Special Needs Classroom Assessment Using a Sign Language Communicator (CASC) Based on Artificial Intelligence (AI) Techniques

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ABSTRACT

This research focuses on deaf students in the United Arab Emirates. The proposed classroom assessment using sign language communicator (CASC) for special needs students (SN) in the United Arab Emirates is based on artificial intelligence (AI) tools. This research provides essential services for teaching evaluations, learning outcome assessments, and the development of learning environments. CASC model is composed of two models. The first model converts the speech to a sign language, which contains a speech recognizer, sign language recognizer. The second model converts the sign language to written text. This model generates a report for students' understanding and class evaluation in advance before ending the course based on the sign language recognition and image processing tools. This model will have a significantly positive impact on SN students' success and on effective lecturing and optimizing teaching and learning in the classroom. The accuracy of the model is 92%. The analysis of the student's feedback in real-time provides effective instructional strategies.

KEYWORDS

Artificial Intelligence, Classroom Assessment, Deaf Students, Image Processing, Speech Recognition

INTRODUCTION

One of the difficulties experienced by Deaf learners is the lack of understanding of Sign language to interact with the teacher in the classroom directly without helping a sign language translator as well as their need to use the supporting tools in the teaching and learning process more efficiently. Assessment is the most significant determinant of student learning, and it should be specific and measurable, it measures the student's knowledge and skills in their learning area. Assessment plays an important role in learning by encouraging the students to ask questions about anything they have not understood. The students are involved in indirect assessments such as course assessment surveys to increase their self-awareness and engagement.

This paper presents the designing and implementation of Classroom Assessment using United Arab Emirates Sign Language Communicator (CASC) based on Artificial Intelligence (AI) tools to

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enable Special Needs Students (SN) to overcome the language barrier for the discussion-based learning in classrooms that are focused on giving SN skills to apply their knowledge to real-life problems will make the classes more effective and engaging and help achieve desired outcomes.

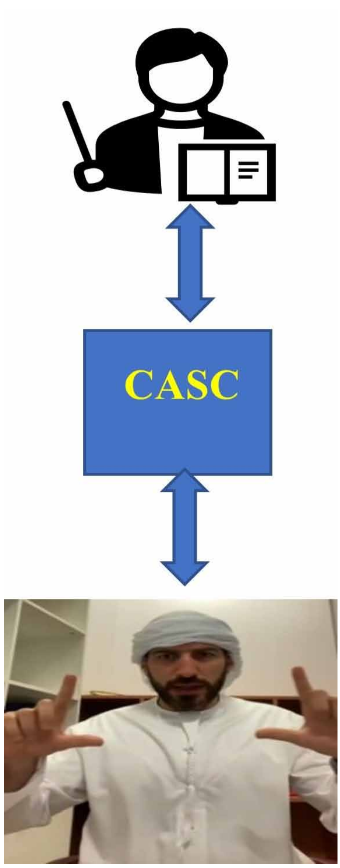
CASC model generates a report for students' understanding and class assessment before ending the course. The generated report is used to customize the courses, teaching methods, and activities to suit SN learners' needs. This model also predicts SN learners' learning outcomes based on their responses and guides them in an effective learning environment. CASC model uses oral surveys to monitor the face and body gestures of Deaf students to reduce the failure rate and identify students at risk. The CASC model is shown in Figure.1.

CASC model supports the teaching development and specifies how can we reduce the failure rate of SN students, how can we identify SN students at risk and help teachers choose a strategy to support and motivate them, and how to overcome the language barrier between Deaf students and teachers.

LITERATURE REVIEW

Recently a lot of Classroom Assessment Techniques were suggested to give the teachers and students useful feedback on the teaching and learning (Classroom Assessment Techniques (CATs), 2021) (Diane M. Enerson, 2020). These techniques are considered as one of the parameters to develop the learning and teaching methods, where the following are also involved in the development plan: Class

Figure 1. Teacher and SN student communication



Planning, Questioning Strategies, Problem-Based Learning (PBL), Case Method, Group Learning, and Community-Based Learning: Service Learning. (Center for Innovation in Teaching & Learning, 2020). Finding the key information during the semester regarding the teaching and learning of special needs students in the classrooms plays an important role to determine the necessary changes that should be applied for development (Angelo, T. A. & Cross, K. P., (1993)). Classroom assessment is based on the quality of student learning and teaching, it can be carried out by collaborating with students, where faculty and students enhance learning and personal satisfaction, students should give their feedback on getting the instructors' goals in the classroom to improve the effectiveness of the teaching, to improve their learning, students need to receive appropriate and focused feedback from the instructor about their achievements (Angelo, T. A. & Cross, K. P., (1993)). The used techniques were categorized into three parts: Techniques for assessing course-related knowledge and skills. Techniques for assessing learner attitudes, values, and self-awareness. Techniques for assessing learner reactions to instruction (TEACHING & LEARNING, 2020).

To implement these techniques in the Deaf-Dump classrooms a lot of research was done. Sign Language System (SLS) was designed based on Raspberry Pi (RPi), it picks up the speech from the instructor and translates it into UAE Sign Language in a real domain. It retrieves and plays the sign video based on the translation rules (Mouti & Rihawi, IoT and Sign Language System (SLS), 2020).

An individualized Education Plan (IEP) for students with special needs was addressed to present the curriculum design and methods for reporting student progress (Joseph's, 2002).

To help students with exceptional learning needs, the educators should be aware of the range of assessment opportunities and approaches, and the nature of acceptable accommodations in the teaching strategy and assessments to achieve academic success (Rieck & Wadsworth, 2005).

Issues, challenges, and recommendations in the assessment of students with disabilities were provided for schoolteachers and administrators (Bowen & Rude, 2006). Also, the challenges of students with disabilities in education and their relationships with teachers, learning resources, and social situations were discussed (Bakken, Jeffrey, Obiako, & Festus, 2019). Technology and inventions lead the future and change our brains, habits, and our way of living and interacting with each other and with the outside world (Pozzi, 2020). For future Personalized Learning principles, common issues were addressed and focused on the quality of learning, it should be sustainable, complete, actionable, representative, cohesive, effective, individualized, meaningful, and equitable (Ward, 2020). Innovative trends in personalized software engineering and information systems were presented, where the level of knowledge of a student and their preferences were identified, a student's performance was predicted, and software personalization to students' strengths/needs (Sgouropoulou & Troussas, 2020). Modern applications are designed as self-teaching using Artificial Intelligence (AI), where concepts related to AI, including searching processes, knowledge representation, machine learning, expert systems, programming, and robotics were clarified (Gupta & Mangla, 2020).

Examining the challenges and risks of AI was explained to understand the reality and implications of AI (Rahman, 2020).

Smarter assessment practices to empower and engage students were studied, and improving assessment practices to make the results accurate, meaningful, informative, and fair were discussed in addition to presenting troubling issues related to traditional approaches, clarifying examples of educators who are transforming assessment by using tools and methods that engage and empower students (Dueck, 2021). Contemporary issues related to analytics systems and how they support students at higher education institutions were presented. The contributions provide insights into how educational data, analytics systems, and advanced digital technologies contribute toward successful learning and teaching scenarios at higher education institutions (Supporting higher education students through analytics systems, 2020).

The following are some successful AI applications: Google's AI-Powered Predictions, Commercial Flights Use an AI Autopilot, Smart Email Categorization, Robo-readers, Mobile Check Deposits, Fraud Prevention, Language translation services (Google), Translating Telephone (Skype), News aggregation and summarization (Google), Speech recognition (Nuance), Song recognition (Shazam), Face recognition (Recognizer, Google, …), Image recognition (Google), Question answering (Apple Siri, IBM Watson, …), Chess playing (IBM Deep Blue), 3D scene modeling from images (Microsoft Photosynth), Driverless cars (Google), Traffic prediction (Inrix), Game playing (Chess, Go, Risk, Bridge, Checkers (AI Applications: Top 14 Artificial Intelligence Applications, 2022).

ARTIFICIAL INTELLIGENCE AND SPECIAL NEEDS APPLICATIONS

Alan Turing, in his paper "Computing Machinery and Intelligence" published in the Mind journal in 1950, proposed an operational approach to the question of whether machines can think. He proposed replacing the question "Can machines think?" with an experiment he called "The imitation game" (Turing, 2009). The experiment compares the performance of a supposedly intelligent machine against the performance of a human on a given set of queries. Since then, AI researchers are growing up to serve many sectors including Special Needs (SN) or people with disabilities (Turing, 2009).

There are different stages of Artificial Intelligence: Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Super Intelligence (ASI) (What are the 3 types of AI?, 2021).

Artificial Narrow Intelligence (ANI) is known as weak AI. This stage of Artificial Intelligence involves machines that can perform only a narrowly defined set of specific tasks (Mouti, Artificial Intelligence Stages, 2022). ANI doesn't possess any thinking ability, and it has a narrow range of abilities. ANI systems don't perform outside of the single task that they are designed to perform. Examples of weak AI: Bots powered by ANI can be used to automate repetitive service tasks, such as searching the knowledgebase, looking up product details, shipping dates, order histories, and performing countless other customer requests. Other examples are Google Assistant, Google Translate, Siri, natural language processing tools, e-commerce product recommendation tools, disease prediction, mapping solutions, social media behavioral algorithms, self-driving cars, Alexa, alpha-go, Sofia, crawling a webpage or playing chess, and so on (Mouti, Artificial Intelligence Stages, 2022).

Artificial General Intelligence (AGI) is known as strong AI. This stage is the evolution of Artificial Intelligence where machines will possess the ability to think and make decisions just like human beings. AGI is called deep AI, which can mimic human reasoning and intelligence to learn about a problem and its contexts and solve it. AGI is expected to be able to reason, solve problems, make judgments under uncertainty, plan, learn, integrate prior knowledge in decision-making, and be innovative, imaginative, and creative. AGI is playing an important role in many fields, such as: Cybersecurity; breach detection, monitoring, threat intelligence, incident response, and risk analysis. Entertainment and content creation, in addition to behavioral recognition and prediction (Mouti, Artificial Intelligence Stages, 2022).

Artificial Super Intelligence (ASI) is more capable than a human, it surpasses human intelligence in creativity, general wisdom, and problem-solving. ASI algorithms will be capable of defeating the smartest of humans in all domains. This stage can be the real solution to the problems that are still complex for the human mind. The development paths of ASI would be able to connect the minds of each other and be like the human internet, it would be like an imaginary life (Mouti, Artificial Intelligence Stages, 2022).

Design and implementation of the Voiced Operating System was an important target to allow Blind people to communicate with computer equipment and Information Technology (IT) (Mouti, Design and Implementation of Voiced Operating System for Blind Using Artificial Intelligence Techniques, 2005). The required technique should simulate human beings' actions. Artificial Intelligence (AI) is concerned with the theory and practice of developing systems that exhibit characteristics associated with intelligence in human behavior like; perception, Natural Language Processing (NLP), reasoning, planning, and problem-solving. (AI) techniques are qualified to build up a consistent system to serve the blind. Expert System is that branch of (AI) interested in building systems that incorporate logical mechanisms of a human experience in specific skills. The Arabic language is particularly a challenging area of research for computer analysis, especially in data processing and reasoning applications. Arabic words frequently incorporate grammatical elements indicating verb aspect, object, conjugation, person, number, gender, and other attributes. An Expert System was developed for (NLP) and presents an approach for Arabic language processing, which integrates Syntactic, Morphological, Semantic, Phonological Analyzers and Synthesizers. The work includes the transformation of Text to Speech (TTS) and Speech To Text (STT) techniques. It illustrates the methodology for Arabic language processing using Artificial Intelligence techniques. It facilitates the analysis of written text in the Arabic language by normalizing Arabic text, performing logical procedures, and utilizing advanced linguistics algorithms for language utterance (Mouti, Design and Implementation of Voiced Operating System for Blind Using Artificial Intelligence Techniques, 2005). Arabic language processing was performed through different Analyzers and Synthesizers. Expert algorithms are created using data structures and grammatical rules that involve optimization methodology. Conventional databases are developed by integrating a wide range of inductive inference capabilities, to reach the correct syntactic parsing and semantic meaning of an input sentence. Many rules were implemented for reasoning and inference. Using a segmentation algorithm based on forward and backward maximum matching, together with a database, each Arabic sentence is represented in a sequence of Arabic words. Backward chaining is particularly suitable for this context, where designing an intelligent system can be generated in automated methods. Collection of indexed data is performed where related expressions are formed to make accurate predictions on future data and to obtain correct reasoning and inference. To optimize the goal from specific knowledge provided by domain examples, the depth-first method is used to obtain the best solution. An intelligent engine is achieved as a high-performance linguistic expert engine that facilitates analyses of written texts in the Arabic language, performs full linguistic processing on text, and generates a robust parser for Arabic sentences. Knowledge is obtained through predicates and expressions. Reasoning and inference are accredited to help grammar induction containing syntactic, morphological, and semantic mechanisms using depth-first search. A backpropagation neural network is designed for Phonological Analyzer and understanding of presented speech (Mouti, Design and Implementation of Voiced Operating System for Blind Using Artificial Intelligence Techniques, 2005).

An Arabic screen reader was developed to convert written text into voiced texts, in conjunction with the linguistic system. Arabic text was processed syntactically, morphologically, semantically, and phonologically (Mouti, Design and Implementation of Arabic Screen Reader Using Artificial Intelligence Technique, 2009). The phonological synthesizer was built up relying on the movement of articulators during the utterance of Arabic letters. The movement of each articulator (Tongue, Palate, Lower Jaw, Trachea, Lung, and others) was fitted for an appropriate function. Each character/word/text was projected on a related acoustic signal obtained from a real-time system that originated from a physical phenomenon (Mouti, Design and Implementation of Arabic Screen Reader Using Artificial Intelligence Technique, 2009). The system identifies signals in time and frequency domains for each articulator, and compensation for unbalanced/ailing articulators to serve deaf people. A linguistic analyzer was designed based on fuzzy logic for processing Arabic texts syntactically, morphologically, and semantically. Parser system using Petri net was established for vowellation of text after syntactic, morphological, and semantic processing. Expert systems and artificial neural networks were used to design lexical linguistic statistical systems, and to interact between voiced systems and statistical systems. Letters of written text are predicted, and uttered speech is generated. Syntactic, morphological, and semantic processing for Arabic text was developed using the above resulting lexical system. A phonological synthesizer was designed depending on human speech signals based on mathematical models of articulators. Appropriate algorithms were discovered for the morphological processing of real-time medical images (Mouti, Design and Implementation of Arabic Screen Reader Using Artificial Intelligence Technique, 2009). The general speech model related to articulators for Arabic screen readers was obtained in both time and frequency domains. The stages of this research were addressed in the following points: Fuzzy linguistic analyzer was designed for Arabic sentences to convert represented frames into uttered sentences using a screen-reader and vocal operating system. The algorithm of Fuzzy Linguistic Analyzer (FLA) was built up to analyze sentences and determine the inputs and outputs of the system. Parser system using Colored Petri Nets (CPN) was designed for vowellation of Arabic sentence after syntactic, morphological, and semantic processing was applied on this sentence, pre-submitted to the speech synthesizer approved by the screen reader. The algorithm of parser Petri net was established to parse nouns and verbal sentences. The text was analyzed into a group of words, identifying several elements of the sentence. A set of emerged rules is created to find syntactic tokens properly and fire the correct frame in the sentence. Arabic sentence was identified as an input of Petri net, constituted linguistic place, and the correct syntactic token was considered as an output. Several conditions were designed for this aim. Linguistic places were established for syntactic tokens of noun and verbal sentences (Mouti, Design and Implementation of Arabic Screen Reader Using Artificial Intelligence Technique, 2009).

Functional linguistic places were represented (Mouti, Design and Implementation of Arabic Screen Reader Using Artificial Intelligence Technique, 2009). The best solution was reached, which contains tokens referenced to functional sets in related Arab languages. Condition of transitions controls an appropriate token of the input sentence. A suitable token for each sentence is generated. Vowellation of noun and verbal sentences is reached by parser Petri net. Many sentences are applied to this parser system and correct parsing is reached. The articulatory system was imaged by various medical imaging sequences during the utterance of Arabic letters. Optimal imaging of the human's vocal tract during the utterance of Arabic letters was reached. Many processing on Computerized Axial Tomography (CAT) and Magnetic Resonance Imaging (MRI) was implemented to extract essential features of the vocal tract. A set of modeling data of articulators in humans forms a phonological database. Movements of these articulators were obtained, and speech signals of each articulator were the result of the auto-generation of speech. Imaging was applied to a group of users to control their articulators during silence and pronunciation of Arabic letters (28 letters), and in its four cases (4*28); 112 letters (Mouti, Design and Implementation of Arabic Screen Reader Using Artificial Intelligence Technique, 2009). Photography imaging was useful to study the movement of the tongue and vocal cords during speech, where the mouth cavity is closed by the tongue in some Arabic letters. This method is dangerous for human life as suffocation can happen due to a telescoping path through the nose to mouth cavity after anesthesia of this region. In addition to the lack of audio recording facilities for movement within video film. Fluoroscopy image sequences were optimal images. They were useful to study the movement of the tongue, palate, lower jaw, trachea, and lungs (diaphragm) during speech. The dynamic movement of these articulators was created. Sophisticated processing resulted in medical images being generated to find the edges of their components. Models in the Simulink environment were designed. Modeling of Speech Production System (MSPS) was designed. A representative function of movement of articulators was found. Processing of picked-up images of articulators drawn up from video files during the pronunciation of all Arabic letters was made. Segmentation of the video file into a series of static images shows articulator shapes during the utterance letters. Images of articulators were read and transformed into grey images. Morphological processing was applied to determine the active region of the articulator. The disturbance was removed, the noise was filtered up and the edges of the image were traced. Resulted data was approached and a static mathematical model for articulators was concluded (Mouti, Design and Implementation of Arabic Screen Reader Using Artificial Intelligence Technique, 2009). The position of the articulator in each case (scenery) was represented to determine the trajectory of movement of articulators. The static curve in each case was analyzed, and values of samples for all articulators were founded, i.e., space of samples is identified. Many mathematical methods were applied, such as the NonLinear Auto-Regressive model with an eXternal input (nlARX), and the Modified NonLinear Auto-Regressive model with an eXternal input (MnlARX), and the method of Rational Function (RF). Model and signals of movement of articulators were obtained. State Space Model Based on Data (SSMBD) was designed. An algorithm of (SSMBD) for the representation of articulators (tongue, palate, lower jaw, trachea, and lungs) for pronunciation of Arabic letters was established. State-space equations of articulators' positions were formed (data of articulators in each case) during the pronunciation of a letter. Also, State Space Model Based on Gradient (SSMBG) was built up to map speech signals into each articulator during speech. A general speech model of letters, composed of speech models of each articulator was obtained (Mouti, Design and Implementation of Arabic Screen Reader Using Artificial Intelligence Technique, 2009). The algorithm of Acoustic to ARticulator (ACAR) was implemented to find meeting signals between acoustic speech and articulator in both time and frequency domains. Comparison between real speech signal of uttered letter and Speech Model (SM) resulting from each articulator was made to create common values of tongue, palate, lower jaw, trachea, and lungs. Other sound effects are included in the error signal. The algorithm of Generation of Speech Signals (GSS) was established to generate audio signals from articulators and to obtain words and text. The database of phonological synthesizers in operating systems is composed of mathematical models. The appropriate function of utterance was applied to produce a real speech signal of written text (Mouti, Design and Implementation of Arabic Screen Reader Using Artificial Intelligence Technique, 2009)

RESEARCH METHODOLOGY

This research focuses on indirect assessment through student surveys that will be measured to use in the course assessment report and annual program learning outcome attainment. Using this formative assessment will help the instructors to follow up on the student's progress gradually and during class time. Classroom Assessment using Sign Language Communicator (CASC) for Special Need Students (SN) in the United Arab Emirates depends on the students' responses to the oral survey by the teacher to gather the data about students.

CASC contains two main models; the first model is to convert the spoken language to sign language (Mouti & Rihawi, IoT and Sign Language System (SLS), 2020), and the second model is to convert the sign language to written texts.

Speech recognizer in the first model composes of three modules for translating speech into UAE sign language. The first module is the speech recognizer for converting the oral instructor questions into a written text using Google Speech API. The second module is the natural language processor to split the written text into a list of words. The third module is the videos generator contains a database of the Sign Language System. CASC has an inference engine to transform each word into a sequence of videos using translation rules to play the suitable matching in the CASC model database. Raspberry Pi (RPi) is energized with a power bank; it picks up the speech and translates it into UAE Sign Language in a real domain.

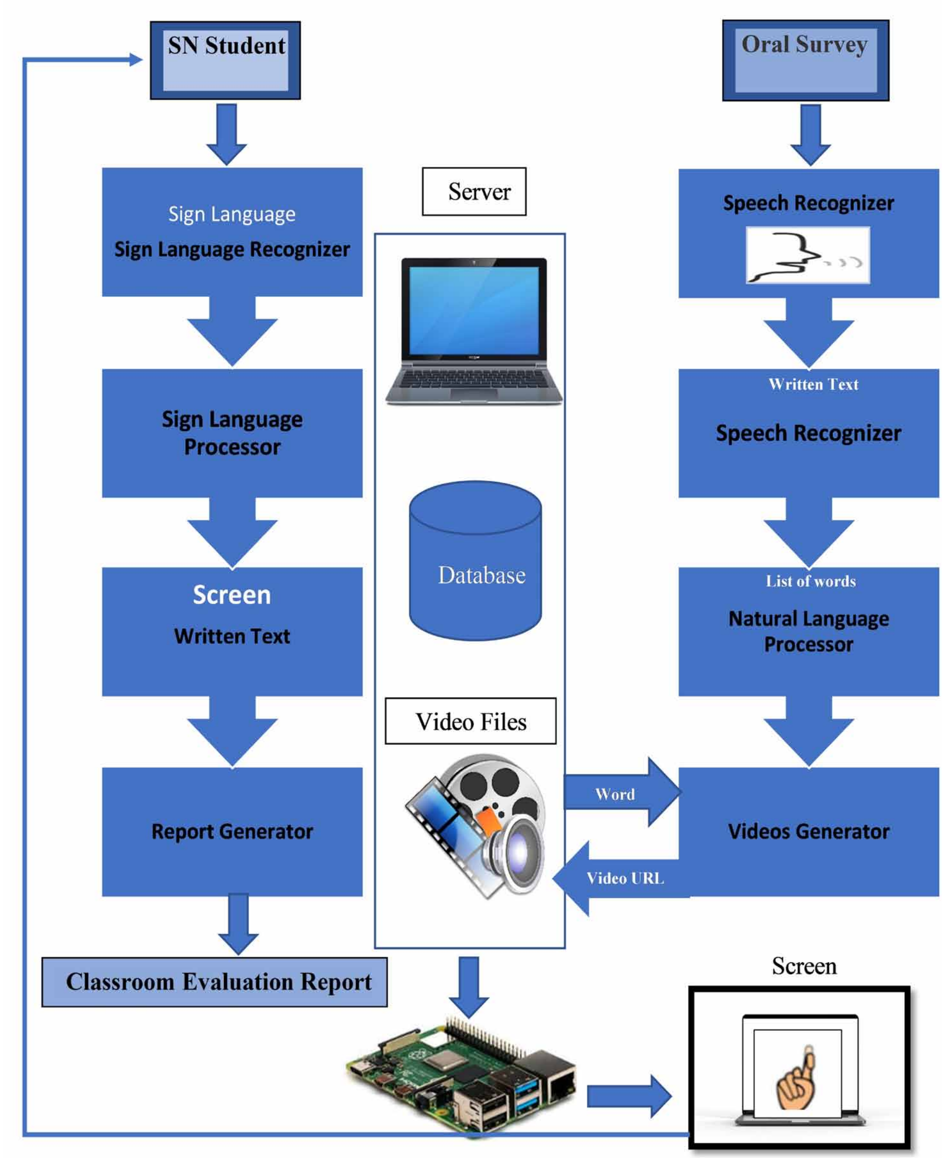
Sign Language Recognizer in the second model receives the SN student's feedback on the oral survey and converts it into a written text through a sign language processor based on the image processing algorithm to extract Keypoint values and collect these values for training and testing. This model preprocesses data, creates labels, trains LSTM Neural Network, and makes predictions. CASC model gathers the data about students and generate the student report and produces the classroom evaluation report. CASC model methodology is presented in Figure.2

CASC IMPLEMENTATION AND RESULTS

CASC model contains two models: The first model recognizes the speech from the teacher and converts it to UAE sign language, and the second model converts the sign language from the SN student into text. Python and OpenCV were used for creating the CASC model.

The first model was implemented to receive the question from the teacher, where the teacher asks the student a question about whether the class is going well, or the topic is clear. The question will be recognized using the Speech Recognition library in Python.

Figure 2. CSC model methodology



This text was used as a query from MySQL database which will send the URL for the video of the sign language for the corresponding question to be played on the student's screen. The student class evaluation survey contains the following information:

- How likely is it that you would recommend this course to a friend or colleague?
- Overall, how would you rate this course?
- How clear were the objectives of this course?
- How would you rate the instructors of this course?
- Do you consider this course as interactive?
- Are you satisfied with this course?

- Overall: Satisfaction that course objectives were clear
- Lecturer-related: Learning resources (slides, readings, case studies, textbooks)
- Lecturer-related: Teaching methodology
- Skills enhancement: it helped develop independent learning
- Skills enhancement: it helped develop research skills
- How organized was this course?

Figure 3 shows some samples of the CASC database (Mouti & Rihawi, IoT and Sign Language System (SLS), 2020).

Connection function was built to build link with the CASC database.

Table 1 represents some samples of the First model that recognized the speech at the delayed time retrieved results (Mouti & Rihawi, IoT and Sign Language System (SLS), 2020).

Figure 4 shows an example of the speech recognizer steps for the sentence processing (Mouti & Rihawi, IoT and Sign Language System (SLS), 2020).

The second model was implemented as a classroom assessment tool for SN students. It generates a report for students' understanding and class evaluation before ending the course. Figure 5. shows a sample of the partially generated report through CASC for 7 responses.

Figure 3. Sample of CASC database

signid	signname	signvideo	category
6	السلام عليكم	salam	compound words
7	حل	answer	verbs
8	امتحان	exam	education
9	تمرين	exercise	education
10	أول	first	numbers
11	علامة	grade	education
12	كيف الحال	howareyou	compound words
13	يجب	must	verbs
14	مشروع	project	education
16	عشرة	ten	numbers
17	يوم	today	situations
18	بدء	start	verbs
19	محاضرة	lecture	education
20	ع	aeen	alphabets
21	ل	lam	alphabets
22	ي	yaa	alphabets

Table 1. First model tested samples

Word Said	Category	Accuracy	Delay time
Learning	Educational words	80%	2.5 sec
Course Objective	Compound words	100%	3 sec
Course Satisfaction	Compound words	80%	3 sec
Teaching methodology	Compound words	95%	3 sec
Skills	Noun	90%	3 sec

Figure 4. Example of speech recognizer

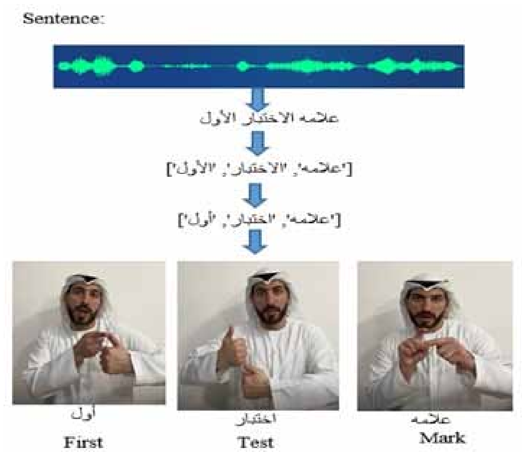
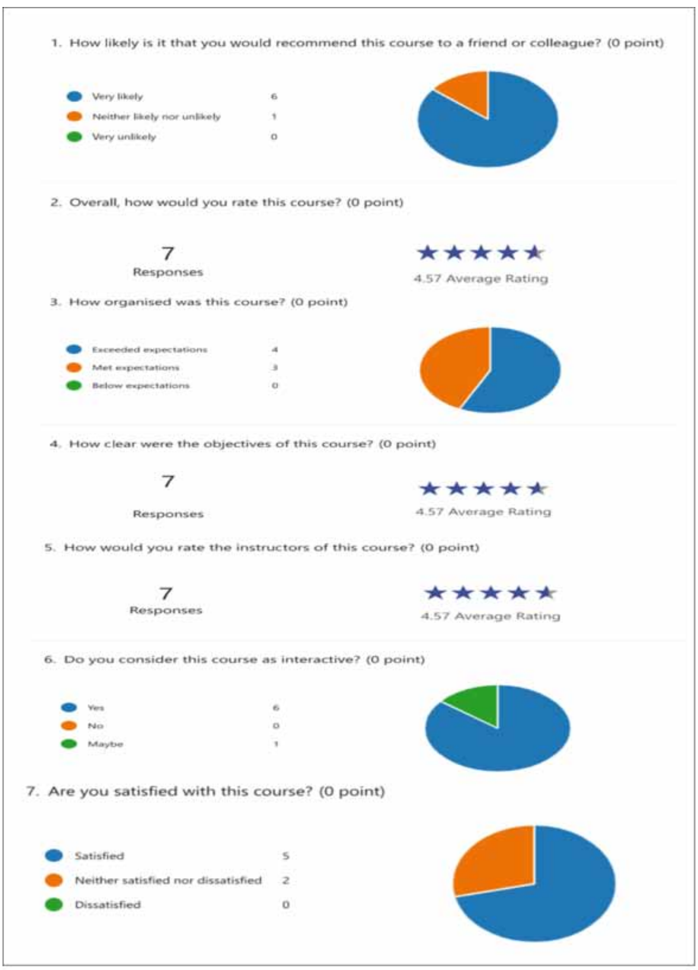


Figure 5. Sample: Part of the generated report for 7 responses



This report helps the instructors to customize the course, teaching methods, and activities to suit SN learners' needs based on the students' feedback. Predict SN learners' learning outcomes based on their responses. Monitor and guide SN learners in an effective learning environment. The model captures the facial and hand movements of the students using the media pipe library provided by Python. It extracts key point values, collects key point values for training and testing, preprocess data and creates labels and features, builds and trains LSTM Neural Network, and makes predictions as shown in the following points.

Extract Keypoint Values

The student's responses were captured by a webcam installed on the student's computer. *mediapipe* library was imported and used it to draw the landmarks that show the joints of the face, left hand, and right hand as well as the lines that represent the bones. NumPy array was used to store them in data frames. Figure 6 shows an example of extracting key point values from the recorded images.

Collect Keypoint Values for Training and Testing

Around 30 frames can be used to extract the features and create the labels and save them into separate files which can be used for training the model. In the 30 frames, there are 1662 facial and pose landmarks that have been extracted. Table 2 shows a sample of the values of the landmarks for two frames that have been captured for each response.

Figure 6. Extract key point

Table 2. Sample of the values of the landmarks for two frames

Response 1: Yes		Response 2: No	
Frame 1	Frame 2	Frame 1	Frame 2
0.5011106133460999	0.5193696618080139	0.6350286602973938	0.5296657085418701
0.36503875255584717	0.38109639286994934	0.4325958788394928	0.24632495641708374
-1.1592991352081299	-1.2970306873321533	-0.8591551780700684	-0.26548492908477783
0.5332522392272949	0.9999306201934814	0.9999645948410034	0.999967098236084
0.9999339580535889	0.5475198030471802	0.6653443574905396	0.554975152015686
0.29043662548065186	0.30243200063705444	0.3560483157634735	0.24173229932785034
-1.1194686889648438	-1.2611496448516846	-0.8104025721549988	-0.20564286410808563

Preprocess Data and Create Labels and Features

Preprocess data and create labels and features were implemented. All input values were given to CASC model in the form of Integers as showed in the previous section. Also, natural language preprocessing operation was done in the CASC as the following sample:

Sentence “First test mark” “ةمالع رابتخالا لوالا”:

- Sentence is splited to the list of words:
  ‘ەمالع’, ‘رابتخالا’, ‘لوألا
  Stem of each word is founded [‘ەمالع’, ‘رابتخا’, ‘لوأ’]
- Corresponding video files are generated.

Noun “ALY” “يلع”:

- Word is splited to list of letters [‘ع’, ‘ل’, ‘ي’]
- Corresponding video files are generated for each letter.

Sentence “Today lecture will start” “أدبنس ةرضاحم مويلا”:

- Sentence is splited to the list of words:
  ‘ادبنس’, ‘ەرضاحم’, ‘مويلا.
  Stem of each word is founded [‘بدع’, ‘ەرضاحم’, ‘يوم’].
- Corresponding video files are generated.

Build and Train LSTM Neural Network and Make Predictions

The proposed CASC model was created using Long Short Term Memory Neural Network as it can be used data frames for training and testing and can memorize the patterns better than regular neural networks. The following packages were imported:

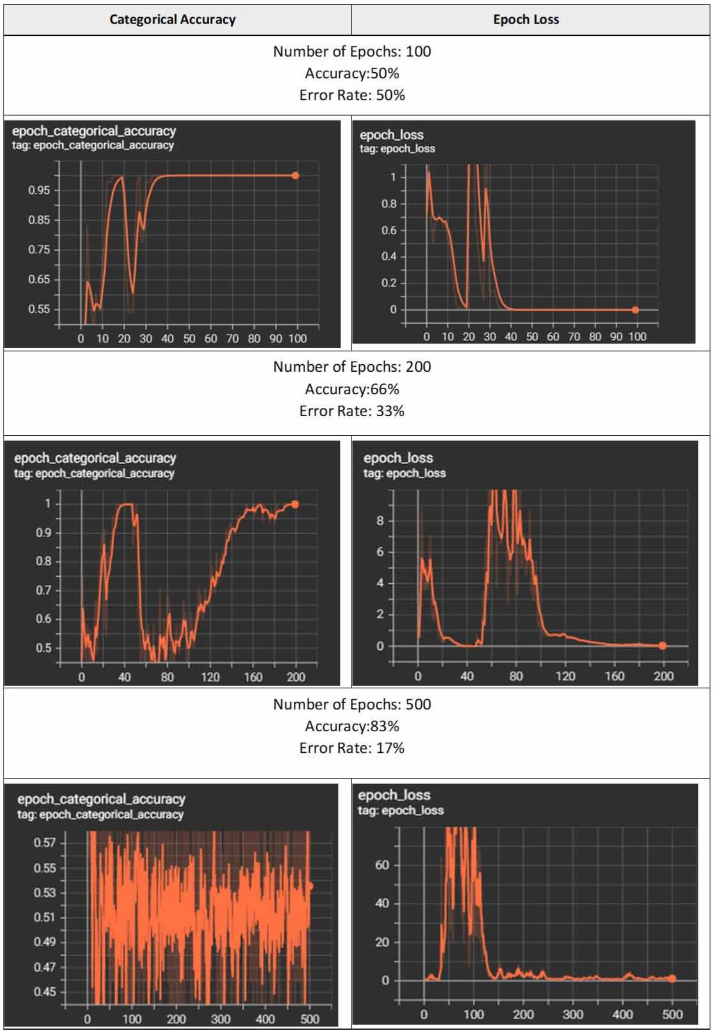
from tensorflow.kers.models import Sequential
from tensorflow.keras.layers import
LSTM,Dense
From tensorflow.keras.callbacks import
TensorBoard
from tensorflow import keras

The model is composed of three layers: an input layer that is composed of 64 units, a hidden layer composed of 128 units, and 64 units for the output with *relu* as an activation function. The model has been trained over 100,300, and 500 epochs to test its accuracy. Predict function was called to make predictions, the following section shows some samples.

Evaluation Using Confusion Matrix and Accuracy

The gathered frames were split into training and testing groups with 80% of the frames for training and 20% of the frames for testing. The results are in Figure 7. It shows the responses of the students, and the epochs are proportional to accuracy. A trained NN model receives this sign language, and recognizes the student who sent the response, CASC generates a report based on the student feedbacks and send it to the teacher.

Figure 7. Second Model Tested Samples



The analysis of the student's feedback in the real-time the class is important in forecasting learning outcomes as well as providing effective instructional strategies for special needs students to get the best results and achievements. CASC model enables Deaf students to overcome the language barrier that prevents them from directly interacting with the teacher in the classroom. This model makes feedback on students' learning more systematic, flexible, and effective. CASC has an oral evaluation classroom tool that checks student understanding in "real-time". This indirect assessment provides information that can be used to modify/improve course content and adjust teaching methods in the day-to-day operations of the course.

Through the experimental Deaf students were satisfied with using the CASC system as support services during class time and their performance was similar to hearing peers in the same class.

The experiments were performed on 25 students. Some experiments didn't give the correct results because of the below reasons:

- Poor lighting which didn't help in capturing all the landmarks.
- Some students tend to hide their faces using masks or niqab in the case of female students, which caused to get inaccurate results since some parts of the face were hidden.
- The distance between the students and the camera as it gets more difficult to capture the facial and body expressions of the students who sit at the back of the class.

A performance test has been conducted to evaluate the CASC efficiency. A confusion matrix includes prediction results of any binary testing that is often used to describe the performance of the CASC model. Predicted values were described as Positive and Negative and actual values as True and False. Accuracy and error rate were calculated as the following:

Accuracy rate = (true positive value + true negative value) / (total number of samples)
= (20 + 3) / (25) = 0.92=92%

Misclassification (error) rate = (false positive value + false negative value)
/ (total number of samples) = (1 + 1) / (25) = 0.08=8%

CONCLUSION

Formative assessment through nongraded activities such as oral surveys help the instructor in identifying the student's needs and weaknesses. Faculty and student evaluation of the course are involved in the course assessment report each semester and potential areas for course improvement will be filled by the instructor at the end of the semester to be considered in the next offering for the course and tracking the progress of implementing these feedbacks. Design and implementation of an innovative tool such as Classroom Assessment using Sign Language Communicator (CASC) for Special Need Students (SN) in the United Arab Emirates-based on Artificial Intelligence (AI) tools will support and motivate the Deaf students to overcome the language barrier with the teachers. This research will help the SN students to achieve their learning objectives by being able to get an accurate and real evaluation of their understating during the classes. Also, the proposed CASC model helps the teacher to get some insight into his/her teaching methodologies during the class as the model will observe and record the feedback of the students.

Python, OpenCV, and Keras were used for creating the CASC modules such as Neural Networks and Machine Learning models. The experiments were done in two phases: recognizing the speech from the teacher and receiving the response from the SN student using Emirate Sign language. The benefits of the CASC model are: Generate a report for students' understanding and class evaluation before ending the course. Customize the courses, teaching methods, and activities to suit SN learners' needs. Predict SN learners' learning outcomes based on their responses. Monitor and guide SN learners in an effective learning environment. This oral survey will monitor the face and body gestures of the Deaf students in the classroom and will reduce their failure rate by identifying students at risk. This research provides essential services for the courses and teaching methods development, and it will evaluate creative learning environments.

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