

S. Jiang *et al.*, "Developing a wearable wrist glove for fieldwork support: A user activity-driven approach," *2014 IEEE/SICE International Symposium on System Integration*, Tokyo, 2014, pp. 22-27.

doi: 10.1109/SII.2014.7028005

Abstract: This paper presents a wearable assistance system for service and maintenance personnel in industrial facilities, when used together with mobile smart devices. It provides a practical interaction metaphor designed to fully utilize the user's physical activities, such as touch and hand gestures. As a result of a user activity-driven design approach, the presented system frees user from various constraints during various working operations. Especially, our new developed gesture input method enables the user to immediately interact with services using one-handed motions in an arbitrary postures. Furthermore, an event-driven architecture is proposed to solve the power management problem. We also developed a wristwatch-like wearable device to evaluate the effectiveness of the proposed method. The results presented in this paper demonstrate that the proposed system not only allows for effective and satisfactory service but also cuts down on errors and oversights. Finally, potential applications of this research that include design guidelines for future interface configurations are discussed.

keywords: {data gloves;gesture recognition;human computer interaction;mobile computing;personnel;event-driven architecture;fieldwork support;gesture input method;industrial facilities;interaction metaphor;interface configuration design guidelines;maintenance personnel;mobile smart devices;motion gesture recognition;power management problem;service personnel;touch-based tangible interface;user activity-driven design;wearable assistance system;wearable wrist glove;wristwatch-like wearable device;Computer architecture;Context;Maintenance engineering;Mobile communication;Power demand;Wearable computers;Wrist},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7028005&isnumber=7027993>

A. Cañizares, J. Pazos and D. Benítez, "On the use of 3D printing technology towards the development of a low-cost robotic prosthetic arm," *2017 IEEE International Autumn Meeting on Power, Electronics and Computing (ROPEC)*, Ixtapa, 2017, pp. 1-6.

doi: 10.1109/ROPEC.2017.8261579

Abstract: This article explores the feasibility of using 3D-printable technology towards the development of low cost robotic prosthetics. As an initial validation, two prototypes were fabricated: a hand with 5 fingers controlled by a wearable instrumented glove and a hand-arm that can be controlled by flexing any muscle in the user's arm through a sensor that collects electromyographic (EMG) signals from the muscle. Finger motions were controlled by servomotors which work as actuators while the rotation of each servomotor was controlled using microcontrollers. The aim was to demonstrate the feasibility of using 3D printing technology for building a prototype of a controlled hand as a first step towards the development of low cost prosthesis as a possible aid for low income people with disabilities.

keywords: {actuators;biomechanics;data gloves;dexterous manipulators;electromyography;handicapped aids;medical robotics;medical signal processing;microcontrollers;prosthetics;servomotors;three-dimensional printing;3D printing technology;3D-printable technology;EMG;controlled hand;electromyographic signals;finger motions;hand-arm;low cost prosthesis;low cost robotic prosthetics;low income people;low-cost robotic prosthetic arm;microcontrollers;muscle;servomotor;wearable instrumented glove;Electromyography;Muscles;Prosthetics;Prototypes;Robot sensing systems;Servomotors;3D-printable;Bionic Arm;EMG;Low Cost Prosthesis;Myoelectric Sensor;Prosthesis;Prosthetic Arm},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8261579&isnumber=8261569>

M. Ariyanto, R. Ismail, J. D. Setiawan and Z. Arifin, "Development of low cost supernumerary robotic fingers as an assistive device," *2017 4th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, Yogyakarta, 2017, pp. 1-6.

doi: 10.1109/EECSI.2017.8239172

Abstract: This paper presents the development of new type of wearable robot namely Supernumerary Robotic Finger (SRF) as an assistive robot for healthy people or people with hemiparesis or hemiplegia. SRF comprises of two manipulators attached in user's wrist. Three flex sensors are utilized to measure the finger bending of the user's finger. The posture of SRF is driven by modified glove sensor. The kinematics of both robotic thumb (RT) and robotic finger (RF) is studied using D-H parameter method and RoboAnalyzer software in order to understand the kinematic behavior of this robot. Each of RT and RF has three degrees of freedom (DOF). The posture of RT and RF is controlled using bending angles of thumb and finger from the user that are read by flex sensor. Based on the experimental results for people with healthy hand, the proposed SRF can assist object manipulation task in grasping, holding, and manipulating an object by using single hand when normally it only can be done by using two hands. From the experimental results on a person with healthy hand, the proposed of SRF can be employed as an assistive device for people with hemiparesis or hemiplegia. This device will enable people with diminished hand function work more independently.

keywords: {bending;biomechanics;dexterous manipulators;handicapped aids;manipulator kinematics;medical robotics;motion control;wearable robots;SRF;assistive device;assistive robot;flex sensor;healthy people;hemiparesis;hemiplegia;kinematic behavior;low cost supernumerary robotic fingers;modified glove sensor;object manipulation task;wearable robot;Flexible printed circuits;Radio frequency;Robot sensing systems;Thumb;assistive device;flex sensor;kinematics;supernumerary robot},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8239172&isnumber=8239062>

A. F. Hassanin, D. Steve and N. M. Samia, "A novel, soft, bending actuator for use in power assist and rehabilitation exoskeletons," *2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Vancouver, BC, 2017, pp. 533-538.

doi: 10.1109/IROS.2017.8202204

Abstract: This article presents the development of a fully soft, exoskeleton robot for power augmentation and rehabilitation of a human wrist joint. The system is powered by novel bending pneumatic muscles which have been combined with contractor pneumatic muscles to provide actuation for the glove. This research has assessed the behaviour of the new bending actuators and demonstrated them in a prototype wrist exoskeleton. An accompanying mathematical model of the force generated by the proposed extensor bending artificial muscles has been developed. The proposed wearable robot is capable of producing flexion-extension and abduction-adduction motions of the human wrist to generate rehabilitation motions. The exoskeleton is designed to fit any adult hand size without the need for any mechanical changes, meaning it can easily be swapped between users.

keywords: {actuators;bending;biomechanics;dexterous manipulators;medical control systems;medical robotics;muscle;patient rehabilitation;abduction-adduction motions;artificial muscles;bending actuators;contractor pneumatic muscles;exoskeleton robot;flexion-extension;fully soft robot;human wrist joint;power augmentation;prototype wrist exoskeleton;rehabilitation exoskeletons;rehabilitation motions;wearable robot;Actuators;Bladder;Exoskeletons;Force;Mathematical model;Muscles;Robots},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8202204&isnumber=8202121>

Y. C. Jo *et al.*, "Feasibility of a wearable band type biometric devices using skin spectroscopy," *2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, Banff, AB, 2017, pp. 1903-1907.

doi: 10.1109/SMC.2017.8122895

Abstract: In this work, we studied the feasibility of MSP (Multispectral Skin Photomatrix) module as a new wearable biometric devices. The MSP device measures optical patterns of the wrist skin tissue. Optical patterns consist of 2 $\times$ 16 photocurrent intensities of photodiode arrays, which is generated by optical transmission and diffuse reflection of photons from LED light sources with variable wavelengths into the wrist skin tissue. Optical patterns detected by the MSP device provide information on both surface and subsurface characteristics of the human skin tissue. Totally 73 subjects have been participated in this study, they showed their unique characteristics, as determined by several wavelengths of light. The experimental results show that the best personal identification accuracy can be acquired using a combination of infrared light and yellow light. This novel biometric device, the MSP module, exhibited an excellent false acceptance rate (FAR) of 0.292% and a false rejection rate (FRR) of 3.539%, which are similar value of another biometric technologies such as voice or face recognition, etc. From these experimental results, we found that people exhibit unique optical patterns of their inner-wrist skin tissue and this uniqueness could be used for developing novel high-accuracy personal identification devices.

keywords: {authorisation;biometrics (access control);light emitting diodes;photoconductivity;photodiodes;skin;wearable computers;FAR;LED light sources;MSP module;Multispectral Skin Photomatrix;excellent false acceptance rate;experimental results;high-accuracy personal identification devices;human skin tissue;infrared light;inner-wrist skin tissue;novel biometric device;optical patterns;optical transmission;photocurrent intensities;skin spectroscopy;subsurface characteristics;unique optical patterns;variable wavelengths;wearable band type biometric devices;yellow light;Biomedical optical imaging;Light emitting diodes;Optical reflection;Photoconductivity;Photodiodes;Skin;Wavelength measurement;Multi-spectral;Tissue optics;analysis;biometrics;pattern},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8122895&isnumber=8122565>

H. T. Jung, H. Kim, J. Jeong, B. Jeon, T. Ryu and Y. Kim, "Feasibility of using the RAPAE Smart Glove in upper limb physical therapy for patients after stroke: A randomized controlled trial," *2017 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, Seogwipo, 2017, pp. 3856-3859.

doi: 10.1109/EMBC.2017.8037698

Abstract: We aim to assess the feasibility of using the RAPAE Smart Glove as an assistive tool for therapists in clinical rehabilitation therapy settings and to investigate if it can be used to improve the motor recovery rate of stroke survivors. Our randomized controlled study involved 13 post-stroke inpatients. An experimental treatment consisted of one 30-minute game-assisted therapy and one 30-minute conventional therapy per day while the control treatment consisted of two 30-minute conventional therapies. Each therapy block consisted of 15 days over a period of 3 weeks. The measured outcomes were the scores on the Wolf Motor Function Test and the active range of motion for the forearm and the wrist. The mean Wolf Motor Function Test score for the group that received game therapies as well as conventional therapies was significantly higher than that for the group who received only conventional therapies. The results suggest that the motor recovery rate of the clinical rehabilitation therapies can be improved when wearable sensors and therapeutic games are used by therapists in their routine therapy practice.

keywords: {biomechanics;computer games;medical disorders;patient rehabilitation;patient treatment;RAPAE smart glove;clinical rehabilitation therapy;forearm;game-assisted therapy;motor recovery rate;routine therapy practice;stroke;therapeutic game;upper limb physical therapy;wearable sensor;wolf motor function test;wrist;Games;Hospitals;Motion measurement;Tools;Wearable sensors;Wrist},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8037698&isnumber=8036736>

P. Menghani, S. Barthwal and S. Bansal, "An extreme helping hand for handicap people: Using computer vision," *2016 International Conference on Recent Advances and Innovations in Engineering (ICRAIE)*, Jaipur, 2016, pp. 1-5.

doi: 10.1109/ICRAIE.2016.7939564

Abstract: in today's scenarios world is struggling to develop new technologies for handicap people, so that they can also compete in the modern world. The Main existing solutions are prosthetic devices, voice recognition programs, screen readers, and hand gestures recognition, but developing new technologies faces various problems like time, cost and portability. This paper proposes a new perspective by enhancing the existing technology to make it compatible for handicap people (mainly wrist less). This paper adds a new ingredient in field of Human Computer Interaction [1] (HCI) by reshaping the existing computer technology with computer vision and embedded system. The Key notion of our solution is to detect the motion of a wearable tag to operate an entire computer using aggregation and processing of various data.

keywords: {computer vision;embedded systems;handicapped aids;human computer interaction;image motion analysis;object detection;HCI;computer technology;computer vision;data aggregation;data processing;embedded system;extreme helping hand;handicap people;human computer interaction;motion detection;wearable tag;Algorithm design and analysis;Computer vision;Computers;Hardware;Human computer interaction;Image color analysis;Mice;Computer Vision;Embedded System;HCI;OpenCV},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7939564&isnumber=7939460>

S. T. H. Rizvi, M. J. Asif and H. Ashfaq, "Visual impairment aid using haptic and sound feedback," *2017 International Conference on Communication, Computing and Digital Systems (C-CODE)*, Islamabad, 2017, pp. 175-178.

doi: 10.1109/C-CODE.2017.7918924

Abstract: In this paper, implementation of a wearable glove is presented that can be used to assist the visually impaired people. It can help the blind person to avoid hurdles using haptic and voice feedback. It does not only navigate the path to the blind person but also informs about his/her location to others through a message on the mobile device. It can help his/her caretaker (in case he is not near to the blind person) to locate him using the received coordinates from the communication module of glove having Global Positioning System (GPS) and Global System for Mobile Communication (GSM) technology. This wearable glove is physically realized by interfacing different sensors and communication modules with Arduino UNO. Different modes of obstacles detection and alerts are provided using various sensors and actuators to assist visually impaired person.

keywords: {actuators;handicapped aids;haptic interfaces;microcontrollers;sensors;Arduino UNO;GPS technology;GSM technology;Global Positioning System;Global System for Mobile Communication;actuators;haptic feedback;mobile device;obstacle detection;sensors;sound feedback;visual impairment aid;visually impaired people;wearable glove;GSM;Global Positioning System;Haptic interfaces;Microcontrollers;Sensor systems;Arduino;GPS;GSM;Navigation;Obstacle Detection;Visually Impaired;Wearable device},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7918924&isnumber=7918883>

A. J. Jadhav and M. P. Joshi, "AVR based embedded system for speech impaired people," *2016 International Conference on Automatic Control and Dynamic Optimization Techniques (ICACDOT)*, Pune, 2016, pp. 844-848.

doi: 10.1109/ICACDOT.2016.7877706

Abstract: All over the world deaf and dumb people face many problems while communication. There are various challenges experienced by speech and hearing impaired people at public places in expressing themselves to normal people. The objective of this paper is to provide the solution to this problem. To reduce the communication gap between the common people and speech impaired people the proposed system is designed and implemented. The embedded system consist of wearable sensing gloves along with flex sensors which are used to sense the motion of the fingers. Indian sign language is used for determining the words. Flex sensors and accelerometer are used as sensor, these sensors are mounted on the gloves, the movement include the angle tilt, rotation and direction changes, these signals are processed by the microcontroller and playback voice is generated indicating signs through speaker.

keywords: {embedded systems;handicapped aids;microcontrollers;sign language recognition;signal processing;AVR based embedded system;Indian sign language;accelerometer;flex sensors;hearing impaired people;microcontroller;playback voice;signal processing;speech impaired people;Accelerometers;Flexible printed circuits;Gesture recognition;Sensors;Speech;Thumb;Accelerometer;Indian Sign Language;flex sensor;gesture;speech impaired people},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7877706&isnumber=7877540>

H. P. Wang, A. W. Guo, Z. Y. Bi, Y. X. Zhou, Z. G. Wang and X. Y. Lu, "A novel distributed functional electrical stimulation and assessment system for hand movements using wearable technology," *2016 IEEE Biomedical Circuits and Systems Conference (BioCAS)*, Shanghai, 2016, pp. 74-77.

doi: 10.1109/BioCAS.2016.7833728

Abstract: In this paper, a novel distributed functional electrical stimulation (FES) and assessment system for hand movement using wearable technology is proposed. It consists of an FES of wireless EMG-bridge (EMGB) type, a sensor glove and a smartphone-based application software for displaying the virtual 3D hand environment. Combined with the FES therapy and the sensor glove, the proposed system provides a way to evaluate individual responses to rehabilitation among the stroke patients. The smartphone-based application software for displaying the virtual 3D hand environment has been applied to enhance the engagement and motivation needed to drive neuroplastic changes. The prototype system has been validated by performing wrist and finger extension on one healthy subject.

keywords: {body sensor networks;data gloves;electromyography;gait analysis;medical disorders;medical signal processing;patient rehabilitation;patient treatment;smart phones;virtual reality;EMGB;FES therapy;assessment system;distributed functional electrical stimulation;finger extension;hand movements;neuroplastic changes;rehabilitation;sensor glove;smartphone-based application software;stroke patients;virtual 3D hand environment;wearable technology;wireless EMG-bridge type;wrist extension;Electronic countermeasures;Iron;Medical treatment;Three-dimensional displays;Thumb;Wrist;Edison compute module;assessment;electromyography;functional electrical stimulation (FES);rehabilitation;smartphone-based;stroke;wearable technology},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7833728&isnumber=7833706>

D. Popov, I. Gaponov and J. H. Ryu, "Portable Exoskeleton Glove With Soft Structure for Hand Assistance in Activities of Daily Living," in *IEEE/ASME Transactions on Mechatronics*, vol. 22, no. 2, pp. 865-875, April 2017.

doi: 10.1109/TMECH.2016.2641932

Abstract: This paper presents a new portable exoskeleton glove developed for assistance in activities of daily living (ADL). The proposed glove is soft, adjustable, allows unconstrained motion of the wrist, and leaves the palm free for object grasping and manipulation. In the proposed design, both flexion and extension motions of the thumb and three fingers (excluding the little finger) are supported by respective bidirectional actuators. The kinematics of the device were derived and are presented along with an experimental evaluation. The developed glove system is compact and light, with the weights of the wearable part and the whole system being 250 and 340 g, respectively. The maximum pinch force provided by the device was experimentally measured to be 16 N, which gives the proposed device one of the highest power-to-weight ratio among existing portable devices for hand ADL assistance. The usability of the developed device was verified in a series of indoor and outdoor tests. The glove allowed test subjects to hold and manipulate versatile objects with diameters up to 90 mm and weighing 300 g. When powered by a conventional 3000-mAh battery, the glove could operate continuously performing grasping task for 4 h.

keywords: {actuators;assisted living;manipulators;medical robotics;motion control;ADL;activities of daily living;bidirectional actuator;extension motion;flexion motion;hand assistance;manipulation;object grasping;portable exoskeleton glove;soft structure;wrist motion;Actuators;Exoskeletons;IEEE transactions;Mechatronics;Medical treatment;Robots;Wrist;Cable-driven glove;exoskeleton;wearable robot},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7792131&isnumber=7900484>

Mondol, Emi and Stankovic, "MedRem: an interactive medication reminder and tracking system on wrist devices," *2016 IEEE Wireless Health (WH)*, Bethesda, MD, 2016, pp. 1-8.

doi: 10.1109/WH.2016.7764555

Abstract: Medication adherence is pivotal for effective health outcomes. One of the main reasons behind poor medication adherence is forgetfulness, and reminder systems are often used in addressing the problem. This paper presents MedRem, a novel medication reminder and tracking system on wearable wrist devices. The system is handy and interactive, and it is enriched with several useful features. To address the limitations of the tiny display size of the wrist devices, MedRem incorporates speech recognition and text-to-speech features along with clever interface design. Users interact with the system using voice commands as well as using the display available on the device. A dictionary based training approach is used on top of the state of the art speech recognition systems to reduce the errors in recognizing the commands from the users. The system is evaluated for both native and non-native English speakers. The error rates for recognizing voice commands are 6.43% and 20.9% for the native and the non-native speakers, respectively, when a off-the-shelf speech recognition system is used. MedRem reduces the error to nearly zero for both types of users through a dictionary based training approach. On average, only 1.25 and 15 training commands are required to achieve this performance for the native and the non-native speakers, respectively.

keywords: {biomedical communication;dictionaries;patient care;MedRem;dictionary based training approach;interactive medication reminder;interface design;medication adherence;medication tracking system;reminder systems;speech recognition;wrist

devices;Dictionaries;Monitoring;Smart phones;Speech recognition;Stakeholders;Training;Wrist},
 URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7764555&isnumber=7764547>

S. M. Neis and M. I. Blackstun, "Feasibility analysis of wearables for use by airline crew," *2016 IEEE/AIAA 35th Digital Avionics Systems Conference (DASC)*, Sacramento, CA, 2016, pp. 1-9.
 doi: 10.1109/DASC.2016.7778023

Abstract: Jeppesen GmbH is researching new communication and interaction systems for the next generation flight deck. One such opportunity is the determination of use cases for wearable technology in support of airline personnel. Key attributes of wearables, pertinent to the ongoing research efforts, include mobility, persistence, ability to be proactive, and context awareness. Wearables also enable hands-free use. The current study attempts to exploit these characteristics to determine their efficacy in the flight deck. The study used a Sony SmartWatch 3 to test two identified use-cases for wearables by delivering Air Traffic Control commands and other flight relevant information graphically and textually to pilots while conducting flights in a simulator setting. These trials were compared with the delivery of the same information via traditional voice instructions and the Controller-Pilot Data Link Communications screen as is integrated in a Boeing 787 auxiliary panel, next to the Primary Flight Display. A preliminary symbology for Air Traffic Control instructions was developed. In the first experiment, instructions depicted on the SmartWatch were evaluated for subjective usability, subjective workload, performance, and effect on pilot situation awareness. In the study, performance was determined by response time, detection of intentionally placed anomalies in, and the correct execution of Air Traffic Control instructions. Performance from instructions displayed graphically and textually on the SmartWatch was not significantly different than on the datalink communications screen. The three aforementioned methods, however, significantly improved response times in comparison with voice communication with Air Traffic Control. The study also determined that a smartwatch is not preferred by pilots for delivering textual Air Traffic Control commands due to the added workload of turning the wrist to view Air Traffic Control messages. In a second experiment, flight-relevant information was provided on the SmartWatch, such as live field winds and Minimum Equipment List items, in reduced visibility, terminal area operations to test acceptance by pilots. This information was considered useful by pilots. Further research needs to be conducted to understand the interactions between information type, information delivery method, and the effects on pilot acceptance. Additional findings of the two-part study include the preference of graphical data over textual information, and for live field winds to be displayed in field of view, when field winds affect the target threshold speed. The implications of this work are two-fold. Firstly, future research should be conducted to expand on and test the identified use cases of wearables in the aviation industry. Additionally, the representation of Air Traffic Control communications graphically should be investigated on other display areas, e.g. Multi-Functional Display, Head-Up Display, and datalink communication sections on a Primary Flight Display or Flight Management Computer. The symbology needs to be refined and expanded to accurately represent a broader range of Air Traffic Control commands. The graphical representation of information should be investigated further in its ability to improve communication efficiency and reduce analog radio and data link communication errors due to static, accent, and language barriers.

keywords: {aerospace computing;air traffic control;control engineering computing;screens (display);ubiquitous computing;wearable computers;Boeing 787 auxiliary panel;Jeppesen GmbH;Sony SmartWatch 3;air traffic control commands;air traffic control communications;airline crew;airline personnel;aviation industry;context awareness;controller-pilot data link communications screen;flight-relevant information;graphical data;information graphical representation;intentionally placed anomalies detection;live field winds;next generation flight deck;voice instructions;wearable technology;Air traffic control;Biomedical monitoring;Computers;Glass;Industries;Mobile communication;Time factors;Wearables;communication methods;decision support;future flight deck;information abstraction},
 URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7778023&isnumber=7777937>

N. Harish and S. Poonguzhali, "Design and development of hand gesture recognition system for speech impaired people," *2015 International Conference on Industrial Instrumentation and Control (ICIC)*, Pune, 2015, pp. 1129-1133.
 doi: 10.1109/IIC.2015.7150917

Abstract: All over world, deaf and dumb people face struggle in expressing their feelings to other people. There are various challenges experienced by speech and hearing impaired people at public places in expressing themselves to normal people. The solution to this problem is determined in this paper, by the usage of the Indian sign language symbols which are generic to all deaf and dumb people in India. The gestures illustrated by the Indian sign language symbols will be conquered with the support of the flex sensors and accelerometer. The movements included during gesture representation are rotation, angle tilt, and direction changes. The flex sensor and the accelerometer are incorporated over fingers and wrist respectively to acquire their dynamics, a these sensors are fitted over the data glove. These voltage signals will then be processed by microcontroller and sent to voice module, where the words voice outputs are stored and play backed equivalent to each word values to produce the appropriate voice words with the help of the speaker.

keywords: {accelerometers;biomedical measurement;data gloves;handicapped aids;medical control systems;microcontrollers;palmprint recognition;sign language recognition;Indian sign language symbols;accelerometer;angle tilt;data glove;deaf people;direction changes;dumb people;flex sensor;gesture representation;hand gesture recognition system;hearing impaired people;microcontroller;rotation;speaker;speech impaired people;voice module;voice outputs;voice words;voltage signals;word values;Assistive technology;Flexible printed circuits;Gesture recognition;Sensors;Speech;Thumb;Indian sign language;accelerometer and voice module;flex sensors;speech impaired},
 URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7150917&isnumber=7150576>

D. Dutta, B. Champaty, K. Pal and I. Banerjee, "Finger movement based attender calling system for ICU patient management and rehabilitation," *2014 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2014]*, Nagercoil, 2014, pp. 394-397.
 doi: 10.1109/ICCPCT.2014.7054843

Abstract: There is a need of smart attender calling system for efficient patient care especially for those who are unable to communicate with the health caregiver by natural means (vocal communication or through mobility; a common problem in intensive care unit (ICU)). Keeping the aforesaid perspective in mind, here we have developed a hand finger movement based attender calling system which is portable and wearable. The device is prepared by assembling a flex sensor on hand glove platform corresponding to its 'fore finger' position. Finger movement of the patient leads to flexion induced variation in output voltage. The circuit consists of a voltage comparator that compares the aforesaid output with respect to a preset voltage input obtained from a potentiometer (10 kΩ). A comparative voltage ratio of magnitude above 1 enables the comparator to pass an electric signal to an APR9600 voice module located in remote place. This signal plays a prerecorded message from APR9600 module to alert the concerned persons about patient's need. The sensitivity of the

setup can be adjusted by changing preset voltage of potentiometer as per the requirement of the patient. It is believed that the aforesaid system could be useful for ICU patient management and rehabilitation of vocally impaired person.

keywords: {biomechanics;biomedical telemetry;body sensor networks;health care;patient rehabilitation;potentiometers;telemedicine;voice communication;APR9600 voice module;ICU patient management;ICU patient rehabilitation;electric signal;flex sensor assembly;hand finger movement based attender calling system based;hand glove platform;health caregiver;intensive care unit;potentiometer;resistance 10 kohm;vocal communication;vocally impaired person;voltage comparator;wearable device;Flexible printed circuits;Integrated circuits;Light emitting diodes;Potentiometers;Thumb;Voltage measurement;APR9600 voice module;flex sensor;flexion;vocally impaired},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7054843&isnumber=7054731>

Suresh Kumar C and A. Julian, "Wearable messaging device for visually impaired person," *2014 IEEE International Conference on Advanced Communications, Control and Computing Technologies*, Ramanathapuram, 2014, pp. 994-998.

doi: 10.1109/ICACCCT.2014.7019243

Abstract: Today's technology has innumerable wearable solutions to alleviate the problems of disabled persons. The solution presented here is for the visually impaired persons and proposes to develop a wearable device that uses embedded system technology for data input functionalities in a hand glove based keyboard. The hand mounted keypad is easily adaptable by the user and provides flexibility as no prior knowledge is required to handle the hand mounted wearable device. The key glove acts as a prototype which enables the user to have the total functionality of a keyboard in one hand. Key glove is attached with alpha numeric keypad buttons that are mounted on the gloves. The character or number is generated by using mode Selection. (Alpha/Num). The hand mounted keypad can be interfaced with any kind of display device. It can be used for the visually impaired person to send message/call from one person to another using GSM modem. The GSM modem is attached with the gloves. Reply Message from others can be converted into text to voice format using Robo voice shield. The efficiency of the proposed work is evaluated with reference to decreased error rate and increased speed of operation. Voice conversion is also added to this device.

keywords: {cellular radio;data gloves;electronic messaging;embedded systems;handicapped aids;speech synthesis;vision defects;wearable computers;GSM modem;Robo voice shield;alpha numeric keypad buttons;data input functionalities;disabled persons;embedded system technology;hand glove based keyboard;hand mounted keypad;mode selection;text to voice format;visually impaired person;voice conversion;wearable messaging device;wearable solutions;Belts;Computers;Error analysis;GSM;Keyboards;Standards;GSM;Text to Voice Conversion;Wearable input device;alphanumeric keypad;embedded technology;key gloves},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7019243&isnumber=7019129>

A. M. Murray, R. L. Klatzky and P. K. Khosla, "Psychophysical Characterization and Testbed Validation of a Wearable Vibrotactile Glove for Telemanipulation," in *Presence*, vol. 12, no. 2, pp. 156-182, April 2003.

doi: 10.1162/10547460321640923

Abstract: This paper describes and evaluates a high-fidelity, low-cost haptic interface for tele-operation. The interface is a wearable vibrotactile glove containing miniature voice coils that provides continuous, proportional force information to the user's finger-tips. In psychophysical experiments, correlated variations in the frequency and amplitude of the stimulators extended the user's perceptual response range compared to varying amplitude or frequency alone. In an adaptive, force-limited, pick-and-place manipulation task, the interface allowed users to control the grip forces more effectively than no feedback or binary feedback, which produced equivalent performance. A sorting experiment established that proportional tactile feedback enhances the user's ability to discriminate the relative properties of objects, such as weight. We conclude that correlated amplitude and frequency signals, simulating force in a remote environment, substantially improve teleoperation.

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6790440&isnumber=6790407>

J. H. Bae, Y. M. Kim and I. Moon, "Wearable hand rehabilitation robot capable of hand function assistance in stroke survivors," *2012 4th IEEE RAS & EMBS International Conference on Biomedical Robotics and Biomechanics (BioRob)*, Rome, 2012, pp. 1482-1487.

doi: 10.1109/BioRob.2012.6290736

Abstract: In this paper, we propose DULEX-II, a wearable hand robot capable of assisting stroke survivors with hand function rehabilitation. DULEX-II is a robotic orthosis that has three degrees of freedom for assisting motions of the wrist, and all fingers, excluding the thumb. Each exoskeleton mechanism enclosing the wrist and fingers is designed to fit the user's motion trajectory. DULEX-II is actuated by three linear actuators: a double-acting pneumatic cylinder for the wrist and two electric linear motors for the fingers. All mechanisms were analyzed by kinematics, and then a control system for hand rehabilitation was designed. Using the experimental results obtained for self-motion control using a data-glove, we demonstrated that DULEX-II is capable of performing hand rehabilitation exercises similar to those performed in mirror therapy.

keywords: {data gloves;dexterous manipulators;human-robot interaction;manipulator kinematics;medical robotics;motion control;orthotics;patient rehabilitation;pneumatic control equipment;trajectory control;DULEX-II;data-glove;double-acting pneumatic cylinder;electric linear motors;exoskeleton mechanism;hand function assistance;hand rehabilitation exercises;linear actuators;motion trajectory;robotic orthosis;self-motion control;stroke survivors;wearable hand function rehabilitation robot;Actuators;Mathematical model;Pistons;Robots;Thumb;Wrist},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6290736&isnumber=6290255>

R. K. Megalingam, V. Radhakrishnan, D. C. Jacob, D. K. M. Unnikrishnan and A. K. Sudhakaran, "Assistive Technology for Elders: Wireless Intelligent Healthcare Gadget," *2011 IEEE Global Humanitarian Technology Conference*, Seattle, WA, 2011, pp. 296-300.

doi: 10.1109/GHTC.2011.94

Abstract: Improving the quality of life for the elderly persons and giving them the proper care at the right time is the responsibility of the younger generation. But due to lack of awareness on proper elder care, unavoidable busy schedule etc. the elderly population is seem to be quite ignored. In such a scenario we are trying to find an amicable solution to this problem using a compact and user friendly system design. The proposed system is a compact device which has various wearable sensors all attached inside a glove. It has a process flow controller module and a communication control module. These modules perform together to excite an alert mechanism to the relatives or to the doctors via an SMS or a voice call to their mobile phones, whenever some critical situations arise. The system measures the heart rate, oxygen content in blood, body temperature and the pressure of the elderly person, which are the important parameters for a proper diagnosis.

keywords: {biochemistry;biothermics;blood;body sensor networks;cardiovascular system;electronic messaging;emergency services;geriatrics;haemodynamics;intelligent sensors;mobile handsets;patient monitoring;telemedicine;voice communication;SMS;alert mechanism;assistive technology;blood oxygen content;blood pressure;body temperature;communication control module;elderly care;glove;heart rate;mobile phones;process flow controller module;voice call;wearable sensor;wireless intelligent healthcare gadget;Biomedical monitoring;Monitoring;Senior citizens;Software;Temperature measurement;Temperature sensors;Assistive technology;Elder care;SMS alert;mobile health;voice call},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6103653&isnumber=6103596>

S. Sasidhar, S. K. Panda and X. Jianxin, "A real time control algorithm for a myoelectric glove for the rehabilitation of wrist and elbow of stroke patients," *IEEE ICCA 2010*, Xiamen, 2010, pp. 745-749.

doi: 10.1109/ICCA.2010.5524324

Abstract: This paper presents the initial work on implementing a simple control algorithm for a wearable orthotic glove using the myoelectric signals of a stroke patient as the input. The glove is used to assist in the rehabilitation of wrist and elbow. Surface myoelectric signals (MES) are acquired from the biceps brachii and the flexor carpi ulnaris. The MES is processed and temporal features are extracted which are then classified using a multilayer perceptron classifier (MLP) in simulation under real time application constraints. Control signals are generated by the classifier that can be used to actuate servo motors in the glove to facilitate elbow and wrist movement. The simplicity in the glove design and control motivates the patient to use the glove in physiotherapy sessions and at their homes, which is inherent to stroke rehabilitation, for better and faster recovery.

keywords: {electromyography;orthotics;patient rehabilitation;patient treatment;pattern classification;perceptrons;biceps brachii;control algorithm;flexor carpi ulnaris;multilayer perceptron classifier;physiotherapy sessions;servomotors actuation;stroke patient rehabilitation;stroke rehabilitation;surface myoelectric signals;wearable orthotic glove;Automatic control;Drives;Elbow;Electromyography;Frequency;Orthotics;Servomechanisms;Servomotors;Signal generators;Wrist},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5524324&isnumber=5523980>

R. Voyles and J. Bae, "The gestural joystick and the efficacy of path tortuosity in rubbled environments," *2008 SICE Annual Conference*, Tokyo, 2008, pp. 992-996.

doi: 10.1109/SICE.2008.4654800

Abstract: In this paper a gestural joystick embedded in safety gloves for applications requiring 2-D pointing control similar to a mouse or joystick, is described. A gestural joystick is a pointing device based on hand gestures. The WRIST (wearable responder interface for search tasks) system is being developed specifically for hazardous environments that require gloves, which normally interfere with the operation of conventional computer interfaces. Rather than competing with the human/computer interface, WRIST uses the cumbersome gloves to interpret the gestures, rendering them both a necessary piece of safety equipment as well as necessary piece of the human/robot interface.

keywords: {data gloves;gesture recognition;interactive devices;path planning;robots;2D pointing control;WRIST;gestural joystick;path tortuosity;rubbled environments;safety gloves;wearable responder interface for search tasks system;Application software;Computer interfaces;Humans;Magnetic sensors;Mice;Robots;Safety devices;Wearable sensors;Wires;Wrist;gestural joystick;human/computer interaction;metrics;path tortuosity},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4654800&isnumber=4654597>

J. Bae, A. Larson, R. M. Voyles, R. Godzdzank and J. Pearce, "Development and User Testing of the Gestural Joystick for Gloves-On Hazardous Environments," *RO-MAN 2007 - The 16th IEEE International Symposium on Robot and Human Interactive Communication*, Jeju, 2007, pp. 1096-1101.

doi: 10.1109/ROMAN.2007.4415244

Abstract: For controlling robots in an urban search and rescue (USAR) application, a wearable joystick is presented with improved sensing capability as well as a giant magneto-resistance (GMR) sensor model for use with rare-earth magnets. Scientists have been studying a variety of existing human/robot interface devices to control USAR robots in a disaster. Due to the stresses involved in USAR environments, the selection of an appropriate interface device out of the numerous interactive devices available has to be carefully considered. Furthermore, the total burden to the user of human/robot interface devices in USAR tasks includes not only the periods of interaction, but also the burden of transporting and remotely setting up the devices. The wearable joystick presented is developed with the design goal of minimizing total encumbrances. The features of this wearable joystick include easy and wire-free installation into regular gloves. An improved hardware structure for the sensor pad and the alignment of magnets is described that completely wraps the wrist. This band-type mechanism provides more robust data acquisition than previous prototypes. To evaluate performance, time-to-complete tests are performed, with a comparison to a metric for path tortuosity. The fractal dimension of the resulting path is analyzed to represent the degree of control the user has over the interface device. Experimental results are provided from both computer screen tests and real USAR robot driving tests.

keywords: {data gloves;disasters;interactive devices;man-machine systems;mobile robots;service robots;wearable computers;GMR sensor model;USAR robot control;disaster;gestural joystick;giant magneto-resistance model;gloves-on hazardous environments;human-robot interface devices;rare-earth magnets;urban search-rescue application;user testing;wearable joystick;Hardware;Human robot interaction;Magnetic sensors;Magnets;Robot control;Robot sensing systems;Sensor phenomena and characterization;Stress;Testing;Wearable sensors},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4415244&isnumber=4415042>

F. Ahmad and P. Musilek, "A keystroke and pointer control input interface for wearable computers," *Fourth Annual IEEE International Conference on Pervasive Computing and Communications (PERCOM'06)*, Pisa, 2006, pp. 10 pp.-11.

doi: 10.1109/PERCOM.2006.2

Abstract: The widespread adoption of mobile electronic devices and the advent of wearable computing have encouraged the development of compact alternatives to the keyboard and mouse. These include one-handed keyboards, digitizing tablets, and glove-based devices. This paper describes a combination pointer position and non-chorded keystroke input device that relies on miniature wrist-worn wireless video cameras that track finger position. A hidden Markov model is used to correlate finger movements to keystrokes during a brief training phase, after which the user can type in the air or above a flat surface as if typing on a standard keyboard. Language statistics are used to help disambiguate keystrokes, allowing the assignment of multiple unique keys to each finger and obviating chorded input. In addition, the system can be trained to recognize certain finger positions for switching between input modes; for example, from typing

mode to pointer movement mode. In the latter mode of operation, the position of the mouse pointer is controlled by hand movement. The camera motion is estimated by tracking environmental features and is used to control pointer position. This allows fast switching between keystroke mode and pointer control mode

keywords: {hidden Markov models;keyboards;mobile computing;tracking;wearable computers;finger position tracking;glove-based device;hidden Markov model;keystroke interface;language statistics;miniature wrist-worn wireless video camera;mobile electronic device;one-handed keyboard;pointer control interface;wearable computing;Cameras;Fingers;Hidden Markov models;Keyboards;Mice;Mobile computing;Motion estimation;Statistics;Tracking;Wearable computers},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1604787&isnumber=33716>

A. Tognetti, F. Lorussi, R. Bartalesi, M. Tesconi, G. Zupone and D. De Rossi, "Analysis and synthesis of human movements: wearable kinesthetic interfaces," *9th International Conference on Rehabilitation Robotics, 2005. ICORR 2005.*, 2005, pp. 488-491.

doi: 10.1109/ICORR.2005.1501148

Abstract: Electrically conductive elastomer composites (CEs) show piezoresistive properties when a deformation is applied. In several applications, CEs can be integrated onto fabric or other flexible substrate and can be employed as strain sensors. Moreover, integrated CE sensors may be used in biomechanical analysis to realize wearable kinesthetic interfaces able to detect posture and movement of the human body. In the following a kinesthetic upper limb garment realized by CEs which allows to reconstruct shoulder, elbow and wrist movements and a kinesthetic glove able to detect posture and gesture of the hand are presented.

keywords: {biomechanics;patient rehabilitation;strain sensors;biomechanical analysis;elbow movements;electrically conductive elastomer composites;hand gesture;hand posture;human body movement;human body posture;human movements;integrated CE sensors;kinesthetic upper limb garment;shoulder movements;strain sensors;wearable kinesthetic interfaces;wrist movements;Clothing;Elbow;Fabrics;Monitoring;Piezoresistance;Prototypes;Sensor phenomena and characterization;Wearable sensors;Wires;Wrist},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1501148&isnumber=32216>

"Table of contents," *2014 11th International Conference on Wearable and Implantable Body Sensor Networks Workshops*, Zurich, 2014, pp. v-vi.

doi: 10.1109/BSN.Workshops.2014.9

Abstract: The following topics are dealt with: wearable and implantable body sensor networks; energy expenditure estimation using accelerometry and heart rate for multiple sclerosis and healthy older adults; applications of the PowerGlove for measurement of finger kinematics; classification of stair ascent and descent in stroke patients; flexible wearable sensor network for bio-signals and human activity monitoring; characteristics of a piezo-resistive fabric stretch sensor glove for home-monitoring of rheumatoid arthritis; design and development of an inertial sensor based Exergame for recovery-step training; comparative study of four instrumented mobility analysis tests on neurological disease patients; comparing Google glass with tablet-PC as guidance system for assembling tasks; diary-like long-term activity recognition: touch or voice interaction?; user interface beaming-seamless interaction with smart things using personal wearable computers; and head and eye movement as pointing modalities for eyewear computers.

keywords: {biomechanics;biomedical telemetry;body sensor networks;computer games;diseases;geriatrics;home computing;medical computing;medical disorders;neurophysiology;notebook computers;patient monitoring;patient rehabilitation;prosthetics;telemedicine;textile technology;user interfaces;wearable computers;BSN workshop;Exergame design;Exergame development;Google glass;PowerGlove application;accelerometry;assembling task guidance system;biosignal monitoring;conference;diary-like long-term activity recognition;energy expenditure estimation;eye movement;eyewear computer pointing modality;finger kinematic measurement;flexible wearable sensor network;head movement;healthy older adult measurement;heart rate;home monitoring;human activity monitoring;implantable body sensor network workshop;inertial sensor based Exergame;instrumented mobility analysis test;multiple sclerosis;neurological disease patient;personal wearable computer;piezoresistive fabric stretch sensor glove;recovery-step training;rheumatoid arthritis;smart thing;stair ascent classification;stair descent classification;stroke patient;tablet-PC;touch interaction;user interface beaming-seamless interaction;voice interaction;wearable body sensor network workshop},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6970611&isnumber=6970606>