International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Sign Language Recognition For Deaf and Dumb

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ABSTRACT:-

Hand Gesture is the method used in sign language for non-verbal and verbal communications. It will be used by deaf & dumb people who have hearing or speech problems to communicate between themselves or with normal people. Different sign language systems have been developed by many makers around the world but they are neither flexible nor cost-effective for the end-users. Hence, it is software that presents a system prototype that can automatically recognize sign language to help deaf and dumb people to communicate more effectively with each other or normal people. Dumb people are usually deprived of normal communication with other people in society, also normal people find it difficult to understand and communicate with them. These people have to rely on an interpreter or some sort of visual communication. An interpreter won't always be available and visual communication is most difficult to understand. Sign Language is important for communication in the deaf and dumb community. If a normal person is unaware of the grammar or meaning of various gestures that are part of a sign language, it is primarily limited to their families and/or deaf and dumb community.

Keywords:- Hand gesture, Sign language, Communication , Open CV, Artificial Neural Network, CNN.

Introduction:-

"Sign language serves as a vital mode of communication, employing visual methods such as facial expressions, hand gestures, and body movements to convey meaning. It is particularly beneficial for individuals experiencing hearing or speech impairments. Sign language involves the conversion of these gestures into words or alphabets of established spoken languages, bridging the communication gap for those with hearing or speech impairments. Vision-based hand gesture recognition stands as an active area of contemporary research in computer vision and machine learning. This field aims to facilitate human-computer interaction by enabling natural interactions without the need for additional devices. The primary objective of gesture recognition research is to develop systems capable of identifying specific human gestures for various applications, including conveying information. Vision-based hand gesture interfaces necessitate rapid and robust hand detection and gesture recognition in real-time. Gestures represent a powerful human communication modality with numerous potential applications, among which is sign language recognition, a crucial communication method for the deaf community. Hand gesture recognition for human-computer interaction remains an area of active research in computer vision and deep learning. The primary focus is on developing systems capable of identifying specific gestures to convey information or control devices. Gestures are modeled in both spatial and temporal domains, where hand posture represents the static structure of the hand, and gestures denote the dynamic movement. Two main approaches to hand gesture recognition exist: vision-based and data glove-based. This work concentrates on creating a vision-based system capable of real-time sign language recognition due to its simplicity and intuitive communication between humans and computers. Hand gestures serve as fundamental communication tools in daily human life, and their continuous evolution drives advancements in human-computer interaction."

"In recent years, the advancement of image and video processing techniques has spurred research in human-machine interaction, particularly through Gesture Recognition, finding application across various domains such as touch screens, video game consoles, virtual reality, medical applications, and notably, sign language recognition. Sign language serves as a natural mode of communication for individuals who are deaf or hard of hearing, facilitating the exchange of information in their daily interactions. Notably, challenges arise in their interaction with hearing individuals. Sign language, akin to verbal language, comprises a vocabulary of signs; however, it lacks standardization and universality, with grammatical structures varying across countries and languages.

Literature Review:

Previous research in this domain predominantly utilized glove-based systems, wherein sensors like potentiometers and accelerometers are affixed to each finger, enabling the recognition of hand gestures. Lee and Xu developed a glove-based gesture recognition system proficient in identifying 14 letters from the manual alphabet, with provisions for learning new gestures and updating gesture models online. Subsequent advancements led to the creation of sophisticated glove devices such as the Sayre Glove, Dexterous Hand Master, and Power Glove. However, a significant drawback of glove-based systems is the need for recalibration upon user changes, particularly concerning fingertip identification by the Image Processing unit. Our project adopts an alternative approach utilizing Image Processing.

Hand Gesture Recognition Using PCA: This paper introduces a scheme based on database-driven hand gesture recognition, employing a skin color model and thresholding approach alongside effective template matching, suitable for applications in human robotics and related fields. Initially, hand region segmentation occurs through a skin color model in the YCbCr color space, followed by thresholding to differentiate foreground and background. Finally, template-based matching leveraging Principal Component Analysis (PCA) facilitates recognition.

Hand Gesture Recognition System for Dumb Individuals: This work proposes a static hand gesture recognition system employing digital image processing, utilizing the Scale-Invariant Feature Transform (SIFT) algorithm to extract hand gesture feature vectors from edge information, thus ensuring scalability and rotation invariance.

An Automated System for Indian Sign Language Recognition: This paper presents a method for automatic sign recognition based on shape-based features. Hand region segmentation is accomplished through various methods, such as

To segment the hand region from images, our system employs Otsu's thresholding algorithm, which selects an optimal threshold to minimize within-class variance, effectively distinguishing between black and white pixels. Subsequently, features of the segmented hand region are computed utilizing Hu's invariant moments, which are then inputted into an Artificial Neural Network (ANN) for classification. System performance is evaluated based on metrics such as Accuracy, Sensitivity, and Specificity.

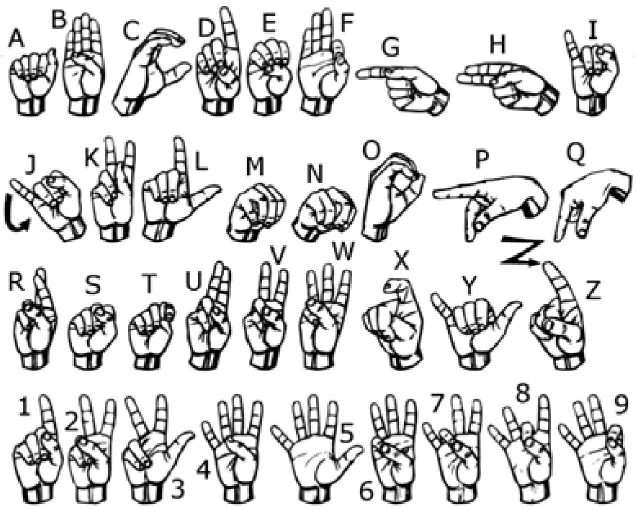
Regarding Hand Gesture Recognition for Sign Language, researchers have explored various methodologies proposed by different scholars in the past. Sign language stands as the primary mode of communication for individuals who are deaf or hard of hearing, serving as a medium through which they express their emotions and thoughts.

Objectives:

The Sign Language Recognition Prototype represents a real-time vision-based system designed to recognize American Sign Language gestures depicted in the alphabet (Fig. 1). The prototype aims to validate the effectiveness of a vision-based approach for sign language recognition and simultaneously identify hand features suitable for integration with machine learning algorithms, enabling their application in real-time sign language recognition systems.

The implemented solution utilizes a single camera and operates under the following assumptions:

1. Users must be within a predefined distance range due to camera limitations.
2. Hand poses are captured without obstruction by other objects.
3. The system is intended for indoor use, as the selected camera does not perform well under sunlight conditions.



The proposed system architecture comprises two modules: data acquisition, pre-processing, and feature extraction, followed by sign language gesture classification.

Methodology:

Dataset:

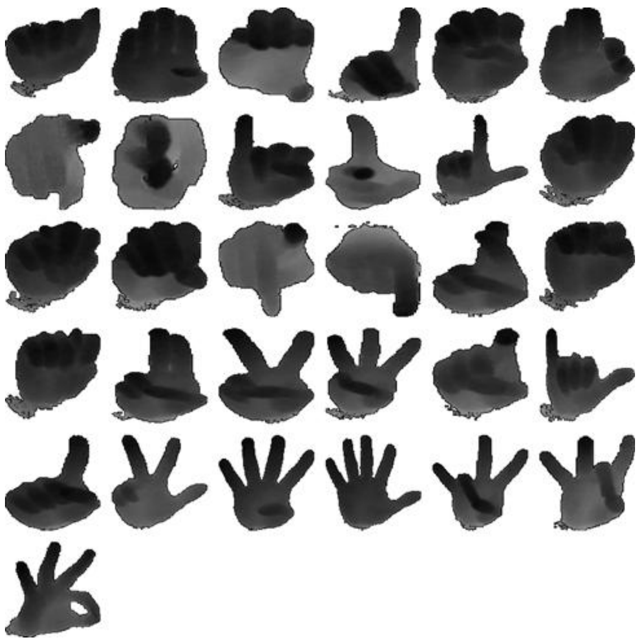
We have gathered a dataset consisting of 31,000 depth maps captured using a depth sensor, specifically the Creative Senz3D camera, with a resolution of 320."

"The dataset comprises 1,000 images for each of the 31 distinct hand signs, captured from five subjects. These signs encompass all finger spellings of both alphabets and numbers, excluding J and Z, which necessitate temporal information for classification. Notably, the differentiation between (2/V) and (6/W) relies on contextual cues, leading to the amalgamation of these signs into a single class representing both an alphabet and a number. To maintain clarity and avoid ambiguity among signers, formal signs are predominantly chosen over informal variants. Collection of the dataset involves capturing images from various viewpoints, with subjects moving their hands across both the image plane and along the z-axis.

Hand Segmentation:

Our approach assumes that the user's hand is the closest object to the camera. This assumption holds particularly true in fingerspelling scenarios and in most gesture recognition tasks.

"The captured image, prior to preprocessing, prominently features the hand as the nearest object, as indicated by the depth map. Notably, there exists a distinct depth void surrounding the hand, providing an opportunity for effective hand segmentation through the identification of connected components within the region closest in depth."



From a data separation perspective, we explore two scenarios: one where subjects are not separated into distinct sets for training, validation, and testing, and another where data from different subjects are utilized for each of these stages."

The integration of the internet into education, especially in higher education, has led to profound changes in the dynamics of learning and communication. The internet has emerged as a pivotal platform for both students and educators to exchange and access information, playing a crucial role in the creation of learning materials, instructional delivery, and course management. The adoption of e-learning methodologies for teaching and learning has witnessed a rapid ascent in recent years, driven by advancements in technical infrastructure supporting the deployment of e-learning courses within academic institutions.

E-Learning, characterized by the utilization of innovative multimedia technologies and the internet, aims to enhance the quality of learning by improving accessibility to educational resources and services while facilitating remote interactions and collaborations. However, as educational technology continues to evolve and researchers harness these emerging tools, arriving at a consensus regarding a unified definition and terminology for the e-learning paradigm has become increasingly challenging (Rodrigues et al., 2019).

1.1. Students' Perceptions of E-Learning

Understanding students' perspectives on e-learning is pivotal in assessing the quality and effectiveness of the learning experience. Despite the myriad benefits associated with e-learning, such as enhanced communication, collaborative learning, and improved access to resources, student satisfaction remains a prominent concern in e-learning literature. The key findings regarding students' perceptions of e-learning are outlined below.

Student satisfaction serves as a crucial metric for evaluating the quality of e-learning experiences, given the transformative impact of technology on student-instructor and student-peer interactions. A longitudinal study spanning three years examined graduate and undergraduate students' satisfaction with online instruction, defining satisfaction as the learners' perceived value of their educational experiences. Positive interaction with peers and instructors emerged as significant predictors of e-learning satisfaction. Notably, convenience was the most cited reason for satisfaction, while lack of interaction was a common cause of dissatisfaction. Additionally, partially online courses received higher satisfaction ratings compared to fully online courses. Interaction, internet self-efficacy, and self-regulated learning were identified as prominent predictors of student satisfaction in the literature.

Given the inherent isolation of instructors in e-learning environments, fostering interaction is paramount for enhancing student satisfaction. Several studies underscored the positive impact of interaction on students' satisfaction in distance education. Moreover, the design of online content significantly influences interaction and student satisfaction. As students spend a substantial amount of time engaging with online content, factors such as organization, layout, and accessibility play a crucial role in shaping their interaction with course materials.

Internet self-efficacy, reflecting individuals' confidence in navigating online tasks, is closely associated with positive outcomes and satisfaction with online courses. Consequently, institutions must provide adequate internet skills training to students to enhance their internet self-efficacy before implementing online courses. Additionally, self-regulated learning, encompassing student motivations and strategies for achieving learning objectives, plays a pivotal role in e-learning success. Future research should explore the impact of self-regulation on student satisfaction in e-learning settings.

A study assessing the impact of an e-learning platform on learning outcomes in a European university revealed significant improvements in professor-student communication and student satisfaction with courses utilizing the platform. Notably, students using the platform demonstrated higher rates of homework submission and course attendance compared to traditional methods, highlighting the efficacy of e-learning platforms in increasing student engagement.

Overall, students value clearly structured learning materials, support for self-regulated learning, and effective information dissemination in e-learning environments. While both online and traditional learning environments offer unique advantages, achieving a good fit between students and courses is essential for optimizing learning outcomes. In some cases, students may prefer online courses, while in others, traditional classroom settings may be more conducive to their learning needs.

2. Methodology

2.1. Investigative Site and Participants

The authors initiated a discussion on terminology disparities by conducting a poster presentation at an educational technology conference in 2009. This platform also served as a data collection opportunity. The strategic approach aimed to enhance accessibility for conference attendees with disabilities, facilitating engagement with diverse practitioners and researchers in the field of learning environments. A total of 43 conference participants from various continents contributed to the study by completing a nine-question survey (Moore et al., 2011).

2.2. The Instrument

The survey comprised one open-ended question and eight questions featuring checkboxes for respondents to select their answers. The questionnaire commenced with an open-ended query prompting participants to delineate the distinctions among distance learning, e-learning, and hybrid learning modalities. Subsequently, respondents were queried about their roles within the learning environment. The final open-ended question aimed to elicit insights into the overarching features characterizing the learning environment in which the participants were involved. The subsequent four questions presented scenarios, requiring respondents to select the most suitable term to describe each setting from a range of options, including types of learning environments and potential labels for teaching resources (Moore et al., 2011).

3. Findings

3.1. Perception of Terminology

The first question of the survey, "Is there a distinction between distance learning, e-learning, and online learning? If so, please clarify," elicited considerable interest among participants. Many participants endeavored to elucidate the disparities through verbal descriptions or diagrams. Table 1 summarizes the diverse range of responses, categorizing them into themes such as "No Difference," "Hierarchical Organization," "Media Type," "Access Type," "Difference," "Interaction Type," and "Correspondence." Notably, the hierarchical relationship between concepts emerged, with participants delineating parent-child relationships to represent sublevels within broader descriptions of the learning environment.

The survey yielded intriguing insights. One participant considered the term "distance learning" outdated and seldom used, while another questioned its relevance. This prompted a return to the survey's initial objective: to comprehensively understand and predict specific aspects of the learning environment based on terminology usage. However, achieving this proved challenging without insight into distribution mechanisms and student interaction patterns (Moore et al., 2011).

Additionally, participation in online and e-learning activities did not significantly differ among respondents from different continents. Notably, individuals from Europe, Australia, and Asia selected twice as many learning environment descriptors compared to those from North America (Moore et al., 2011).

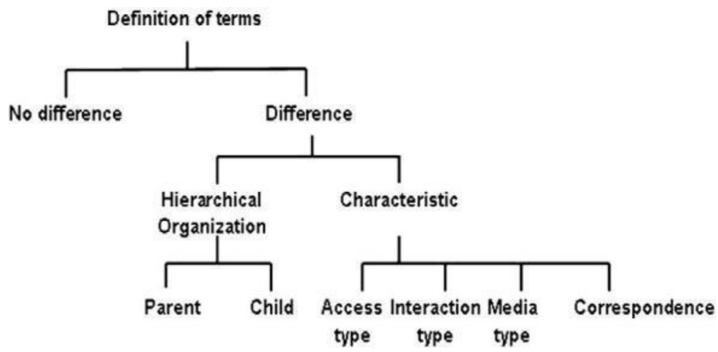
3.3. Data Collection

To encourage participation and foster engagement, participants were invited to partake in discussions on the subject matter, with a minor incentive offered to enhance their interest. Individuals displaying interest during the initial discussions were encouraged to further contribute by completing a survey. The survey, designed to gather comprehensive insights, required approximately ten minutes for completion on average. Following the completion of all questionnaires, the collected data underwent coding and analysis utilizing mixed methods (Moore et al., 2011).

3.4. Data Analysis

The survey responses were consolidated using a Microsoft Excel spreadsheet as a primary data management tool. Analysis of the responses to question one employed qualitative methods, initially employing open coding techniques followed by axial coding to classify and integrate emerging themes (Creswell, 2007). Six overarching themes emerged from this process: "No Difference," "Difference," "Hierarchical Relationship," "Access," "Interaction," "Media Type," and "Correspondence." A visual representation illustrating these themes is presented in Figure X.

To establish connections between the concepts, the remaining survey questions underwent general statistical analysis. Given that multiple options could be selected for most questions, the total frequency of replies exceeded 43 (Moore et al., 2011).



3.2. Participant Demographics and Engagement

The survey captured responses from individuals representing at least twelve different countries. Specifically, three respondents hailed from Australia, eleven from Asia, ten from Europe, eleven from North America, and ten participants were unclassified. Participants were queried about their involvement in distance, online, or e-Learning courses. The data revealed that twenty-four individuals, constituting 56 percent of respondents, had engaged in all three types of learning environments (see Table 2).
Among the findings, it was observed that distance learning events garnered more participation from individuals in Europe, Asia, and Australia compared to other continents. However, there was no significant disparity in the origin of participants involved in online and e-Learning events. Notably, respondents from Europe, Australia, and Asia displayed a propensity to select a broader range of learning environments compared to those from North America (Moore et al., 2011).

4.3. Roles within the Learning Environment

Among the respondents, the most common roles identified were "students" (31 replies) and "instructors" (30 replies). Nine respondents selected all available roles, including student, instructor/facilitator, designer, and evaluator. However, two participants did not specify a role: one respondent mentioned "researcher" under the "other" category, while another mentioned "teacher" (Moore et al., 2011).

4.1Learning environment characteristics and tools

The participants' experiences regarding instructional aspects and tools within the learning environment were also collected. Respondents highlighted various instructional qualities present in their learning environment, including "assignments" (33), "other students" (32), "modules" (29), "deadlines" (31), and "instructor/facilitator" (33). Twenty-one respondents reported that their learning environment encompassed all of these instructional features.
Regarding technology tools/techniques, discussion boards and email emerged as the most frequently mentioned. Notably, only one respondent indicated that their learning environment incorporated all of the specified technology tools and approaches (Moore et al., 2011).

4.5. Classification of Learning Environments Based on Scenarios

Survey participants were presented with learning environment scenarios and instructed to select the most appropriate description from a list of nine options for the final survey questions. In Scenario 1, 57 percent of respondents opted for online learning, while 19 percent selected both eLearning and online. Scenario 2, resembling Scenario 1 but featuring student-instructor face-to-face interactions, resulted in 51 percent of respondents choosing a hybrid learning environment, with 22 percent opting for online learning. Scenario 3 showed less consensus, with 43 percent favoring an e-Learning environment, while 14 percent each chose online learning and other options. The remaining 33 percent was distributed among five alternative choices.

Scenario 4, devoid of any student-to-student or instructor-to-student interactions, saw 32 percent of respondents selecting online learning and 19 percent choosing e-Learning. Six respondents struggled to determine the most appropriate term for each scenario, selecting more than three options. Consequently, these responses were excluded from the study's analysis. (Moore et al., 2011.

4.Limitations

This study delved into various conceivable systems and their key success factors. While there exists research on general education and e-learning, there is a dearth of literature on the impact of pandemics, such as the current global predicament with COVID-19. One limitation of multi-criteria decision analysis techniques is their sensitivity to complexity, contingent upon the viewpoint from which the research is approached. Consequently, identical tools may yield divergent outcomes, contingent upon whether the topic was examined from the student's perspective or otherwise. Disparities in perspectives and regulations also exist among different countries. (Alqahtani & Rajkhan, 2020)

Discussion

This study reveals that focusing solely on the merits and demerits of technology overlooks the broader factors influencing students' utilization of technology as a supportive tool. Access to technology and computer skills are equally crucial to the learning process, alongside students' motivation, peer influence, and study strategies. The study aimed to address two fundamental inquiries concerning learning with and through technology: how students employ it and the overall impact of ICT.

It's noteworthy that students approach the study process in much the same manner as they did before the integration of technology. However, the significant difference lies in students' utilization of the Internet as a supplementary resource alongside textbooks to complement lecture and tutorial notes. Moreover, the medium is reshaping students' learning habits, guiding them towards continual revision for online assessments—a practice unattainable if solely reliant on a lecturer editing hundreds of exam scripts three times per semester. Additionally, the medium enables students to review materials at their own pace using flash demos, either during tutorials or at a later time. Large lab sessions posed challenges for questioning, and the tutor struggled to provide individualized instruction due to varying levels of prior Excel proficiency among students.

In higher education, students perceive e-learning as an essential and anticipated aspect of the learning journey. The provision of a unified space for students to access information or extensive materials related to each module is identified as a significant advantage, especially given the limited number of books available in the library. In an end-of-semester survey, over 70% of students expressed satisfaction with the e-learning component of the module.

Educators need to consider the role expected of ICT in the educational process. As per the findings, students view it as a valuable tool in the learning journey, supplementing traditional face-to-face instructional methods. They leverage the medium's flexibility and motivational aspects for continuous study and assessment preparation for final exams. While advancements such as personalized feedback and tailored content are still warranted, the e-learning component is welcomed and anticipated, particularly for large class cohorts. It falls short of the transformative visions of a virtual university but is not regarded as ineffective or misguided support for university-level learning. Instead, e-learning is seen as a value-addition and enhancement in teaching quality, grounded in robust pedagogical rationale, and offering feedback, engagement, and access to course resources. (Concannon et al., 2005)

Conclusions

The divergent responses provided by the participants in this survey echo the discrepancies found in other literature regarding definitions. The inconsistency in language not only impacts researchers seeking to build upon their findings but also designers tasked with crafting similar environments. When the specific context of the learning environment lacks sufficient definition or when its delineation is not prominently featured in both the methodological explanation and other sections of the paper, terminology becomes a challenge. This not only affects the assessment of such learning experiences but also has implications for the future delivery of distance learning initiatives. The results uncover notable disparities in the definitions of crucial terminology utilized in the field. (Moore et al., 2011)

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