demand drops, the purchase of production materials will be reduced accordingly, affecting the income of the upstream industry and bringing about the overall contraction of the demand. When node i is affected by demand, the demand of the adjacent node j can be used for production will decrease, and the ratio of the income of industry j in t to the income of the previous period is expressed by θ_j^t:

$$\theta_j^t = \frac{\sum_{i=1}^{n} r_{ij}^t}{\sum_{i=1}^{n} r_{ij}^{t-1}} \tag{10}$$

Assuming that there is a threshold of P_c, β_i^t represents the impact intensity. When the ratio of the income supply of an industry to the initial situation is lower than the threshold, the industry is determined to be suspended, and the demand and income of the industry are reduced to 0:

$$\beta_j^t = \{\theta_j^t, \quad \theta_{0j}^t \geq P_c\, 0, \quad \theta_{0j}^t < P_c \tag{11}$$

Due to the decline in demand for production materials, the demand for other industries in the next phase:

$$r_{ij}^{t+1} = r_{ij}^t \beta_i^t \tag{12}$$

At the same time, in order to simulate the operation of the economy under the impact of emergencies, the capacity utilization index E is constructed to quantify the impact of each emergency on the impact of the overall economy:

$$E = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij}^t}{\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij}^0} \tag{13}$$

Where $\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij}^t$ represents the total of intermediate products in period t, and $\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij}^0$ represents the total of intermediate products in the initial case.

VI. EMPIRICAL ANALYSIS

4.1 Input–Output Network Model

As the digital economy plays an important role in promoting the economic development of a country. Referring to Statistical Classification of Digital Economy and Its Core Industries (2021) and Chen et.al.(2023)[8]. The digital economy industry is classified and other industries are split and merged. The collated input-output table includes the following industrial sectors: (1) digital product manufacturing industry (DPM, corresponding to 39 categories in the input-output table, abbreviated as 39), (2) digital product service industry (DPS, 63-65), (3) digital media industry (DM, 86-87), (4) digital trading industry (DT,51-52,60,66-68,75), (5) agricultural services and products (AGR, 01-05), (6) Fossil fuel mining (FOS,06-07), (7) metal, non-metal and other mining (MET, 08-11), (8) food and tobacco (FT,13-16), (9) textile industry (TEX,17-19), (10) wood processing products and furniture (WOD,20-21), (11) paper, printing and cultural education sporting goods(PE,22-24), (12) petroleum, coking products and nuclear fuel processing products (PET,25), (13) chemical products (CHE,26-28), (14) non-metallic mineral products (NMET,29-30), (15) metalwork (MW,31-33), (16)general equipment (GE,34), (17) special equipment (SE,35), (18) transportation equipment (TE,36-37), (19) electrical machinery and equipment (ELE,38), (20) instrument and meter (INS,40), (21) other manufacturing goods (OMG,41-43), (22) production and supply of electricity, heat, gas and water (EHGW,44-46), (23) architecture (ARC,47-50), (24) transportation (TRA,53-59), (25) accommodation and catering (AC,61-62), (26) real estate (RE,70), (27) rental and business services (BSR,71-72), (28) scientific research and technical services (ST,73-74), (29) water conservancy, environment and public utilities management (WEU,76-78), (30)residential services, repairs and other services (RRO,80-81), (31) education (EDU,83), (32) health and social work (HW,84-85), (33) culture, sports and recreation(CSR,88-90), (34) public administration, social security and social organization (PSO,91 and 94).

Based on merge and accounting of 34 sector input-output table, the direct consumption coefficients are calculated. And then the Dijkstra algorithm is applied into the strongest input-output path matrix coefficient. The matrix describes 1122 even edge industry strongest output path, each even edge represents the intermediate products can realize the maximum value input and form a complex industrial network as shown in Figure 1.

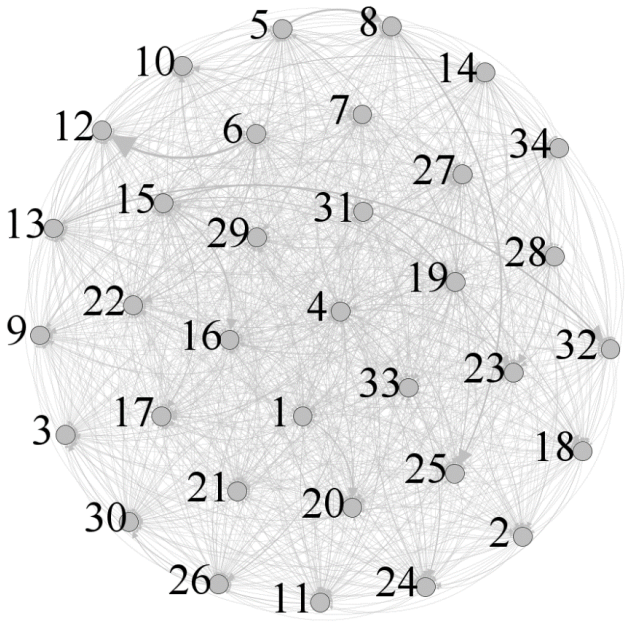

Figure 1: Industrial Strongest Path Network

Table1 shows the industrial betweenness, SP betweenness, downstream closeness and upstream closeness in China's input-output network. As for the industrial betweenness, DT includes the financial industry, which plays the role of resource allocation in the economy.

Therefore, this industry also possesses a very high betweenness in the network. DPM is not an important intermediary industry in China's economy. The digital infrastructure products produced by this industry are less invested in other industries. DPS and DM do not act as the intermediary industries in the strongest path network. For SP betweenness, the path ranking of DT is high, indicating that it is in a relatively core position and the path mediation measurement value of other digital economy industries is low.

For the upstream and downstream tightness, the upstream and downstream tightness of the DT ranks second and first respectively and the upstream tightness measurement value is higher than that of the downstream tightness, indicating that the influence of DT on the downstream industry is stronger than that of the upstream industry. The upstream and downstream tightness measurement values of DPM, DPS and DM are all lower than the average level. In terms of the contribution degree and status to the economy, DT is significantly higher than that of these three industries.

Table 1: Industrial Betweenness, SP Betweenness, Downstream Closeness and Upstream Closeness in the Input-Output Network

Industrial Abbreviation	Industrial Betweenness	Upstream Closeness	Downstream Closeness	SP	SP Betweenness
DPM	354	1140	929	RE→DT	354
DPS	0	1012	954	DT→ARC	0
DM	0	91	31	RBS→DT	0
DT	10351	2635	5550	DT→DPM	10351
				RBS→DPS	354

4.2 Industrial Network Risk Transmission Analysis

4.2.1 Simulation Scenario Setting

According to different types of emergencies, different emergencies are simulated to impact specific industries so as to study the risk transmission direction and time of the overall economic network paralysis, and find the first industry which stops production under different emergency scenarios. The following four kinds of emergency impact scenarios are mainly considered. Scenario 1: The supply shock of DPM is analyzed, and the supply shock of the first period is set as 50%, and the supply of the production means of the industry to other industries is reduced by half, and the impact of the decline in the supply of DPM on other industries is simulated. Scenario 2: It is assumed that the product supply of PET to other industries is reduced by 50%, that is, the industry is affected by the supply shock, and the intermediate use value of the industry is reduced by half. Scenario 3: Set the supply shock coefficient of DT to 50%. Scenario 4: The demand shock coefficient of RE is set at 50%, that is, RE is affected by the demand, and the intermediate input-output value of RE is reduced by half. When studying the cascade effect transmission mode of industrial network risk, the industrial shutdown threshold under all emergency scenarios is set at 0.3. In order to measure the systemic risk state of the industrial network affected by unexpected events, the industrial risk transmission is represented by E in the figure.

4.2.2 Industrial Risk Transmission Scenario Analysis

On the basis of the above-mentioned scenario setting and parameter design, the network cascade failure model is programmed to simulate the industrial risk transmission under the impact of emergencies, and the changes of economic production operation after the impact of various industries are drawn in Figure2 to Figure 5.

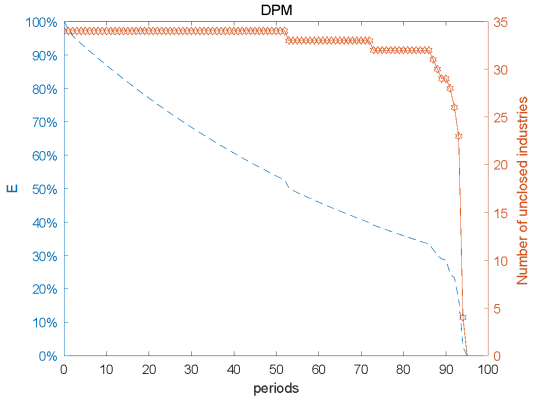

Figure 2: Changes of DPM After Supply Shocks

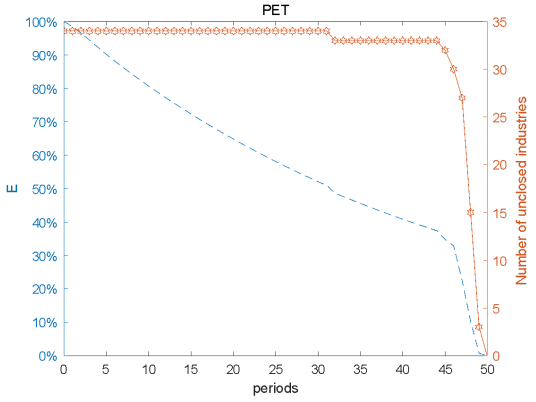

Figure 3: Changes of PET After Supply Shocks

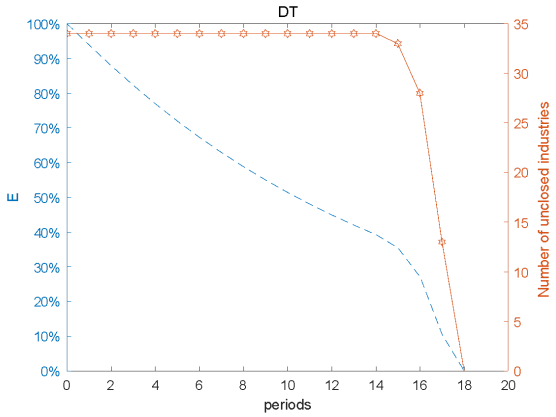

Figure 4: Changes of DT After Supply Shocks

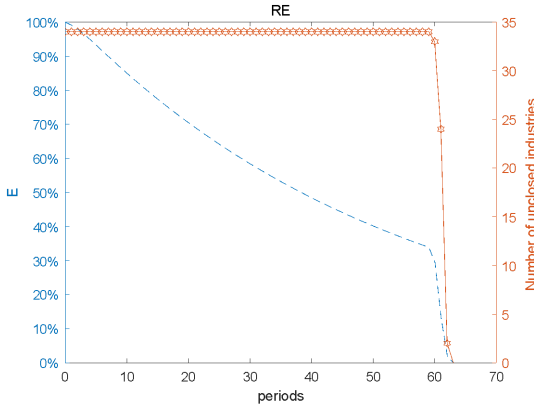

Figure 5: Changes of RE After Demand Shock

As can be seen from figures, no industry stopped production immediately after the economy was hit by unexpected events, and the capacity utilization rate gradually declined. However, as time goes on, the capacity utilization rate has decreased significantly and some industries have begun to stop production, which indicates that the industrial risk transmission has a certain time lag. In the impact of scenario 1, the first industry stopped production in the 53rd phase, followed by the second industry in the 73rd phase, and began to stop production in succession after the 87th phase. In scenario 2, the first industrial shutdown occurs in the 32nd phase, the second industrial shutdown occurs in the 45th phase, and then a large number of industries begin to shut down until the capacity utilization rate drops to 0. In scenario 3, the whole economy stops in the 18th phase alone. After the real estate industry demand shock, the capacity utilization rate declined slowly, and the industrial production stopped continuously in the 60th period, and the capacity utilization rate fell off the cliff.

4.2.3 Industrial Risk Transmission Path

It is observed that different industries stop production in different periods. If the stop production threshold is set as 0.3, the path of industrial risk transmission from the target industry to other industries can be obtained according to the stop production sequence of various industries under different situations, as shown in the following figures.

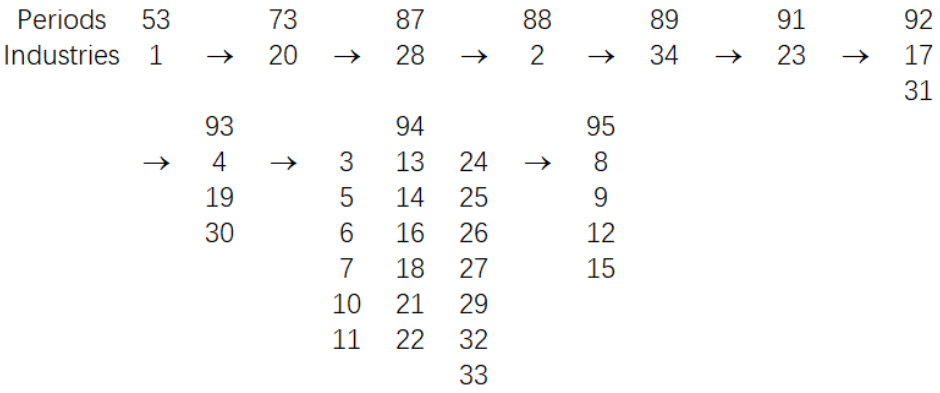

Figure 6: Industrial Risk Transmission Path of Digital Product Manufacturing Industry (DPM)

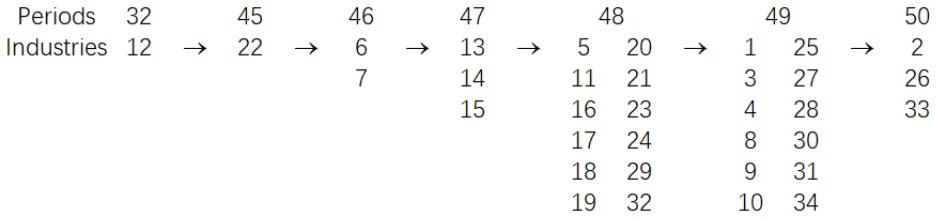

Figure 7: Risk Transmission Path of Petroleum, Coking Products and Nuclear Fuel Processing Products (PET)

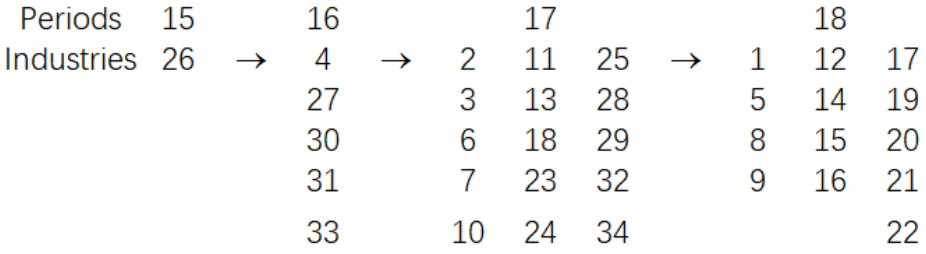

Figure 8: Risk Transmission Path of Digital Trading Industry (DT)

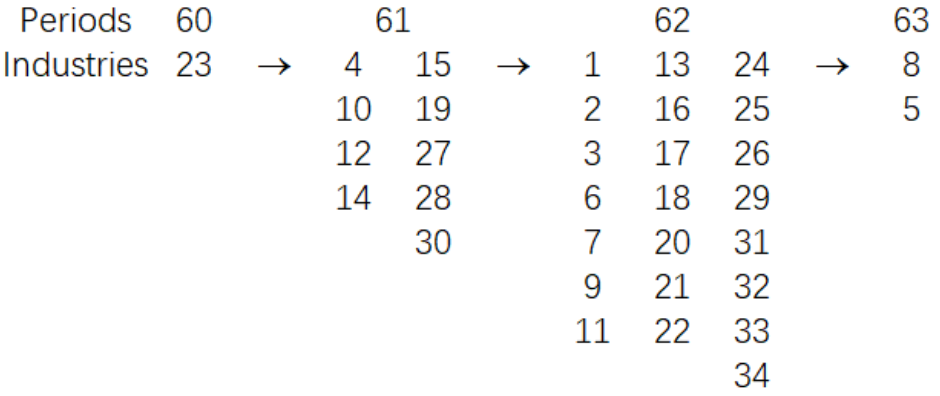

Figure 9: Risk Transmission Path of Real Estate (RE)

As shown in Figure 6, DPM was the first industry to stop production in the 53rd phase after the supply shock; After passing the risk to the INS, the industry stopped production in the 73rd phase, because electronic information manufacturing products are important intermediate inputs for INS, and the production of the downstream INS will be subject to the product supply of the upstream DPM; As time goes on, in the 87th and 88th phases, the risk will be passed on to the ST and other more industries such as the DPS; In the 95th phase, the remaining FT,TEX,PET and MW ceased production.

As shown in Figure 7, PET will stop production in a short time after the supply shock, followed by EHGW begin to spread to other industries. It is easy to find that EHGW is the upstream material link with PET. China has a large demand for crude oil products, and when the external supply chain breaks, it will seriously affect the production of downstream oil products.

As shown in Figure 8, the supply impact of DT leads to a large number of industries to stop production in a short period of time, and RE is the first industry to be affected. Real estate development and construction needs a large amount of loans from banks, and the real estate construction cycle is long, so the capital chain of real estate enterprises will be broken due to the impact of the banking industry and stop production quickly.

As shown in Figure 9, the industrial risk transmission path under public health emergencies shows that the contraction of RE demand also slows down the development of real estate enterprises, and takes the lead in affecting the demand of the upstream ARC.

4.2.4 The Critical Period of Industrial Supply and Demand Shock

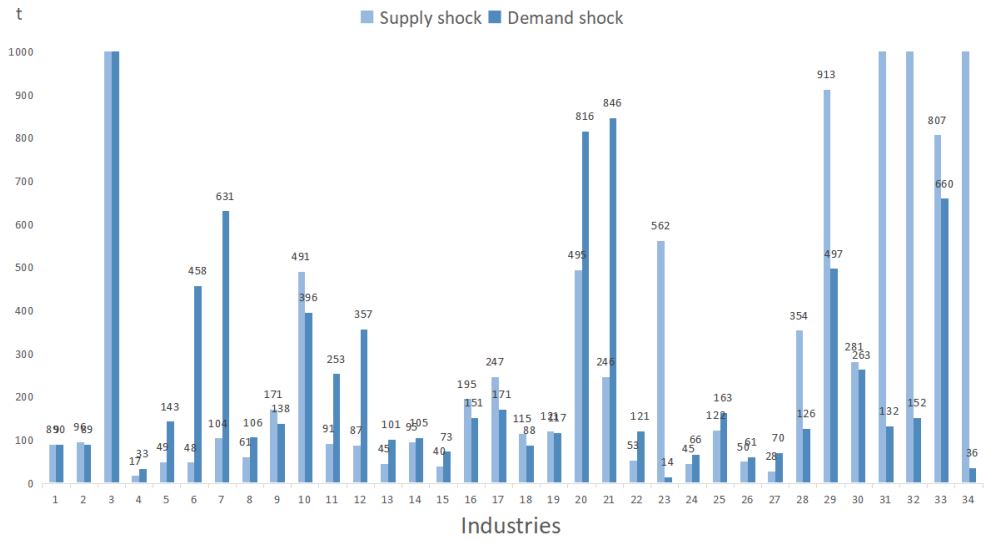

Figure 10: The Critical Period of Industrial Supply and Demand Shock

As shown in Figure10, it can be seen that the economy is very slow to respond to some industrial risks. For example, the risk of DM has a long process of impact on the economy from the perspective of demand and supply. The supply and demand impact of DPM and DPS has a certain degree of impact on the economy. The supply shock of PET has a significantly faster impact on the economy than the demand shock, because PET has a low demand for intermediate products of other industries and a high share of output value supplied to other industries.

V. CONCLUSIONS AND SUGGESTIONS

In sum, the strongest path analysis method is applied to study the structural characteristics of industrial network. The structural characteristics of industrial networks in digital economy are studied by calculating the SP betweenness and closeness of networks, and the cascade failure

simulation model of industrial networks is established to analyze the risk transmission situation of specific industries under different emergency backgrounds. The conclusions are summarized as follows.

1. In the digital economy industry, DPM is not an important intermediary industry in China's economy. DT plays a stronger role of path mediation in the network, while the measurement value of path mediation in other digital economy industries is low. The closeness of the upstream and downstream of DT is significantly higher than that of the other three digital economy industries, and DM has very little driving effect on the macro economy. Compared with other digital economy industries, DT has a higher position in the industrial network, playing a more and more role and controls the flow of more resources.
2. The impact degree and risk transmission speed caused by different emergencies are different. Systemic financial risk is the most destructive and the fastest spread of risk, followed by sudden international political events and major public health events, and the industrial risk transmission speed caused by trade protection and technological blockade is relatively slow.
3. In the process of industrial network failure, when the impact of the emergency reduces the production capacity of various industries, the industrial risk transmission first go through a moderate period, during which only a few industries may stop production. However, with the extension of transmission time, industrial risks continue to accumulate, and the number of production will increase substantially in a certain period.

In the face of the combined impact of multiple emergencies, strong risk confrontation and macro-control should be carried out. The suggestions are stated as follows.

1. Further promote the development of DPM and DPS, help DT of the macro economy, and balance the output value structure of the digital economy industry. In addition, promoting the development of DPM and DPS will also help to accelerate the digital transformation of industries, avoid excessive concentration of single industrial risks, disperse potential industrial network risks, and help to improve the stability of industrial network.
2. Focus on the impact of sudden systemic financial risk events. The simulation results show that the economy is more likely to collapse under the impact of sudden systemic financial risk events, and the systemic financial risks are more destructive than other emergencies. We should reduce the probability of systemic financial risks and continue to promote financial deleveraging. Emphasis should be laid on establishing a mechanism and plan to deal with sudden systemic financial risks, while improving prevention, early warning and response plans for other possible emergencies, and strengthening the national system to tackle key core science and technology, so as to spread potential economic risks.
3. Establish a sound risk prevention and mitigation mechanism for emergencies, and pay attention to the upstream and downstream industries where emergencies mainly impact industries because the industrial risks firstly hit the linked industries.

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Leveraging AI in Clinical Diagnosis: A Paradigm Shift in Medical Decision-Making

Taran Rishit Undru & Dr Lakshmi Jyothi Tadi

ABSTRACT

The integration of Artificial Intelligence (AI) in clinical diagnosis heralds a significant shift in medical decision-making, enhancing diagnostic accuracy and efficiency while introducing new ethical and operational challenges. This review delves into the latest advancements, applications, and implications of AI in clinical diagnostics, discussing its potential to transform healthcare practices.

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Author: Additional Professor, Department of Microbiology, AIIMS Bibinagar.

I. INTRODUCTION

Artificial Intelligence (AI), a field of computer science, is fundamentally changing numerous industries, including healthcare. AI involves the creation of algorithms and software capable of performing tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation (Russell & Norvig, 2016). In the realm of healthcare, AI has been particularly instrumental in clinical diagnosis, promising to enhance the precision and efficiency of medical decision-making.

Clinical diagnosis refers to the process by which the healthcare professionals determine the nature and cause ofpatient's illness. Traditionally, this has been a complex task, involving the interpretation of various types of data, including patient history, physical examination findings, and results from diagnostic tests. The integration of AI into this process is a groundbreaking development, offering the ability to analyze large datasets, recognize complex patterns, and provide diagnostic suggestions with a level of speed and accuracy often challenging for humans to achieve (Jiang et al., 2017).

The application of AI in clinical diagnosis is not just about technological advancement; it is about a fundamental shift in the approach to healthcare. AI algorithms, particularly those based on deep learning, a subset of machine learning, are being trained to interpret medical images, recognize patterns in genetic information, and even predict disease progression (Esteva et al., 2019). This capability introduces a new dimension to patient care, allowing for more personalized, predictive, and preventative healthcare strategies.

As we embark on this journey of integrating AI into healthcare, it is imperative to understand both its potential and its challenges. This review aims to provide a balanced perspective on the advancements, applications, and implications of AI in clinical diagnostics, highlighting the opportunities it presents and the hurdles that must be overcome.

II. AI ADVANCEMENTS IN CLINICAL DIAGNOSIS

Recent advancements in AI, particularly deep learning, have shown remarkable capabilities in various medical fields. For instance, in radiology, AI algorithms have been trained to identify pathologies in imaging with accuracy comparable to or even surpassing that of human radiologists (Rajpurkar et al., 2018). In dermatology, AI systems like deep neural networks have been used to classify skin lesions with a precision level akin to experienced dermatologists (Esteva et al., 2019).

III. AI IN ENHANCING DIAGNOSTIC EFFICIENCY AND ACCURACY

AI's ability to swiftly process and analyze large volumes of medical data greatly enhances the diagnostic efficiency. This rapid data processing capability is crucial in time-sensitive medical situations, such as stroke or heart attack cases (Yu et al., 2018). Additionally, AI's consistency and reduced susceptibility to fatigue and cognitive biases can potentially lead to higher diagnostic accuracy compared to traditional methods (Topol, 2019).

IV. ETHICAL AND PRACTICAL CONSIDERATIONS

Despite these advancements, AI in clinical diagnostics is not without its challenges. Ethical concerns, such as patient data privacy and the risk of algorithmic bias, are significant hurdles (Char et al., 2018). Moreover, the "black box" nature of some AI algorithms, where the decision-making process is not transparent, poses a challenge for clinicians relying on these tools for diagnosis and treatment decisions (Vayena et al., 2018).

V. THE FUTURE OF AI IN CLINICAL DIAGNOSIS

The future trajectory of AI in clinical diagnosis appears promising. Current research is focused on improving the interpretability of AI algorithms and their integration into clinical practice. The goal is to create AI tools that are not only accurate and efficient but also understandable and trustworthy for both healthcare providers and patients (Jiang et al., 2017).

VI. CONCLUSION

The integration of AI into clinical diagnosis represents a significant leap forward in healthcare, offering potential improvements in diagnostic accuracy, efficiency, and patient outcomes. For software professionals, this evolution underscores a unique and profound opportunity to contribute to a field that profoundly impacts human lives. The skills and expertise of software professionals are not just in demand but are essential in shaping the future of healthcare.

Every software professional, whether a developer, data scientist, or AI specialist, has a role to play in this dynamic landscape. The development of AI algorithms requires not only technical acumen but also an understanding of the ethical and practical nuances of healthcare applications. Skills in machine learning, data analysis, and coding are foundational, but the ability to collaborate with healthcare professionals, understand medical data and appreciate the sensitivity of patient-related information are equally important.

The healthcare industry's journey with AI is just beginning, and it presents a horizon rich with opportunities for innovation and impact. As software professionals, our contribution can lead to more accurate diagnostic tools, improved patient care, and ultimately, a transformation in the global healthcare system. The intersection of AI and healthcare is not just a space for technological prowess but also for ethical responsibility, continuous learning, and cross-disciplinary collaboration.

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Effect of Google Meet & Instagram App on Speaking Accuracy in Intermediate Level of EFL Learners in L2

Ahmad Jawad Sharifi & Ahmad Fawad Sharifi

Kharazmi University

ABSTRACT

Foreign language acquisition is a complex process that requires extensive practice, particularly in developing speaking skills. The aims of this study aims to analyze the effect of utilizing digital platforms such as Google Meet and Instagram on improving foreign language speaking abilities. Four key areas will be discussed: greater access to native speakers, interactive and immersive speaking opportunities, increased cultural exposure, and personalized digital language learning tools.

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Foreign language acquisition is a complex process that requires extensive practice, particularly in developing speaking skills. The aims of this study aims to analyze the effect of utilizing digital platforms such as Google Meet and Instagram on improving foreign language speaking abilities. Four key areas will be discussed: greater access to native speakers, interactive and immersive speaking opportunities, increased cultural exposure, and personalized digital language learning tools.

The findings suggest that incorporating Google Meet and Instagram into foreign language learning significantly enhances students' speaking proficiency, motivation, and overall language acquisition. In this study, for completion of this article used from qualitative methods and for data collection is used from interview from the learners the integration of Google Meet and Instagram into foreign language learning offers a multitude of benefits in terms of native speaker interaction, immersive speaking opportunities, cultural exposure, and personalized language learning tools.

By utilizing these platforms, language learners can significantly enhance their speaking skills, build confidence, broaden cultural awareness, and establish connections with individuals from various linguistic backgrounds.

Keywords: mobile application, instagram, google meet and speaking accuracy.

Author α: MA TEFL at Kharazmi University.
σ: Kabul Education University.

I. INTRODUCTION

Mobile assisted learning especially in language learning gives both benefits and challenges in optimizing students' outputs toward learning targets. We investigated the influence of mobile applications as learning assistance which can help students improve their speaking skill and critical thinking in English language learning. Technology permits learners to have seamlessly interaction with peers and lecturers regardless of time and space and it has become an essential tool in teaching and learning process (Nor Hapiza Mohd Ariffin & Saliza Ramly, 2017).

The measure of acquiring a language is speaking (Brown, 2014; Naser and Hamzah, 2018). It is clear that people need to communicate with others to develop their skills and learn more about other cultures, when students cannot find suitable ways to develop their speaking skills, they tend to use "autonomous learning" (Fidyati et al. 2021).

Google Meet is a platform that is very often used in learning, meetings, discussions in the world of business or education, and google meet is an application that plays a role in keeping the world of education still alive. Instagram is a social media that is loved by many young people today.

Social media Instagram is a message delivery tool (application) to be able to communicate with a wider audience by sharing photos or videos, which include other features such as DM (direct message), comments, love etc. Instagram (also called IG or Insta) is a photo and video sharing application that allows users to take photos, take videos, apply digital filters and share them to various social networking services, including Instagram's own. Currently there are many Instagram accounts that not only share photos

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and videos but they also share specific information about English material. Seeing this fact, it can be concluded that actually students nowadays are provided by abundant technology that can help them in learning (Aminatun, 2019).

So google meet and Instagram applications is also has more efficient on language learning skills such speaking fluency in L2 and the lesson became understandable & fantastic for the learners, because of that distance learning it need more new accessibilities and new emerging of technologies that make the learning process easy and enjoy full.

And also this research it shows the qualities & effect on google meet and Instagram application on speaking accuracy in intermediate level of learners in L2, This means that education objectives in the Third World countries should be changed to meet the era's variables, aiming not only to help students in the cognitive domain, but also focus on their needs to attain the skills, capacities, and self -reliance to interact with the era's variables and build a new life based on sovereignty, not dependency on others .

II. STATEMENT OF THE PROBLEM

Google Meet & Instagram applications are basic tools of mobile applications that are used for the learning and teaching process, and they play a major role in language teaching, such as distance learning and the development of foreign language learning. Students use these applications to express themselves, share opinions, and build friendships (Kim, Wang, & Oh, 2016). According to Kim, learners use mobile applications primarily for making friends. However, Pramudana Ihsan (2020) argues that the Instagram application has a positive effect and provides benefits to students, making them feel more confident in speaking.

Additionally, Berita Mambarasi Nehe (2021) claims that the usage of Google Meet video conferencing in the speaking class resulted in a positive response, with students mostly observing the advantages rather than disadvantages of Google Meet video conferencing.

Although many studies on language learning (LL) using mobile applications have been conducted in many countries to the best knowledge of the researcher, there is no research conducted in the context of Afghanistan on the patterns of learners (LL) using Google Meet and Instagram for second language learning in the intermediate level, specifically focusing on speaking accuracy and the more recent and updated issues in language teaching through these applications. The purpose of this study is to investigate and address the challenges of language learning via Google Meet and Instagram applications in the intermediate level of EFL (English as a Foreign Language) and determine their effects and usage on LL."

III. SIGNIFICANT OF STUDY

Synchronous form-focused instruction through Google Meet can have a positive impact on the speaking accuracy of intermediate learners. By providing real-time feedback and guidance, instructors can help learners improve their understanding and use of correct grammar and pronunciation. The immediate interaction and correction offered in synchronous instruction can enhance learners' confidence and motivation to speak accurately. Additionally, the ability to practice speaking with peers in virtual classrooms can further enhance speaking accuracy through collaborative learning and peer feedback.

Similarly, synchronous form-focused instruction through Instagram can impact the speaking accuracy of intermediate learners in several ways. Firstly, it allows learners to receive immediate feedback on their speaking skills as they engage in live conversations with their instructors or peers through video or voice calls on Instagram. This real-time feedback helps learners identify and correct errors in their language usage, thereby enhancing their speaking accuracy.

Additionally, Instagram provides a platform for learners to engage in authentic and meaningful communication with native speakers or other learners. By participating in conversations and discussions on Instagram, learners can practice their speaking skills in a realistic context, which contributes to improving their accuracy over time.

Moreover, the use of multimedia features such as photos, videos, and stories on Instagram can enhance the learning experience by providing visual prompts and contextual information. These features can be utilized to discuss and analyze language structures and form, allowing learners to better understand and incorporate them into their spoken language.

As a result, intermediate learners have positive experiences and perceptions of synchronous form-focused instruction through Instagram and believe it has a positive impact on speaking accuracy.

VI. RESEARCH QUESTIONS

1) Synchronous form-focused instruction through Google Meet impact the speaking accuracy of intermediate learners.
2) Synchronous form-focused instruction through Instagram impact the speaking accuracy of intermediate learners.

V. REVIEW OF RELATED LITERATURE

In the past 20 years, educators have placed greater emphasis on developing foreign language students' speaking skill, especially their ability to communicate effectively. This shift in focus has created a need for instructional materials that offer opportunities for controlled interactive speaking practice outside the classroom. As multimedia technology has advanced, computer-aided language learning (CALL) has emerged as an attractive alternative to traditional methods like language labs or audio-tape-based self-study. CALL allows for self-paced interactive learning environments that can enhance classroom instruction. However, despite many textbook publishers offering educational software, CALL's practical impact on foreign language education has been limited. Some educators are hesitant to adopt this technology because it has not gained widespread acceptance within the language teaching community. M. M., & Kenning, M. J. (1990). Stated to contemporary perspectives, the 21st century is commonly recognized as a period of technological advancements. Technology has become an indispensable component of our daily lives and is considered a fundamental driver of economic progress. In today's context, economies that lack advanced technological infrastructure are unlikely to thrive. This is due to the fact that technology simplifies our tasks and minimizes time required to complete them. The influence of technology is evident in various domains, including education.

Based on the latest insights on how modern students prefer to use technology and its impact on their learning, it has been found that the use of modern equipment, tools, and technology increases students' interactivity and enhances their learning experience. With the aid of technology, students find education more interactive and engaging, while knowledge transfer becomes more convenient and effective. Therefore, the use of modern technology has become indispensable in today's educational institutions, as it facilitates faster thinking and makes life a smoother journey. As a result, studens can now utilize technology in various ways (Raja, 2018).

According to Spears (2012) technology has made complex tasks simpler and more efficient. It has also revolutionized education by enabling the immediate dissemination of knowledge and facilitating faster and more effective communication. Moreover, technology has opened up new avenues for student engagement and learning that were previously unavailable in traditional classroom settings.

With the help of mobile applications, English language learning enters a new era. The use of the mobile application to facilitate learning English can decrease the boredom, which usually arises from the traditional ways of teaching, as well as the time and places limitations. Additionally, West & Vosloo (2013) in Howlett & Waemusa (2019), state that MALL, including mobile application, can bridge formal and informal learning. It affords students the ability to easily access supplementary materials to clarify ideas introduced by a teacher in learning English.

According to the view of (John, 2020).Google Meet is a safe policy in working because Google

has claimed that they operate all the products on a safe foundation, and they believe their product data users will keep exist and private. They also provide built-in protection by default that will keep users' meetings safe ,Google Meet is one of video communication service which is very helpful, the interface provided by Google Meet allows users to meet face to face directly and effectively, but it is also very light and fast. Management is not difficult and can be followed by many participants (Singh & Awasthi, 2020).

Google meet video conferencing it has a special role for the for the lecturer who run the platform well make students feel good, and they lesson become understandable easy for the learners (Pratama et al., 2020).

I view the perpetually expanding repository of posts as a corpus of multimodal texts and believe that wherever smartphones go, so too can language learning. Despite the range of world languages represented on Instagram, Shadiev, Hwang, and Huang (2017) reported that mobile-assisted language learning (MALL) research produced between 2006 and 2017 focused overwhelmingly on EFL or ESL learners (p. 292). To enrich the conversation about MALL with Instagram, this report focuses exclusively on learning non English L2s with the app.

5.1 Mobile Application on Language Learning

A mobile application is a software program created specifically for usage on smartphones and tablets. It has emerged as a product of recent technological advancements, where the worlds of media, information technology, the Internet, and advanced technologies have converged. Mobile applications have been a subject of exploration for mobile device manufacturers, mobile service providers, application developers, and researchers in the field of information technology and information systems.Among the various aspects of mobile telecommunications research, the evolution of mobile applications stands out as an especially intriguing area for investigation, Mobile devices and smartphones can still be considered relatively new concepts within the technology community. When compared to personal computers and laptops, common mobile smartphones have only been in existence for a short period of time. This gives rise to an intriguing topic of conversation regarding online mobile payments. It is not unexpected, given the growing prominence of the digital realm, that money will also adapt accordingly. Current patterns indicate that physical cash and even credit cards may soon be replaced by digital currency stored in mobile wallets (Darya, 2018).

Also in today's era of information and communication systems, people have become accustomed to using computers and computer applications. However, the usage and development of mobile applications is a relatively new and rapidly expanding field. The impact of mobile applications is felt globally, as developed countries are benefiting from enhanced facilities, while developing countries are upgrading their IT infrastructure and improving their societies. Mobile applications are designed to run on portable handheld devices, making them accessible and easy to use from anywhere.

Nowadays, a large number of people utilize mobile applications for various activities such as contacting friends, browsing the internet, managing files and documents, and enjoying entertainment. These applications provide convenience and support for both personal and business tasks. Businesses have also recognized the importance of mobile applications and are generating revenue through their utilization.

Additionally, mobile applications have a significant impact on society. Their performance is influenced by factors like screen resolution, hardware limitations, data usage costs, connectivity issues, and limited interaction possibilities. In recent years, mobile companies have been striving to develop devices with improved screen resolution, greater storage capacity, and better connectivity to create a more favorable environment for modern mobile application (Rashed, & Tridi , 2010).

5.2 Effect of Mobile Phones in Language Learning in EFL

In the field of mobile learning, numerous experiments focused on language have been

conducted. These studies incorporate the latest advancements in mobile phone technologies into their teaching methods.

Acknowledging the significance of these advancements, it is essential to redefine and reconsider the specific characteristics of m-learning to ensure its effectiveness in practical educational environments. Wagner (2005) the author proposes that the effectiveness of mobile learning depends on a diverse range of interactive experiences. To ensure the successful integration of modern wireless mobile technologies in teaching methods, it is crucial to adapt and utilize them according to the unique circumstances of the educational settings and the specific capabilities they provide.

Also In Kadyte's (2004) study titled "Designing the Mobile Language Learning System," an investigation was conducted on a system aimed at teaching Finnish grammar and vocabulary through the use of both sound and text. The system offered a range of multilingual content, allowing learners to choose Finnish as their preferred language when they initially subscribed. Subsequently, learners could select from various categories such as vocabulary, topics, and milestones to receive context-specific information based on their personal profile. Additionally, the system included a language learning guide that explained key grammatical rules within the vocabulary section and provided correct pronunciation to learners through the use of mobile headphones.

Emphasizing both the personal and the community attributes of the users operating in a mobile context, Kadyte (2004) also exploited multimedia messages (MMS) and SMS alerts to support information retrieval and direct the learner to tutor support at the time for a face-to-face meeting. The evaluation showed a positive response from the learners and indicated that the use of mobile devices with value-added features could facilitate but not replace conventional learning and also increase students' motivation and interest (Kadyte, 2004)

5.3 Importance of Google Meet App in Learning Process

Google Meet, created by Google, is a video communication platform developed by the company. It is one of two newly upgraded applications, along with Google Hangouts and Google Chat. Google officially introduced Google Meet in March and released it the following month. This service serves as a video conferencing application that supports up to 30 participants. Compared to its predecessor Hangouts, Meet offers enhanced functionality as it can be accessed through web applications, Android, and iOS applications, (Mona Lisa, 2021).

The utilization of internet-based platforms can provide a viable solution to ensure uninterrupted progress in the learning process. This notion aligns with the findings stated by (Pratama, 2020). Virtual meetings conducted via online applications offer numerous advantages, particularly when utilizing video conferencing. This technology enhances the learning process by promoting efficiency, practicality, and safety. Video conferencing, in particular, fosters a sense of unity and enables interactive communication. Additionally, the diverse features available in various online applications simplify the learning experience as users can seamlessly share files and utilize digital whiteboards. In light of the pandemic situation, online learning serves as a viable alternative for educational endeavors.

A large number of students have encountered the online learning format for the first time. Nonetheless, a considerable portion of these students expresses contentment due to various reasons such as active engagement within online classes, direct motivation imparted by teachers, well-organized course structures, and access to sufficient resources. These positive experiences are commonly observed when utilizing online learning platforms through video conferencing, (Baber, 2020).

5.4 Using Instagram on Language Learning for EFL

Acquiring a new language typically involves developing four key skills. Initially, it is important

to acquire effective English communication through speaking, reading, listening, and writing. Additionally, writing necessitates both practice and proficiency in three other language abilities: listening, reading, and speaking. Lastly, in order for readers to comprehend written content, writers must skillfully express their thoughts and emotions using creativity (Baqiatus Sallamah & Husein As Sabiq, 2020).

Teaching English skills in an EFL (English as a Foreign Language) classroom is widely acknowledged as a challenging undertaking. Initially, teachers guide students through the intricate process of writing compelling essays, which demands significant time and involves several steps. When it comes to instructing students on reading, listening, and speaking abilities, teachers employ various approaches and strategies, encompassing both conventional and contemporary methods. Nevertheless, limited research has been conducted to substantiate the effectiveness of these techniques, particularly in the context of technology-enhanced education (Rinda, Novawan, & Miqawati, 2018).

Instagram has been selected as a valuable platform for foreign language learning, particularly English, due to its exceptional qualities. It is evident that Instagram cultivates a sense of community and enables meaningful communication among students (Rinda et al., 2018).

Instagram serves as a popular social media platform where users can engage with a wider audience by sharing photos or videos. Along with features like direct messaging, comments, and likes, Instagram allows individuals to capture images, record videos, apply digital filters, and publish their creations on various social media platforms. Numerous Instagram accounts exist today that not only share visual content but also provide specific information related to the English language. Consequently, children nowadays have abundant access to technological resources (Soviyah & Etikaningsih, 2018).

VI. METHODOLOGY

This study will be conducted based on Qualitative method and for data collection of this article it used from interview from the learners which select randomly the learners, considering the effect of online form-focused instruction via google meet and Instagram on speaking accuracy on intermediate EFL learner, This part of the research describes the methodology features that is to be used in the present study and also it includes a brief outline of how the data will be analyzed.

6.1 Instrumentation

This research will be conducted using a qualitative method. The data collection procedure for the quantitative method will be based on interviews with students from the English department of a high school. The interviews will focus on the online form-focused instruction via Google Meet and Instagram, specifically on its impact on speaking accuracy. The participants in this research will be approximately 10 secondary high school students selected from a pool of 20 students. These students display exceptional curiosity when it comes to learning English, and their language proficiency is at the high school level, enabling them to communicate effectively for their daily needs and activities.

In addition, another technique for data collection in the qualitative method is considering context analysis procedures. This involves gathering information from reliable sources such as international journals, scientific research papers, MA theses, and PhD dissertations."

6.2 Participants

The total number of participants in this research will be approximately 10 secondary high school students, selected from a pool of 20 high school students. These students display exceptional curiosity when it comes to learning English, and their language proficiency is at a high school level, enabling them to effectively communicate for their daily needs and activities. The selection process is based on their scores in similarity and speaking tests, which are conducted through

interviews. The reason for choosing this particular sample is that they are highly homogeneous in terms of their English language speaking accuracy. The ages of the participants will range between 16 and 19.

The purpose of the interviews is to inquire about the students' agreement regarding learning the language through Google Meet and Instagram, as well as to examine the effect of these applications.

6.3 Findings of Pre-Test and Post-Test Result

This chapter addresses the main issues and presents the findings of the process and subsequent data analysis. First and foremost, The key issues that emerged after analyzing the data in users through Instagram and Google Meet in English language education especially on speaking accuracy. All topics are from the analysis of data obtained through Instagram and Google Meet in English language education. Then this school was contacted and students and learners of language education were studied using Instagram and Google Meet in English language education.

And 10 of these students will be considered for teaching English through Instagram and Google Meet, Finally, all the obtained facts were collected and combined. The results and findings of this research are presented based on the research questions.

Analysis of data and findings through Instagram and Google Meet in teaching English from the following data in this research to answer the question. What is the effect of synchronous form-focused instruction through Google Meet on intermediate learners in speaking accuracy?

What is the effect of synchronous form-focused instruction through Instagram on intermediate learners in speaking accuracy?

At this stage, the researcher has randomly selected 10 students of 10th grades in three different classes from Ghubar Shamal School, whose ages range from 18 to 23 years old.

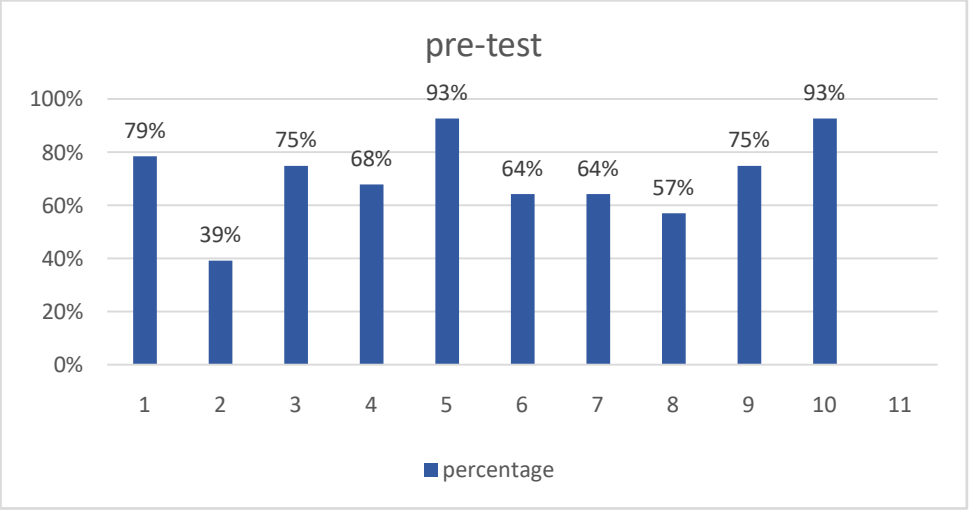
Table No. 1: Shows the Results of the Pre-Test. (N=10)

number	percentage	Average	question7	question6	question5	question4	question3	question2	question1	grade	age	gender	Participants
1	79%	3.14	2	4	3	4	3	4	2	1	21	1	**1**
2	43%	1.71	1	2	1	3	2	2	1	2	19	1	**2**
3	71%	2.86	3	3	4	3	3	3	1	1	20	1	**3**
4	68%	2.71	3	3	3	3	2	2	3	3	27	1	**4**
5	93%	3.71	4	4	4	5	3	3	3	3	23	1	**5**
6	64%	2.57	4	2	4	1	2	3	2	1	18	2	**6**
7	61%	2.43	4	3	2	3	2	2	1	1	18	2	**7**
8	57%	2.29	4	1	2	3	3	1	2	1	18	2	**8**
9	68%	2.71	2	2	2	4	4	3	2	2	19	1	**9**
10	50%	2.00	3	3	2	2	1	2	1	1	13	2	**10**

These students have previous familiarity with Instagram and Google Meet in teaching English, but they have not used it in a practical way. Therefore, this researcher started an English language training program using a pre-test and post-test program. He explained the level of awareness of these students, and then for these students, he held an English language training program for two weeks using Instagram and Google Meet in teaching English, and after the end of the curriculum, he explained the questions again to measure the learning level of these students did.

As the results of the pre-test are shown in Table No. 1, the knowledge level of these students in using Instagram and Google Meet was between 50-79%.

Chart Number (1) Shows the Pre-Test Results



The below graph shows the amount of users of Instagram and Google Meet in teaching English among tenth grade students in Ghubar Shamal School.

6.4 Findings Result of Post Test

Different research studies employ a range of instruments, such as questionnaires, tests, and interviews, for gathering data. In this particular study, interviews were selected as the preferred instrument for data collection from all the research participants. The result of the post also it shows the agreement of the learners from the using of new tools in language learning such as google meet and Instagram and according to the result of the post test there a big difference between pre test and post test result.

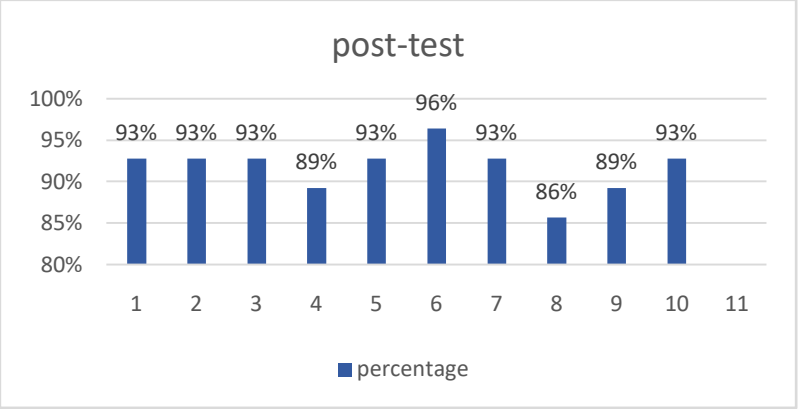
The post-test results among these students. After the implementation of a two-week educational program that was organized through Instagram and Google Meet for N=10 of these students, fortunately, the results of this program have been accompanied by good progress and have reached the satisfaction of the researcher, and as a result, the progress of these students is about 96-80% shows that the use of Instagram and Google Meet has a direct and high impact on teaching English.

Table Number (2) Shows the Post-Test Results

number	percentage	Average	question 7	question 6	question 5	question 4	question 3	question 2	question 1	grade	age	gender	Participants
1	93%	3.71	2	4	4	4	4	4	4	1	21	1	1
2	93%	3.71	3	4	3	4	4	4	4	2	19	1	2
3	93%	3.71	2	4	4	4	4	4	4	1	20	1	3
4	89%	3.57	3	4	2	4	4	4	4	3	27	1	4
5	93%	3.71	2	4	4	4	4	4	4	3	23	1	5
6	96%	3.86	3	4	4	4	4	4	4	1	18	2	6
7	93%	3.71	3	4	3	4	4	4	4	1	18	2	7
8	86%	3.43	3	4	3	4	3	3	4	1	18	2	8
9	89%	3.57	4	3	4	4	3	3	4	4	19	1	9
10	93%	3.71	3	4	3	4	4	4	4	1	13	2	10

Table 2 shows the post-test results among these students. After the implementation of a two-week educational program that was organized through Instagram and Google Meet for N=10 of these students, fortunately, the results of this program have been accompanied by good progress and have reached the satisfaction of the researcher, and as a result, the progress of these students is about 96-80% shows that the use of Instagram and Google Meet has a direct and high impact on teaching English.

Table Number (3) Shows the Post-Test Results



Graph number (3) shows the progress of the users of Instagram and Google Meet in the matter of teaching English language skills among tenth grade students in Ghubar Shamal School.

VII. RESULT AND DISCUSSION

The finding of this present research shows that students viewed the use of the Learn English speaking with mobile app in a positive light. They believed that the mobile app helped them practice speaking and added an element of fun to their learning experience. Additionally, their positive perception was influenced by factors like the app's flexibility and the new learning experience it provided this findings which is done by the result of the present research shows that it is consistent with the findings of the research conducted by Desika Rinanda (2019).

And also the results of the present research show that there were three distinct patterns of interaction observed interaction between the lecturer and students, interaction between

students and the lecturer, and interaction between students themselves. All three interactions occurred successfully, with a participation rate from the students in speaking activities. The teaching and learning process followed a typical structure found in traditional classrooms, including pre-activity, main activity, and post-activity. From a psychological standpoint, the students exhibited positive emotions such as happiness, security, confidence, and bravery. The data reflected a success rate, indicating that there were no hindrances encountered during the English speaking class conducted through the Google Meet video conference platform. The students' speaking skills encompassed pronunciation, vocabulary, grammar, fluency, and comprehension. The research done in the field is confirmed our findings by Berita Mambarasi, (2021).

The result of the present research show that incorporating Instagram Vlog into a beginner-level speaking course led to improvements in the students' speaking abilities, specifically in pronunciation, accuracy and overall use of the target language. The results of the questionnaire also indicated that using Instagram vlog helped EFL learners enhance their accuracy , and increase their confidence and motivation in speaking the language The research done in the field is confirmed our findings by Mega Wulandari (2019).

VIII. CONCLUSION

The purpose of this study is to investigate about effect and using of google meet & Instagram application on speaking skill in second language learning, what are the effective of new tools and new emergent digital learning mostly mobile based learning technologies to improvement of one of the language skill on learning language especially on speaking and skill.

Learning based on application is one of the needs of human and society language learning is not based on theory it should be practical among between of teacher and learners, the purpose of this research is to explore the roles and effect of google meet & Instagram applications on speaking accuracy in L2.

The basic objective of this study is that technologies has main roles and it has impact on language learning through google meet and Instagram and it can interest and the lesson be understandable for the learners, in this case this research investigate on one of the types of new technologies and tools that is used for language learning especially based on mobile application on speaking skill.

Especially by using these tools the learners can learn the language very easy the LL it can be practical on language skills such as speaking and listening,

8.1 Suggestions for Further Research

1) It is suggested to exchange opinions with individuals and groups directly for better foreign language learning.
2) It is suggested to use Instagram and Google Meet with foreign citizens and foreign professors to improve speaking and listening skills for learning if there is no direct exchange of ideas.
3) It is suggested to use newly emerging technology tools such as mobile applications such as Google Meet and Instagram to make foreign language teaching better and more attractive.
4) It is suggested that English language teachers should use Google Meet and Instagram applications for a few lessons a week to learn a foreign language better.
5) It is suggested that English teachers provide students with more practical contexts to teach speaking skills using Google Meet and Instagram.

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Visualization Tool for Data Structures in Real Time

Benita Ojugo Ekene-Okikere, Chidiebere Ugwu & Linda Uchenna Oghenekaro

ABSTRACT

Data structures are crucial aspects of Computer Science, but grasping their abstract nature poses challenges for students and software developers. A visualization tool for data structures such as arrays, stacks, and trees would effectively simplify the complex nature of data structures and algorithms. This research utilized an object-oriented approach to create a real-time Visualization Tool for Data Structures. This tool offers visual representations of fundamental data structures such as arrays and trees. The visualization tool is web-based and developed with HTML, CSS, and JavaScript technologies. The tool's efficacy underwent evaluation using complexity metrics. Results notably demonstrate that as the volume of data increases, the complexity of data structures follows suit. Consequently, this paper serves as an informative resource concerning the selection of data types and their respective implementation styles within data structures. Such insights furnish developers with valuable knowledge regarding the efficiency of diverse data types in software development, empowering informed decisions when choosing between data types based on their impact on space complexities within data structures.

Keywords: data structures, visualization, hybrid input, object-oriented methodology, complexity.

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Benita Ojugo Ekene-Okikere[α], Chidiebere Ugwu[σ] & Linda Uchenna Oghenekaro[ρ]

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Data structures are crucial aspects of Computer Science, but grasping their abstract nature poses challenges for students and software developers. A visualization tool for data structures such as arrays, stacks, and trees would effectively simplify the complex nature of data structures and algorithms. This research utilized an object-oriented approach to create a real-time Visualization Tool for Data Structures. This tool offers visual representations of fundamental data structures such as arrays and trees. The visualization tool is web-based and developed with HTML, CSS, and JavaScript technologies. The tool's efficacy underwent evaluation using complexity metrics. Results notably demonstrate that as the volume of data increases, the complexity of data structures follows suit. Consequently, this paper serves as an informative resource concerning the selection of data types and their respective implementation styles within data structures. Such insights furnish developers with valuable knowledge regarding the efficiency of diverse data types in software development, empowering informed decisions when choosing between data types based on their impact on space complexities within data structures.

Keywords: data structures, visualization, hybrid input, object-oriented methodology, complexity.

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I. INTRODUCTION

Data structures are basic concepts in computer science and play a vital role in developing efficient software applications. Computer Science students must understand these concepts to create optimal and dynamic applications. Research has indicated that students have significant challenges when attempting to use abstract programming concepts such as data structures. They also lack the skills required to function in an abstractive manner and to understand the fundamental components of the concept and their relationships [1, 5, 6]. Data structure is a manner to storing, organizing, and managing data to ease access and alteration of data. There is a range of data structures used in software applications (array, stack, tree, etc). Nevertheless, the unproductive use of data structure and its corresponding operations (such as adding, and deleting elements) generates memory issues that affect systems' performance. For this reason, data structure analysis is a prevalent task during software development [2]. Illustrating the correlation between computing and the real world holds the promise of amplifying students' drive and fascination toward the field of computing [3]. To boost the students' understanding in computer science education, and educational technologies are often used to assist students to understand data structures. These technologies ultimately rely on automated visualization as their main feature; a specific topic is explained through intuitive visuals and animation [4]. This approach helps the development of problem solving skills, such as computational thinking, which are crucial in the field of software development.

Visualizing data structures offers productivity and effectiveness in understanding the underlying abstraction. A survey conducted by [2] detected that 30.46% of visualizations, support developers in inspecting, and analyzing data structures. Again, studies done by [5, 6] have shown that by applying visualization tools, students' understanding is improved, and there is increase

in their motivation and interest in learning data structures. The data structures' tools realistically and dynamically show the behavior of data structures and the state changes of their core components during program execution. These visualizations focused on abstracting the algorithm's data structures and operations, thereby presenting the user with a graphical representation of these abstractions [7]. The primary aim is to assist learners in comprehending the intricacies of implementing data structures, enabling them to create various mental models, establish connections between structures, and develop generalized problem-solving approaches [1,7]. The efficacy of visualization system is determined by measuring the pedagogical value [8].

According to [8, 9], an effective data structures and algorithm visualization systems ought to adhere to multiple guidelines, encompassing accessibility on platforms targeting global audiences, the utilization of a unified user interface to efficiently support diverse animations, and notably, the integration of input features within these visualization systems is deemed crucial for expediting comprehension of the underlying abstraction of the subject. Also, one of the effective features of an efficient visualization system is to provide a robust data set that accommodates all the cases to help students comprehend an unacquainted algorithm [7]. In recent years, the proliferation of HTML5 technology and its subsequent enhancement of high-quality browser-based graphics capabilities have spurred the creation of fully web-based data structure visualization tools, executable across diverse platforms and devices. Researchers have begun integrating various innovations into their visualization tools, such as color, smooth transitions between states, animations, and the integration of input features. However, despite the abundance of available tools, many of them lack a scalable input method and an intuitive user interface. Presently, they only support a single-element input method with a predetermined input size, which impedes the efficient representation of data structures. As data volumes increase, complexities escalate, underscoring the need for a novel approach to simplify data structures.

According to [7], involving students in constructing, customizing, manipulating, and directing various aspects of visualization, while enabling user input, fosters active engagement and enhances understanding. Consequently, we opined that incorporating a Hybrid Input method (supporting both file upload and single-element input) with customizable input sizes into the design of a data structure visualization tool will significantly enhance learner engagement and improve learning outcomes. Based on this idea, we propose a visualization tool for data structures featuring a Hybridized input method. This tool empowers users to visualize data structures using scalable datasets and a hybrid input approach, effectively simplifying the complex underlying abstractions of data structures. The tool will offer visualizations for fundamental data structures like Arrays, Stacks, and Trees. These intuitive visual representations will incorporate Algorithm-Specific Controls, adapting algorithmic operations based on the type of data structure being visualized. For instance, operations like 'push' and 'pop' in a stack structure can be visualized through straightforward button interaction.

Data structure visualization has gained increasing attention in the field of computer science with numerous researchers contributing their insight and techniques in the development of data structures visualization tools [2]. As web browsers and the internet became more prevalent, data structures visualizers also followed this trend. Various web-based data structures visualization systems have been developed over the years with HTML5 technology and high-quality browser-based graphics. Nevertheless, none of them have provided the necessary level of scalability and intuitiveness needed to explore data structures.

Vrachnos et al. [1] developed DAVE, an interactive algorithm visualization environment designed specifically for visualizing Array data structure. Their literature review revealed a significant gap

in research focused on understanding students' mental models and programming challenges related to arrays, despite arrays being a fundamental component of introductory programming curricula. Their work primarily concentrated on assessing the functionality of the system and its potential in aiding students in developing proficient mental models for visualizing array data structure. They capitalized on modern web browser capabilities by incorporating web technologies and methodologies. The researchers found that using visualization tools significantly assisted 98% of Computer Science students in Greek upper schools in solving algorithmic problems related to array data structures. Buchanan et al. [10] presented CSTutor, a sketch based interface designed to aid students' understanding of data structures. The tool utilized the interface to allow users to visually represent data structures such as Linked Lists, BS Trees, Heaps, and AVL Trees. CSTutor allows users to edit the generated code, and any modifications in the code, then animate the corresponding data structure on canvas. This integration aims to bridge the gap between conceptual understanding, represented through diagrams, and the practical implementation of data structures.

One of the most widely used data structure visualization tools today is Data Structure Visualization (DSV). Galles developed an open-source web-based data structure visualization tool [11]. This tool aids students in comprehending intricate data structures through interactive animations and visualizations. It was developed using Java-script and HTML5, ensuring compatibility with a broad array of modern browsers. Šimoňák and Benej [12], developed a desktop application called Algomaster, specifically designed for learning and teaching Data Structures and Algorithms. They used .NET Framework platform and C# programming language for the development of a plugin-based data structure and algorithm visualization tool. In their technique, the researchers combine two panels (for a pseudo code and a visualization) as an effective way of explaining data structures and algorithms. To ensure the extensibility, application could be plugin-based.

Burlinson et al. [3], introduced the BRIDGES (Bridging Real-world Infrastructure Designed to Goal-align, Engage, and Stimulate) system, a software framework aimed at facilitating the creation of more captivating assignments within the introduction to data structures courses. This system offers APIs that empower users to construct data structures using the BRIDGES client classes in either Java or C++. Additionally, the system integrates a BRIDGES server that provides APIs, granting users access to real-world datasets for visualization purposes. The system's capabilities were utilized to visually represent data structures such as queues, linked lists, stacks, arrays, trees, and graphs, alongside the implementation of search algorithms. A notable aspect of BRIDGES is its feature enabling easy sharing of visualizations via web links. Kumari et al. [13], introduced Algoviz, a web-based interactive tool that utilizes modern-day JavaScript to visually represent the logic of different searching and sorting algorithms. The researchers discussed the contrasting outcomes regarding the efficacy of visualization methods when compared to traditional approaches. Their investigation focused on identifying the key features that contribute to an efficient algorithm visualization system, leading them to outline five essential characteristics for achieving this objective. Unlike most web-based visualization systems that rely on java applets, Algoviz is a fully web-based system, Algoviz focuses on dynamic visualizations for only array data structures with the implementation of sorting and searching algorithms.

II. METHODOLOGY

Our goal in this study is to create a scalable and efficient visualization tool for data structures in real time that will increase learning results and engage learners. To achieve this goal, we analyse the proposed system, incorporate Object Oriented approach in the design process of the system and evaluate the tool using space complexity metrics. The first step in our approach is to analyse our proposed system. The tool aims to visualize array,

stack, and tree data structures. By facilitating the visualization of these fundamental data structures, the tool intends to offer users a more comprehensive understanding and flexibility in exploring diverse data inputs and their impact on space complexity. The technologies that were employed in the development of this tool are HTML5, CSS and JavaScript. Furthermore, the system operates entirely on the client side, ensuring there's no added strain from interactions with a server. The proposed system uses Direct visualization algorithm. Direct-visualization algorithms uses a user-defined transfer parameter to allocate color opacity and size to data [15]. Direct visualization algorithms, are algorithms designed specifically to visualize data directly. They take data as input and produce the visualization as output, without an intervening step of data interpretation. Additionally, the proposed system uses Algorithm-Specific Controls to manipulate and control the visualization of data, this control delivered algorithm operation that changes depending on the type of algorithm being visualized. Fig. 1 illustrates the architecture of the system being proposed.

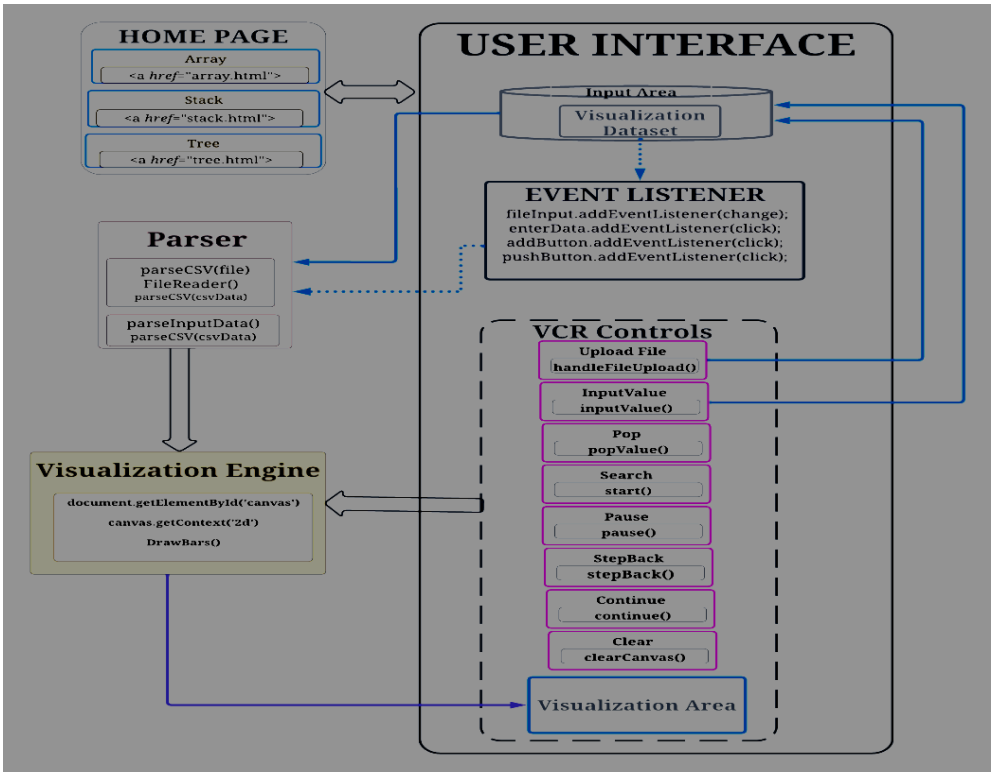

Fig. 1: Architecture of the proposed system

The proposed system's architecture represents the fundamental structure and design blueprint, offering an abstract overview of how its diverse elements collaborate. It delineates the system's constituents, their interconnections, interactions, and the guiding principles steering the system's design. The system comprises two primary components. Firstly, the Home Page functions as a hub for Visual components, showcasing array, stack, and tree data structures. These visuals are interactive, enabling users to navigate to specific interfaces, such as the array interface, through clickable array icon on the homepage. Secondly, the User Interface Components consist of the Data Input Area, Visualization Controls (VCR Controls), and Animation Area. The Input Area employs a Hybrid-Input technique, supporting file uploads (CSV) and single data entry. The Visualization Controls, actively interact with and manipulate the displayed data structures. These controls are embedded with functions like Push, Pop, Clear, Search, Pause, Continue, and

StepBack, facilitating user interaction and manipulation of the visualized data. The third component of the system is the Parser Module that handles the handleFileUpload(event) reads uploaded file content via FileReader API. Parses CSV data into structured arrays/stacks and trees, then transfers the formatted data to the visualization engine. The fourth component is Visualization Engine: which receives the formatted data from the parser and Uses CanvasRenderingContext2D API to renders data structures animations on the visualization area (canvas).

Having analysed the proposed system, we then proceed to design the proposed system using Object-Oriented Analysis and Design (OOAD). Unified Modelling Language (UML) is one of the standards widely accepted languages, generally used for modelling any system considered as objects for better analysis [14]. This technique mainly focuses on the modelling of the exact procedure or near to the exact procedure within its application domain which may be modeled by using different object classes. The different types of UML diagrams used for OOAD and to model the proposed system include the Use Case Diagram, Sequence Diagram, and Class Diagram. *Use Case Diagrams* graphically models functionalities and the various ways the end user may interact with the target system. Fig.2 depicts the Use Case Diagram of the proposed system, by using various types of graphs, the structure illustrates the connections among the internal systems and also different external systems along with end users. In this system, the actors include the user (An individual interacting with the system, utilizing its functionalities) and the System Administrator (Responsible for managing system settings and configurations). The actions are depicted in circles while the dotted lines; '<< extend>>' depicts the corresponding response of the system when a user loads data into the system. Additionally, '<< include >> depicts the methods within a specific action. The sequence diagram of the proposed system in fig. 3 depicts the sequence of interactions between the user, the proposed visualization system and the three data structures. Each vertical line represents a participant, and arrows indicate the flow of messages between them. It starts with user interaction triggering the system's response to visualize the selected data structure. The diagram depicts how the system processes user inputs, manipulates data structures, and updates visual representations accordingly. It highlights the synchronization between user actions, data manipulation, and the real-time reflection of changes in the visualizations, providing a clear overview of how the system handles interactions and updates during data structure visualization.

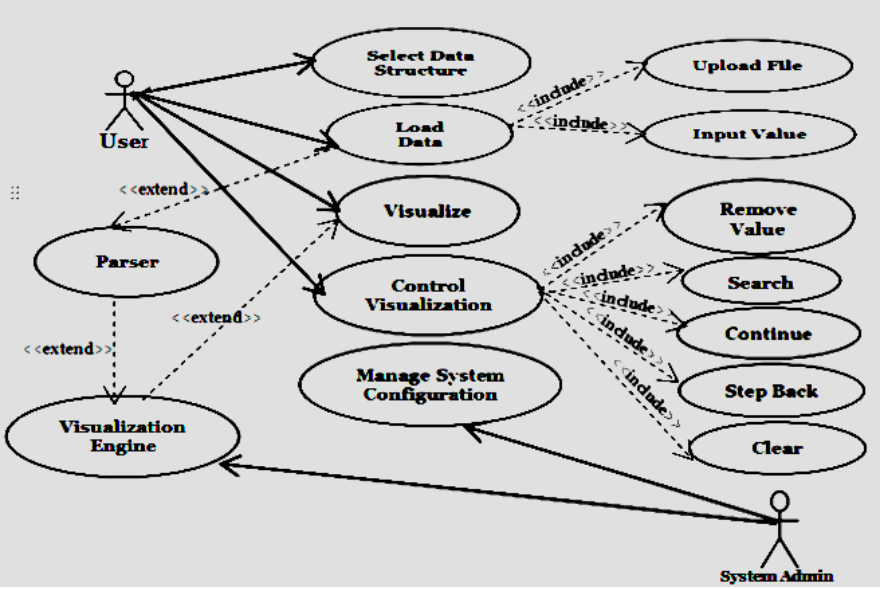

Fig. 2: Use Case Diagram of the Proposed System

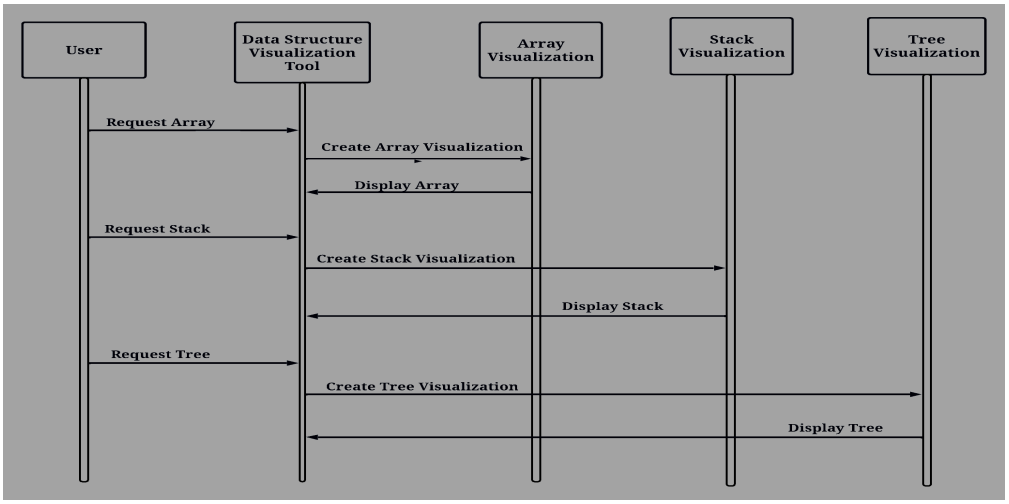

Fig. 3: Sequence Diagram of the Proposed System

Fig.4 depicts the rigid framework of our system built with classes. At the core of this diagram is the 'DataStructure Visualization' class, responsible for orchestrating the visualization process and managing interactions between various data structure classes. This class aggregates instances of 'ArrayDataStructure,' 'StackDataStructure,' and 'TreeDataStructure,' each dedicated to managing the visualization of arrays, stacks, and trees, respectively. The 'ArrayDataStructure,' 'StackDataStructure,' and 'TreeDataStructure, classes inherit from 'DataStructure Visualization,' leveraging common visualization functionalities while focusing on rendering their specific data structures graphically. Furthermore, the 'Visualization Controls' classes handles user interactions with the visualizations, controlling functionalities such as play, pause, and step forward/backward. The 'Array Visualization Control,' 'Stack Visualization Control,' and 'Tree Visualization Control,' classes associate with the 'Array Visualization,' 'Stack Visualization,' and 'Tree Visualization,' enabling users to manipulate and interact with the visualized data structures seamlessly. These classes and their relationships form the backbone of the proposed system,

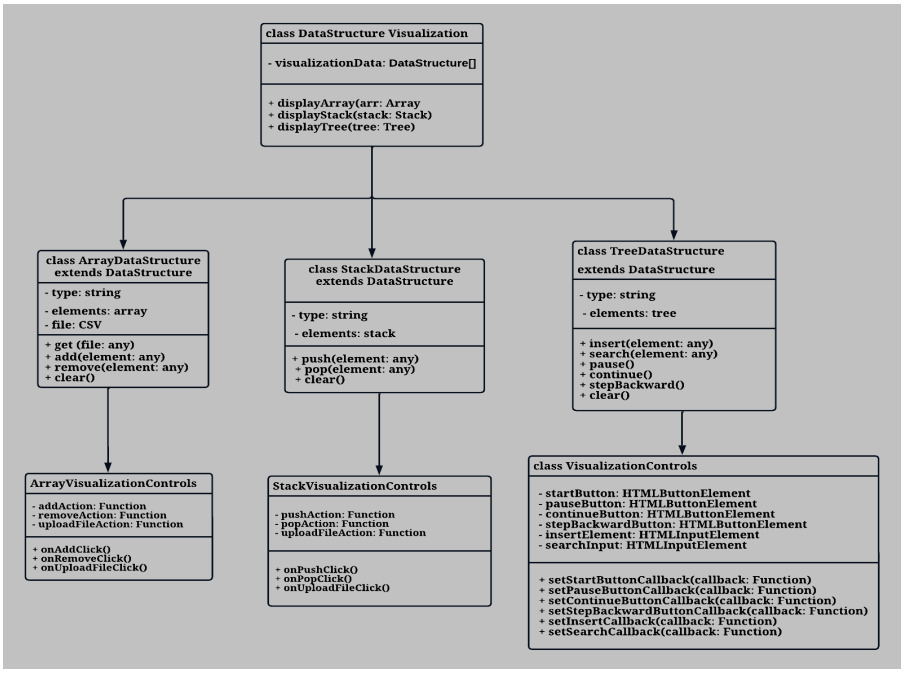

Fig. 4: Class Diagram of the Proposed System

III. RESULTS AND DISCUSSION

To construct the Data Structures Visualization tool, we employed HTML, CSS, and JavaScript. CSS and JavaScript play pivotal roles in designing an efficient user interface and creating visual representations, offering adaptability to the tool. This flexibility ensures platform independence, exemplified by the URL https://dsgrafix.netlify.app/ in Fig, 5. Within the visualization tool, we introduced the Hybrid-Input technique, presenting specific buttons such as "Add," "Push," and "Insert Value" for array, stack, and tree user interfaces respectively, as depicted in Figures 6, 7, and 8. These buttons enable users to practice randomized single-element data entry techniques. Additionally, we included a file upload input method, allowing users to upload CSV files containing large datasets for tailored practice sessions. Various colour gradients are utilized to aid learners in comprehending the fundamental steps and transitions within the data structures. User interaction is facilitated through different buttons like "push," "pop," "search," "pause," "continue," "stepback," and "clear." These buttons ensure smooth navigation through the visualization stages, accommodating users' specific requirements.

In the evaluation of the tool using space complexity metrics, we conducted a detailed experiment with our visualization tool. During the experiment, from the home page(https://dsgrafix.netlify.app/) in fig. 5, we navigated to the data structures interfaces using <a href="array.html"> <a href="stack.html"> and <a href="tree.html"> for the array, stack and tree interfaces respectively. On the array interface we uploaded a CSV file containing 200 float elements using the file upload technique. For the stack and tree, we entered 50 and 22 integer elements respectively into the Data Area through the manual data single element entry technique.

The change event listener was activated by the file upload to handle the file input element's alteration. The event listener for change (fileInput.addEventListener('change',this.handleFileUpload.bind(this));) responds to the change event occurring in the file input element, initiating the execution of the handle File Upload (event) function. The `handleFileUpload(event) retrieves the uploaded file and reads its content using the FileReader API. The FileReader() called the parseCSV(file) function, which is a function responsible for parsing the contents of the selected file. The Parser Parsing CSV Data: Inside the onload callback function, received the content of the CSV file as a string in the csvData variable.

The content was assumed to contain data separated by newline characters (`\n`). The parser then parsed this CSV data into a structured format of arrays, stacks and trees respectively. The parser then transferred the formatted data to the Visualization Engine. The Visualization Engine; draw(), then used the 2D context API to draw and render the formatted data on the Visualization Area (HTML canvas element).

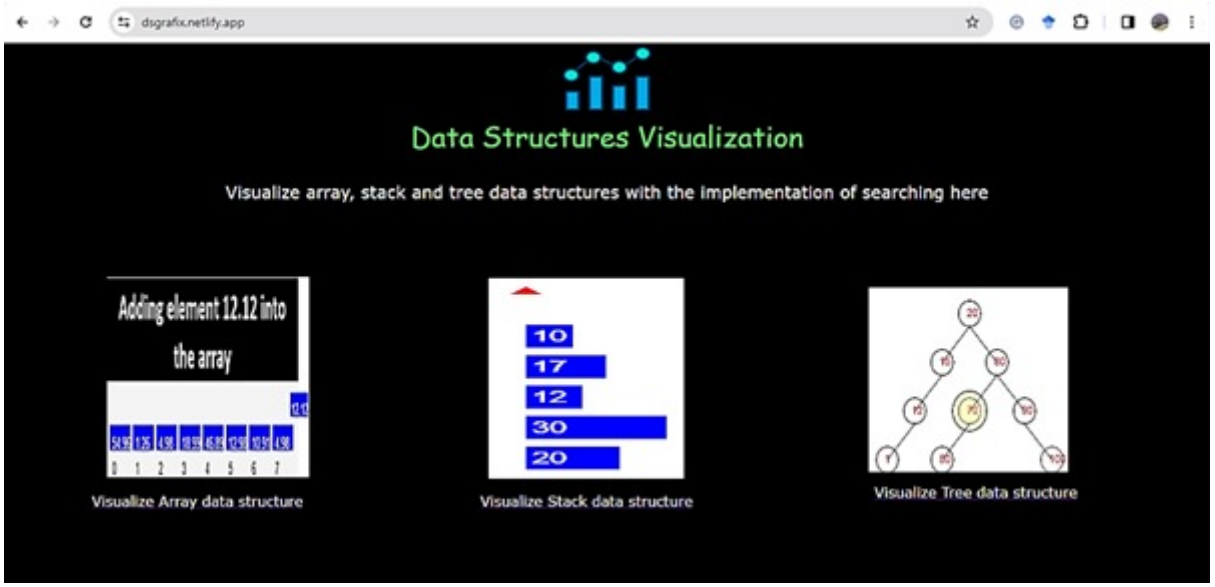

Fig. 5: Data Structures Visualization Home page

The graphical representation of the array data structure is depicted in Fig. 6, demonstrating array with a length of 200. The indices range from 0 to 199, serving as numerical identifiers. The initial index is 0, concluding at 199. The values within the square boxes denote the array elements. The array's first index, 0, holds the value 54.98, while the final index, 199, holds the value 3.08. However, index 200 remains empty as each array element possesses a distinct memory address, beginning with a zero index. The graphical representation in Fig. 7 demonstrates the stack structure, starting from element 45, which was the first input pushed into the stack as the base element, up to 378, the last input and the top element. The red pointer on top of the stacked elements indicates the top of the stack. The stack operates on a 'First In, Last Out' principle where the first element added to the stack is the last element to be removed from the stack. The 'push' adds an object to the stack, and 'pop' removes an object from the top of the stack.

Fig. 8 illustrates the binary tree data structure, commencing with the insertion of 25 as the initial element, functioning as the root at level zero or the first index of the tree. Subsequently, elements 22 and 89 were added in sequence as the immediate nodes branching from element 25. Further additions represent subsequent nodes or children of elements 22 and 89, positioning them as grandchildren based on their arrangement as shown in the figure. In a tree structure, multiple sub-trees can be delineated. The terminal elements, such as 10, 15, 93, and 102, often termed as leaf nodes, serve as the endpoints without further branches. These leaf nodes are parented by elements 11, 85, and 100, forming the hierarchy within the tree. A search operation was performed to locate the element 20 within the tree data structure. The indication of a double circle on the element signifies that the search operation successfully found the element within the structure.

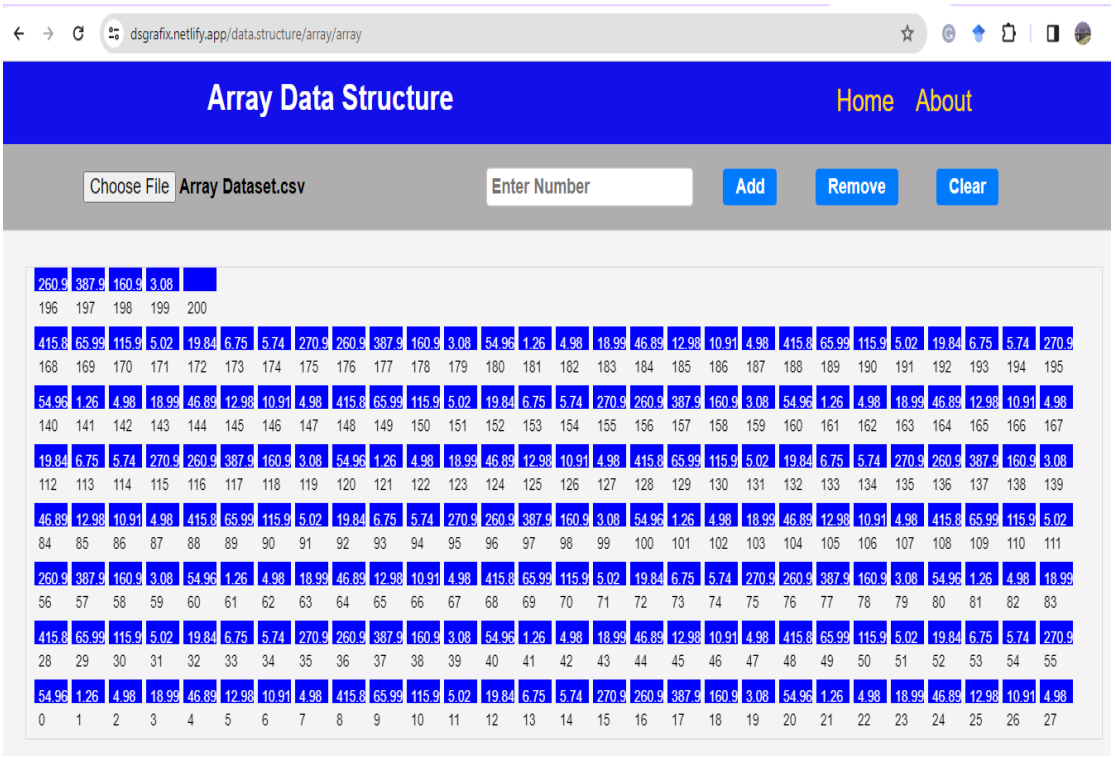

Fig. 6: Visualization of Array of Two Hundred Elements.

Fig. 7: Visualization of Stack Data Structure with Fifty Elements.

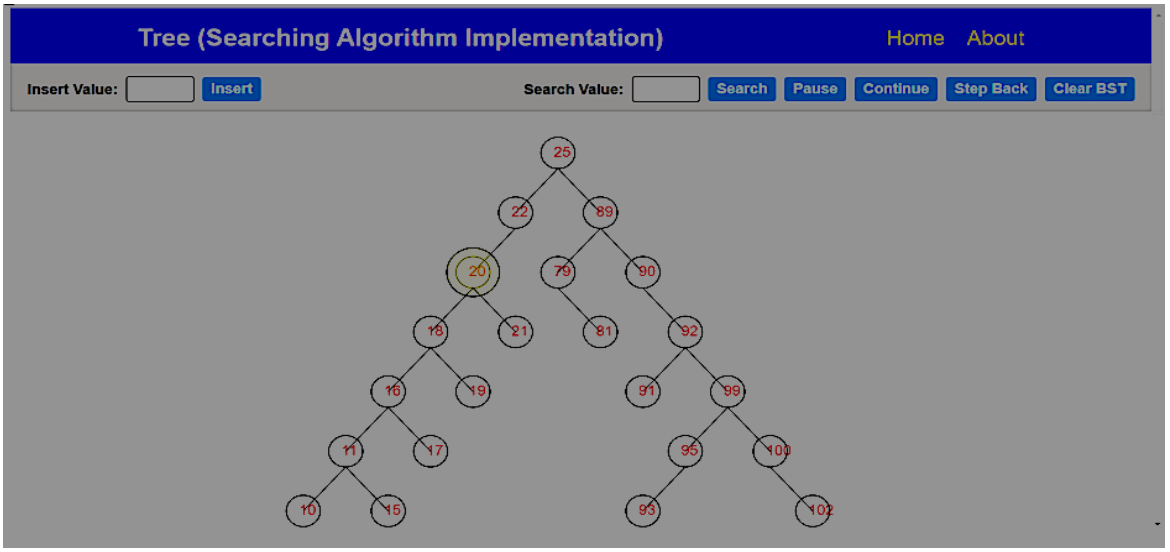

Fig. 8: Visualization of Tree Data Structure with Twenty Two Elements.

Table 1 shows the space complexities of the visualized array, stack and tree data structures. For arrays, the space complexity O(n) is directly related to the total number of elements multiplied by the size of each element. Here, the array contains 200 elements, and the assumption is that each element takes up 4 bytes of memory. Hence, the total space required to store all 200 elements is 800 bytes. The space complexity for a stack often relies on the number of elements and the way elements are stored. Also noted with O(n) is the space complexity of the binary tree data structure. Fig. 9 shows that the complexity of data structures rises along with increase in the volume of data. The space complexity by memory consumption depends on the storage required by each value.

Table 1: Tests Results for the Data Structures Visualization.

Data Structures	Elements Attributes		Space Complexity	
Type	Type	Number	By Number	By size
Array	Float	200	O(200)	800 bytes
Stack	Integer	50	O(50)	200 bytes
Tree	Integer	22	O(22)	88 bytes

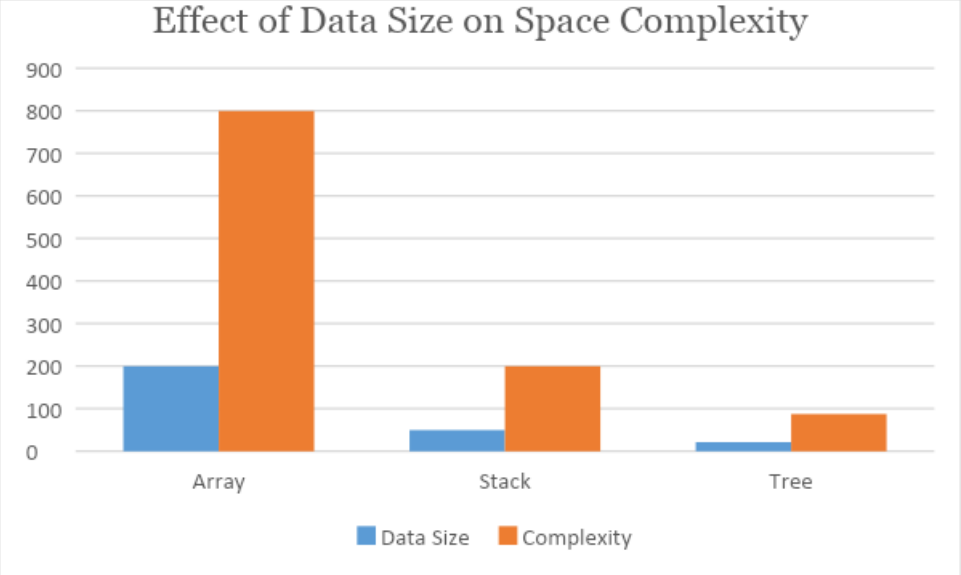

Fig. 9: Effect of Data Size on Space Complexity

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