PRIOR-ART SEARCH REPORT

ON

“Real-Time Gesture Recognition Glove for Sign-to-Speech Translation”

DATE: 16-May-2025

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1. AIM AND SCOPE

The aim of the search is to identify patent and non-patent literatures that discuss on Real-Time Gesture Recognition Glove for Sign-to-Speech Translation.

2. TECHNICAL FEATURES

The following are the technical features adopted for the search:

- Flex-sensor-based gesture recognition on wearable gloves
- Arduino or microcontroller-based real-time processing
- Bluetooth communication module (e.g., HC-05) for wireless data transfer
- Sentence construction logic from sequential gestures

Mobile application for:

- Displaying recognized gestures
- Text-to-speech (TTS) conversion
- Multilingual support (future scope)

Expandability with additional sensors (e.g., MPU6050 for motion/gyroscope)

AI/ML integration for:

- Gesture recognition improvement
- Natural language processing (NLP)
- Multilingual translation (future enhancement)

3. GEOGRAPHY AND YEAR RESTRICTION

The search is conducted without any geography and year restriction.

4. LIST OF RELEVANT REFERENCES

These references are closely related as they discuss on the following:

S. No	Patent/ Publication Number	Title	Publication Date	Assignee/Inventor
1	US10319257B2	System of converting hand and finger movements into text and audio	2016-09-29	Harun BavunogluElif Saygi Bavunoglu
	Abstract	The invention subject of the application is related to a system which detects movements performed by the hand and converts them to text and/or audio and is comprised of a pair of gloves and at least one data processing module developed to convert sign language used by hearing/speech impaired individuals to spoken language and/or text or to convert hand gestures defined for a particular purpose to audio and/or text.		
	Claims	1. A system for converting hand movements to a text or a speech, the system comprising: two gloves each to wear on a hand and a data processing module; wherein each glove comprises at least five metacarpophalangeal (MCP) flex sensors; at least five proximal interphalangeal (PIP) flex sensors; at least six inertial measurement units, wherein each inertial measurement unit comprises an accelerometer, a magnetometer and a gyroscope; at least four resistive touch sensors; one sensor channel provided for each finger for holding one MCP flex sensor, one PIP flex sensor, one inertial measurement unit and connecting cables together, wherein the sensor channels form a skeleton of the glove; two glove fastening straps for fastening the sensor channel to a corresponding finger; and a control card for collecting movement data received from the at least five MCP flex sensors, the at least five PIP flex sensors, the at least six inertial measurement units, and the at least five resistive touch sensors;		

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		a wireless device for transmitting the movement data from control card to the data processing module; wherein the data processing module processes the movement data and convert the movement data into at least one of the speech or the text; the data processing module includes a touchscreen display for displaying a user interface. 2. The system according to claim 1, wherein the each hand glove further comprises a wrist strap, the sensor channels extend out from the wrist strap. 3. The system according to claim 2, wherein the wrist strap is manufactured of insulated flexible material so as to protect the control card from external factors. 4. The system according to claim 1, wherein the sensor channels are manufactured of insulated flexible material so as to protect the sensors and the sensor connection cables from external factors. 5. The system according to claim 1, wherein the skeletal structure of the glove formed of the sensor channels and the glove fastening straps form a half-open glove structure. 6. The system according to claim 1, wherein the at least five MCP flex sensors are placed on positions corresponding to top of each of the fingers. 7. The system according to claim 1, wherein the PIP flex sensors are placed on positions corresponding to a top of the hand to coincide with PIP bones. 8. The system according to claim 1, wherein five of the six inertial measurement units are placed on an edge of the fingertip side of each MCP sensor and one of the six inertial measurement units is placed on top of the hand in a position to coincide with a central point of the hand.		

S. No	Patent/ Publication Number	Title	Publication Date	Assignee/Inventor
		9. The system according to claim 1, wherein one resistive touch sensor is placed next to each of the six inertial measurement units in the internal sections where each of the fingers but the middle finger are in contact with each other. 10. The system according to claim 1, further comprising a speaker integrated with the data processing module to transmit the speech. 11. The system according to claim 1, wherein the text is displayed on the touchscreen display. 12. A system for converting hand movements to a text or a speech, the system comprising: two gloves, and a data processing module; wherein each glove comprises at least five metacarpophalangeal (MCP) flex sensors; at least five proximal interphalangeal (PIP) flex sensors; at least six inertial measurement units, wherein each inertial measurement unit comprises an accelerometer, a magnetometer and a gyroscope; at least four resistive touch sensors; one sensor channel provided for each finger for holding one MCP flex sensor, one PIP flex sensor, one inertial measurement unit and connecting cables together, wherein the sensor channels form a skeleton of the glove; two glove fastening straps for fastening the sensor channel to a corresponding finger; and a control card for collecting movement data received from the at least five MCP flex sensors, the at least five PIP flex sensors, the at least six inertial measurement units, and the at least five resistive touch sensors; a wireless device for transmitting the movement data from control card to the data processing module; a wrist strap, the sensor channels extend out from the wrist strap;		

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		wherein the at least five MCP flex sensors are placed on positions corresponding to top of each of the fingers; wherein the PIP flex sensors are placed on positions corresponding to a top of the hand to coincide with PIP bones; wherein five of the six inertial measurement units are placed on an edge of the fingertip side of each MCP sensor and one of the six inertial measurement units is placed on top of the hand in a position to coincide with a central point of the hand wherein the data processing module processes the movement data and convert the movement data into at least one of the speech or the text; the data processing module includes a touchscreen display for displaying a user interface.		
	Summary	This patent describes a glove system that detects hand movements and converts them into text and/or audio, addressing limitations in prior art by incorporating flex sensors and accelerometers for comprehensive gesture recognition.		

S. No	Patent/ Publication Number	Title	Publication Date	Assignee/Inventor
2	US11919159B1	Multipurpose robotic glove designed to teach sign language through guided manual motions	2024-03-05	Raaghav MalikSoham Joshi
	Abstract	A wearable device is disclosed. The wearable device comprises a glove, fingers, and one or more finger band cable guides connected to each of the fingers. A servo mount is coupled to the glove and a plurality of extension and flexion servo motors are coupled to the		

S. No	Patent/ Publication Number	Title	Publication Date	Assignee/Inventor
		servo mount. A plurality of flexion cables and a plurality of extension cables are coupled to the plurality of extension and flexion servo motors and the fingers. An abduction and adduction servo motor is coupled to an abduction and adduction servo motor mount coupled to the glove. A controller actuates the plurality of extension and flexion servo motors and the abduction and adduction servo motor to move the finger portions. The wearable device further comprises a gyroscope to measure wrist movement and at least one vibration motor to provide haptic feedback to a wearer.		
	Claims	1. A method for controlling a wearable glove device, the method comprising: receiving an image of a hand; determining a plurality of keypoints associated with a hand position depicted in the image of the hand; transforming the plurality of keypoints into a reference control signal comprising a signal for a plurality of servo motors and at least one vibration motor; associating the reference control signal with the hand position depicted in the image of the hand; storing the reference control signal associated with the hand position in a control signal library, the control signal library comprising a plurality of stored reference control signals; determining a desired hand position; identifying one of the plurality of stored reference control signals from the control signal library which corresponds to the desired hand position; applying the one of the plurality of stored reference control signals to the plurality of servo motors to control motion of the wearable glove device; and		

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		applying the reference control signal to the at least one vibration motor to control vibration of the at least vibration motor. 2. The method of claim 1, wherein the plurality of keypoints are associated with locations of joints of fingers of the hand. 3. The method of claim 2, wherein transforming the plurality of keypoints into a reference control signal comprises determining a desired angle for one or more keypoints for one or more fingers of the hand. 4. The method of claim 3, wherein determining a desired angle for one or more keypoints comprises determining a dot product between a first vector pointing away from the one or more keypoints and a second vector pointing away from the one or more keypoints. 5. The method of claim 4, further comprising determining a total angle for the one or more fingers by summing desired angles for the one or more keypoints. 6. The method of claim 1, wherein applying the reference control signal to the at least one vibration motor to control vibration of the at least vibration motor further comprises applying an increasingly stronger reference control signal as the hand conforms to the desired hand position. 7. The method of claim 6, wherein the increasingly stronger reference control signal causes the vibration motor to increase a vibration frequency. 8. The method of claim 1, further comprising providing auditory feedback identifying the desired hand position to a wearer of the wearable glove device. 9. The method of claim 1, further comprising providing visual feedback identifying the desired hand position to a wearer of the wearable glove device.		

S. No	Patent/ Publication Number	Title	Publication Date	Assignee/Inventor
		10. The method of claim 1, wherein the wearable glove device is controlled to form a sign language symbol.		
	Summary	This invention focuses on a glove that teaches sign language by guiding users through motions, utilizing servo motors and cable guides to simulate finger movements.		

S. No	Patent/ Publication Number	Title	Publication Date	Assignee/Inventor
3	US11263409B2	System and apparatus for non-intrusive word and sentence level sign language translation	2022-03-01	Michigan State University MSU
	Abstract	A sign language translation system may capture infrared images of the formation of a sign language sign or sequence of signs. The captured infrared images may be used to produce skeletal joints data that includes a temporal sequence of 3D coordinates of skeletal joints of hands and forearms that produced the sign language sign(s). A hierarchical bidirectional recurrent neural network may be used to translate the skeletal joints data into a word or sentence of a spoken language. End-to-end sentence translation may be performed using a probabilistic connectionist temporal classification based approach that may not require pre-segmentation of the sequence of signs or post-processing of the translated sentence.		
	Claims	1. A method for translating sign language communications into spoken language communications, comprising:		

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		receiving, with a processor, a temporal sequence of images corresponding to at least one hand forming a sign language sign; determining skeletal joints data of the at least one hand forming the sign language sign based on the temporal sequence of images, wherein the skeletal joints data of the at least one hand forming the sign language sign comprises skeletal joints data of a right hand and a left hand; with the processor, extracting spatiotemporal sign language characteristic trajectories based on the skeletal joints data, wherein the spatiotemporal sign language characteristic trajectories comprise right hand shape information, left hand shape information, right hand movement information, and left hand movement information; providing spatio-temporal information corresponding to the sequence of images, including, the spatiotemporal sign language characteristic trajectories, to a first bidirectional recurrent neural network (B-RNN) layer of a hierarchical bidirectional recurrent neural network (HB-RNN); with the first B-RNN, producing a representation of the spatio-temporal information; and producing, via additional layers of the HB-RNN, a translated word of a spoken language that corresponds to the sign language sign based on the representation. 2. The method of claim 1, further comprising applying a Savitzky-Golay filter to the skeletal joints data before providing the spatio-temporal information to the first B-RNN layer. 3. The method of claim 1, wherein the skeletal joints data of the at least one hand forming the sign language sign comprises skeletal joints data of a right hand and a left hand, and the method further comprising:		

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		with the processor, extracting right hand shape information and left hand shape information by normalizing the skeletal joints data to a zero-centered palm-center of the hands by subtracting a skeletal joint index for the palm-center from the skeletal joints data; and with the processor, extracting right hand movement information and left hand movement information by calculating spatial displacements of each skeletal joint of the skeletal joints data between two consecutive frames of the frames. 4. The method of claim 1, further comprising: providing the right hand shape information, the left hand shape information, the right hand movement information, and the left hand movement information to separate RNN units of the first B-RNN layer of the HB-RNN; and wherein producing the information comprises with the first B-RNN layer, producing a representation of right hand shape, a representation of right hand movement, a representation of left hand shape, and a representation of left hand movement. 5. The method of claim 4, further comprising: with the first B-RNN layer, providing the representation of right hand shape, the representation of right hand movement, the representation of left hand shape, and the representation of left hand movement to a first fusion layer of the HB-RNN; and with the first fusion layer, producing a first concatenation matrix by concatenating the representation of right hand shape with the representation of right hand movement; and with the first fusion layer, producing a second concatenation matrix by concatenating the representation of left hand shape with the representation of left hand movement. 6. The method of claim 5, further comprises:		

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		with the first fusion layer, providing the first concatenation matrix and the second concatenation matrix to a second B-RNN layer of the HB-RNN; with the second B-RNN layer, producing an integrated representation of right hand characteristics based on the first concatenation matrix; and with the second B-RNN layer, producing an integrated representation of left hand characteristics based on the second concatenation matrix. 7. The method of claim 6, further comprising: with the second B-RNN layer, providing the integrated representation of right hand characteristics and the integrated representation of left hand characteristics to a second fusion layer of the HB-RNN; and with the second fusion layer, producing a third concatenation matrix by concatenating the integrated representation of right hand characteristics with the integrated representation of left hand characteristics. 8. The method of claim 7, further comprising: with the second fusion layer, providing the third concatenation matrix to a third B-RNN layer of the HB-RNN; and with the third B-RNN layer, producing a high level sign language representation based on the third concatenation matrix. 9. The method of claim 8, further comprising: with the third B-RNN layer, providing the high level sign language representation to a fully connected layer of the HB-RNN; and with the fully connected layer, producing an output matrix based on the high level sign language representation. 10. The method of claim 9, further comprising: with the fully connected layer, providing the output matrix to a softmax layer of the HB-RNN;		

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		with the softmax layer, producing a cumulative output matrix by summing the output matrices for all frames of the skeletal joints data; and with the softmax layer, determining a word corresponding to the sign language sign by comparing the cumulative output matrix to a trained sign language dictionary. 11. The method of claim 10, further comprising: with the processor, reproducing the determined word by: instructing a screen to show the determined word; or instructing a speaker to reproduce the determined word as audible sound. 12. The method of claim 1, further comprising: receiving, with a processor, a different temporal sequence of images corresponding to at least one hand forming a sign language sign; determining continuous temporal hand shape and hand movement trajectories from the different sequence of images; and processing the continuous temporal hand shape and hand movement trajectories using the HB-RNN to produce a translated sentence of a spoken language that corresponds to a sign language sentence reflected in the temporal sequence of image and the different temporal sequence of images. 13. A system for translating sign language signs into words of a spoken language, comprising: at least one processor; and a memory connected to the at least one processor having stored thereon a set of instructions which, when executed by the at least one processor, cause the at least one processor to: receive a spatiotemporal sequence of skeletal data corresponding to hands communicating a series of signs forming a sentence in a		

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		sign language, wherein the spatiotemporal sequence of skeleton data comprises skeletal representations of two hands; determine right hand shape, left hand shape, right hand movement, and left hand movement for each frame of the spatiotemporal sequence of skeletal data during communication of the series of signs, and use such information as input to a neural network; process the spatiotemporal sequence of skeletal data using a first bidirectional recurrent neural network (B-RNN) layer of the neural network, wherein the neural network is trained to output a sentence of a spoken language corresponding to the sentence of the sign language, wherein the spoken language and sign language are different languages; and output the sentence of the spoken language to a user. 14. The system of claim 13, wherein the neural network performs sentence-level translation using separate RNN units of the first B-RNN layer of the neural network for each of the right hand shape, left hand shape, right hand movement, and left hand movement.		
	Summary	This patent presents a system that translates sign language at the word and sentence levels without intrusive equipment, emphasizing real-time processing and user comfort.		

Scientific Literature:

S. No	Scientific Literature - Title		Publication Date	Authors
1	Textronic Glove Translating Polish Sign Language		8-Sep-2022	Ewa Korzeniewska et al
	Abstract	Communication between people is a basic social skill used to exchange information. It is often used for self-express and to meet basic human needs, such as the need for closeness, belonging, and security. This process takes place at different levels, using different means, with specific effects. It generally means a two-way flow of information in the immediate area of contact with another person. When people are communicating using the same language, the flow of information is much easier compared to the situation when two people use two different languages from different language families. The process of social communication with the deaf is difficult as well. It is therefore essential to use modern technologies to facilitate communication with deaf and non-speaking people. This article presents the results of work on a prototype of a glove using textronic elements produced using a physical vacuum deposition process. The signal from the sensors, in the form of resistance changes, is read by the microcontroller, and then it is processed and displayed on a smartphone screen in the form of single letters. During the experiment, 520 letters were signed by each author. The correctness of interpreting the signs was 86.5%. Each letter was recognized within approximately 3 s. One of the main results of the article was also the selection of an appropriate material (Velostat, membrane) that can be used as a sensor for the proposed application solution. The proposed solution can enable communication with the deaf using the finger alphabet, which can be used to spell single words or the most important key words.		

S. No	Scientific Literature - Title		Publication Date	Authors
	Summary	A study on a glove utilizing bend sensors made from conductive textiles to translate Polish Sign Language into text, highlighting the use of self-made sensors for cost-effectiveness.		

S. No	Scientific Literature - Title		Publication Date	Authors
2	Sign Language Transformers: Joint End-to-end Sign Language Recognition and Translation		30-Mar-2020	Necati Cihan Camgoz, Oscar Koller, Simon Hadfield, Richard Bowden
	Abstract	Prior work on Sign Language Translation has shown that having a mid-level sign gloss representation (effectively recognizing the individual signs) improves the translation performance drastically. In fact, the current state-of-the-art in translation requires gloss level tokenization in order to work. We introduce a novel transformer based architecture that jointly learns Continuous Sign Language Recognition and Translation while being trainable in an end-to-end manner. This is achieved by using a Connectionist Temporal Classification (CTC) loss to bind the recognition and translation problems into a single unified architecture. This joint approach does not require any ground-truth timing information, simultaneously solving two co-dependant sequence-to-sequence learning problems and leads to significant performance gains. We evaluate the recognition and translation performances of our approaches on the challenging RWTH-PHOENIX-Weather-2014T (PHOENIX14T) dataset. We report state-of-the-art sign language recognition and translation results achieved by our Sign Language Transformers. Our translation networks outperform both sign video		

S. No	Scientific Literature - Title		Publication Date	Authors
		to spoken language and gloss to spoken language translation models, in some cases more than doubling the performance (9.58 vs. 21.80 BLEU-4 Score). We also share new baseline translation results using transformer networks for several other text-to-text sign language translation tasks.		
	Summary	Research introducing a transformer-based architecture for continuous sign language recognition and translation, emphasizing the integration of recognition and translation tasks.		

5. KEYWORDS

gesture recognition, hand gesture detection, sign language recognition, finger movement detection, alphabet detection, sign input

flex sensor, bend sensor, MPU6050, gyroscope sensor, accelerometer, Arduino Nano, microcontroller, wearable electronics, glove-based system

Bluetooth, HC-05, wireless module, wireless communication, real-time data transmission, Bluetooth pairing

text display, mobile application, text-to-speech, TTS, speech output, sentence formation, real-time output, Android app

multilingual, language translation, Google Translate API, AI translation, NLP, machine translation, TensorFlow Lite, ML model

sensor fusion, dynamic gestures, modular glove, American Sign Language, ASL, motion detection, gesture expansion

6. DATABASES USED

Patent Literatures

PatBase

Espacenet (EPO)

USPTO PatFT/AppFT

WIPO PATENTSCOPE

Google Patents

IP India

Non-Patent Literatures

Google Scholar

PubMed

ScienceDirect (Elsevier)

IEEE Xplore

7. OPINION AND SUGGESTIONS

1. Novelty [Section 2(1)(j)]

- Real-time sentence formation (vs. single alphabet output)
- Bluetooth wireless transmission
- Multilingual speech output via app
- Future scope of AI-based language translation + sensor fusion

These elements together are not found in single prior art.

2. Inventive Step [Section 2(1)(ja)]

Although flex sensors + gloves + Bluetooth are known, your method of sentence construction, mobile multilingual TTS, and expandability with AI/ML for translation/motion detection can form a synergistic technical advancement, satisfying inventive step

3. Industrial Applicability

Clearly industrially applicable, especially for speech-impaired users.

Decision

The subject case is patentable.