Home Automation System Based on Gesture Recognition System

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Abstract – Old aged or disabled persons who can't walk are most sensitive persons and they must be served in a systematic, quick, sophisticated and efficient manner by very little effort. The problem is that there is no anybody who is always with them for 24 hours. Speech recognition can be used to serve the old aged or disable persons and to give a full control to them so that they may control all the appliances of home. Traditional home automation systems are not cost effective and they are not suitable for aging populations or disable persons. This paper presents an effective method to overcome these problems. We have designed and implemented a low-cost, reliable, efficient and secure speech operated system for home appliances especially for persons with disabilities to do their work at home. This system is both software and hardware designed using MATLAB R2009a. This system is divided into three main parts namely voice train process, voice recognition process and integration of hardware with MATLAB. This system used speaker dependent method. This proposed design is novel in the way that it is controlling loads by speech recognition using MATLAB to turn on/off loads via parallel port of a computer.

Index Terms – Speaker Identification, Speech operated system, Home Appliances, Aging populations, Speech Recognition, MATLAB.

1. INTRODUCTION

Speech Recognition Systems have become so advanced and main stream that business and health care professionals are turning to speech recognition solutions for everything from providing telephone support to writing medical reports. In many homes there are many people who are old aged or disabled and they can't walk. And there is no anybody who is always with them for 24 hours. There are people who look after them in periodic intervals. The problem is that when a people visits them then it is might not necessary that they needs them but the old aged or disabled person may need a person when he/she is not present with them. Hence home automation systems play a crucial role for elderly or disable persons, so that they can feel comfortable, independent and secure. Development of automation systems using speaker identification began in the 1960s with exploration into speech analysis using text matching, where characteristics of an individual's voice were thought to be able to characterize the uniqueness of an individual much like a fingerprint. The early systems had many flaws and research ensued to derive a more reliable method of predicting the correlation between two sets of speech utterances. The home evolutionary developments time from the era in which man became sedentary to stop living inside caves and start building their homes. These evolutionary trends of homes automation are focused on several main issues such as security, culture, leisure, comfort, energy savings, management and economic activities. Over the years much work has been done in the domain of automatic speech recognition for automation systems. The progress made is significant for small, medium and even large vocabulary systems. Speaker Identification based automation is one of the major growing industries that can change the way people live with security in operation. The aim of such Automation System is to provide those with special needs with a system that can respond to speech commands and control the on/off status of electrical devices, such as lamps, fans, television etc., in the home and office wirelessly. The system should be reasonably cheap and easy to install in any environment. Generally, human voice conveys much information such as gender, emotion and identity of the speaker. The objective of voice recognition is to determine which speaker is present based on the individual's utterance. Several techniques have been proposed for reducing the mismatch between the testing and training environments. The performance of the speech recognition system is given in terms of error rate as measured for a specified technology. Vocal communication between person and computer includes synthesis of speech which is in MATLAB database and matching of speech features with incoming speech commands. Speaker recognition involves speaker identification to output the identity of speaker among the population as switching on/off of the electrical equipment. Voice activated technology is a rapidly developing area of the computer world. Today, many devices incorporate voice activation technology so certain functions of the device can be performed based on voice commands. For example, many home appliances are equipped with voice-activated technology as to allow a consumer to orally command, for example, a lighting system to power on by using voice commands. Such a feature is particularly advantageous when a person cannot manually activate a device because their hands are occupied or the device switch is in an inconvenient place. For example, one may be carrying groceries into a house and is unable to manually activate the light switch, consequently, if the lighting system in the house

has voice activated technology there in, the person may simply say, for example, "lights on" to activate the lights. Speech recognition is the process by which a computer (or other type of machine) identifies spoken words. Basically, it means talking to your computer, and having it correctly recognize what you are saying. This is the key to any speech related application. There are a number ways to do this but the basic principle is to somehow extract certain key features from the uttered speech and then treat those features as the key to recognizing the word when it is uttered again. In this paper, a low cost, reliable, efficient and secure Speaker identification based home automation system is presented which utilizes the use of biometric method such as human voice as a directive to activate any electrical appliances. This objective makes the human's voice as an input to the system and this system is speaker dependent that mean only the real or trained user and right command can activate the appliances. This produces and improves the security level of the system.

2. SYSTEM OVERVIEW

Block Diagram of Hand Gesture Recognition System

Implementation of this proposed problem mainly involves two steps. They are gesture recognition and controlling direction of using microcontroller based on the received gesture commands. The block diagram of the system is shown in following Figure 2.1Transmitter section of Block Diagram and 2.2 Receiver section of Block Diagram.

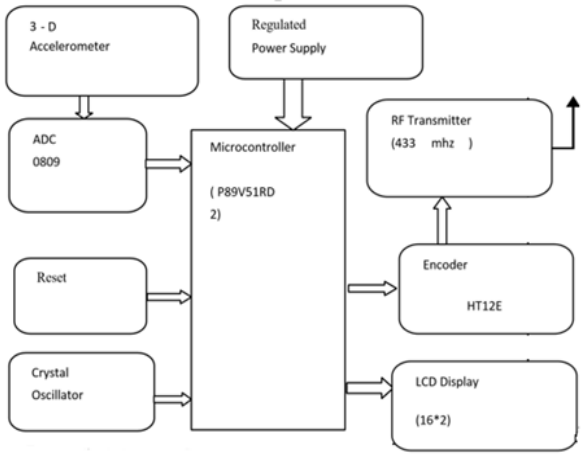

Fig.1: Block Diagram of Transmitter

As overviewed in the block diagram the hand gesture is sensed by accelerometer using the instrumented glove approach. The ADXL 330 accelerometer which convert the hand position into 3-Dimensional Output. The values obtained from the accelerometer are analog values which should be further converted into digital values so they can be used by the microcontroller. The accelerometer analog outputs are converted into digital with the help of ADC 0809. ADC converts the data from sensor and proceeds to the microcontroller (P89V51RD2) for further conversion and calibration. Microcontroller gets the data from the accelerometer and converted into ASCII code for LCD display. LCD display the X— Y—Z values and display the values on the LCD.

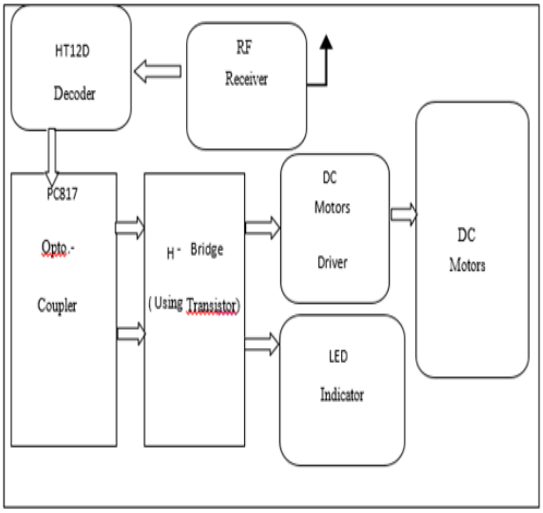

Fig. 2: Block Diagram of Receiver

In this use the readings obtained from accelerometer for movements. As the position of the hand changes, data from the accelerometer and microcontroller also changes automatically. And use HT12E encoder for serial communication. Data from the microcontroller is connected to the input pins of encoder and transmits via output pins of the encoder. Outputs from the encoder is connected to the RF transmitter module and transmit with frequency 433 MHz the RF receiver module sends it to the decoder which further decodes the signal and gives the signal to the opto-coupler and H-Bridge circuitry which drives the motors based on the hand gesture and same result shown by the LCD.

i) Technology

Gestures have recently become attractive for interaction with consumer electronics and mobile devices block diagram in fig. 2.1 by the use of gesture recognition technique via the accelerometer the movement will be controlled. The primary goal of gesture recognition research is to create a system which can identify specific human gestures and use them to convey information or for device control. Gesture Recognition is the act of interpreting motions to determine such intent. There are different types of gestures such as hand, face (emotion), body gestures etc. To identify and recognize these gestures there are different ways of gesture recognition such as:

1. Hand and arm gestures: recognition of hand poses, sign languages, and entertainment applications (allowing children to play and interact in virtual environments).

2. Head and face gestures: Some examples are a) nodding or head shaking, b) direction of eye gaze, c) raising the eyebrows, d) opening and closing the mouth, e) winking, f) flaring the nostrils, e) looks of surprise, happiness, disgust, fear, sadness, and many others represent head and face gestures.
3. body gestures: involvement of full body motion, as in a) tracking movements of two people having a conversation, b) analyzing movements of a dancer against the music being played and the rhythm, c) recognizing human gaits for medical rehabilitation and athletic training

ii) Gesture Recognition Approach

For any system the first step is to collect the data necessary to accomplish a specific task. For hand posture and gesture recognition system different technologies are used for acquiring input data. Present technologies for recognizing gestures can be divided into vision based, instrumented (data) glove.

1. Vision Based Approaches

In vision based methods the system requires only camera(s) to capture the image required for the natural interaction between human and computers and no extra devices are needed. Although these approaches are simple but a lot of gesture challenges are raised such as the complex background, lighting variation and other skin color objects with the hand object, besides system requirements such as velocity, recognition time, robustness, and computational efficiency.

2. Instrumented Glove approaches

Instrumented data glove approaches use sensor devices for capturing hand position, and motion. These approaches can easily provide exact coordinates of palm and finger's location and orientation, and hand configurations .however these approaches require the user to be connected with the computer physically , which obstacle the ease of interaction between users and computers, besides the price of these devices are quite expensive it is inefficient for working in virtual reality Instrumented Glove based (smart glove) solutions can recognize very fine gestures, e.g., the finger movement and conformation but require the user to wear a glove tagged with multiple sensors to capture finger and hand motions in fine granularity. As a result, they are unfit for spontaneous interaction due to the high overhead of engagement.

iii) Proposed Model

There are two essential characteristics for any effective GSR system: accuracy and speed. In addition, to meeting these demands, GR systems face a number of additional challenges including the large variance that exists individual human hand patterns (e.g. tracking, motion, variation). A successful GR system requires extraordinary flexibility to accommodate these variances. The process of GRS typically follows these steps:

1. Hand gesture is captured by an Accelerometer sensor and undergoes analog-to- digital conversion.
2. Different Gestures are converted into signal features that can be used by microcontroller.
3. Series of different gestures are compared to save information, the result shown on the LCD screen in the 3 Co-ordinates(X, Y, Z). LCD shows the numerical values which will be helpful to know about the position of hand.
4. For serial transmission the encoder is used and the RF Transmitting antenna is used with 433MHZ frequency.
5. At the receiver side the An H Bridge is built with four switches (solid-state or mechanical). When the switches S1 and S4 (according to the first figure) are closed (and S2 and S3 are open) a positive voltage will be applied across the motor. By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the motor

iv) Advantages

1. Low power requirement.
2. Simple circuitry as it does not require special hardware.
3. Higher security as directionality of the beam helps ensure that data isn't leaked or spilled to nearby devices as it is transmitted.
4. Devices can controlled more comfortably

v) Disadvantages

1. It has distance limit in controlling devices.
2. Line of sight communicggty6ation as transmitters and receivers must be almost directly aligned (i.e. able to see each other) to communicate.
3. Speed: data rate transmission is lower than typical wired transmission.

vi) Applications

1. To overcome situations where normal cabling is difficult or financially impractical.
2. It can be used in home theatre system where short distance communication is required.

3. Suitable for physically impaired people to operate the devices within the room

3 CIRCUIT DETAILS

Circuit Diagram of Hand Gesture Recognition System

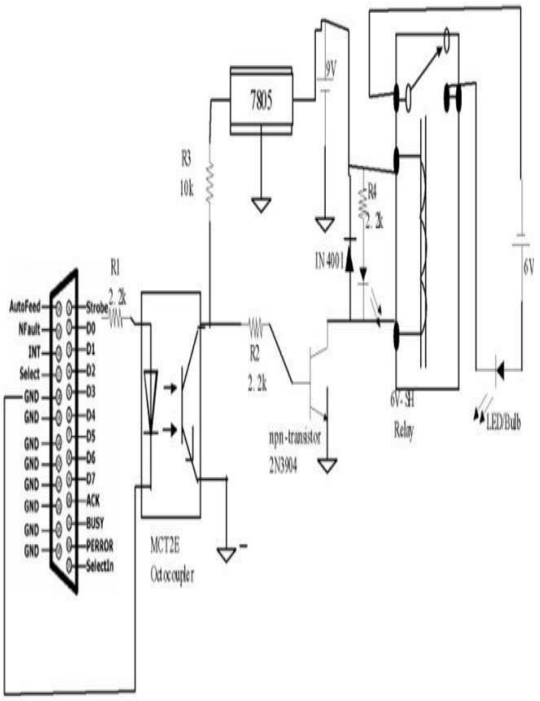

Fig. 3: Circuit Diagram of Hand Gesture Recognition System

In the above circuit the parallel port is used to send control signal to the circuit to drive the relay. The above circuit is used to operate a relay to which the desired appliance is connected. The parallel port has pin number 2 to 9(i.e. D0 – D7) which are the data pins that can be used for data transmission. In the above figure, we use the pin number 2 (D0) at which the computer gives a logic 0 or logic 1, i.e. either a high bit (+ 5V) or a low bit (0V) signal. This signal is then given to an octo-coupler (MCT2E), which has an LED and a phototransistor within it. As the active high signal from the computer is given to the D1 pin of parallel port, it switches ON the LED, hence turning the photo transistor ON. In this way, as the low power circuit turns the LED on, the high power circuit is switched ON as well by the phototransistor. A 5V power supply from the computer is used in conjunction with a 330Ω resistor to ensure that the LED gets enough power to brighten enough to induce the phototransistor to turn on and off. The figure shows the actual LED hardware used by us to operate on. To the output of the octo-coupler's photo transistor an NPN- type transistor is connected. A 9V power supply is used to drive the relay as well as the octo-coupler's photo transistor. But octo- coupler is a low power driven device which only needs 5V. Flowchart

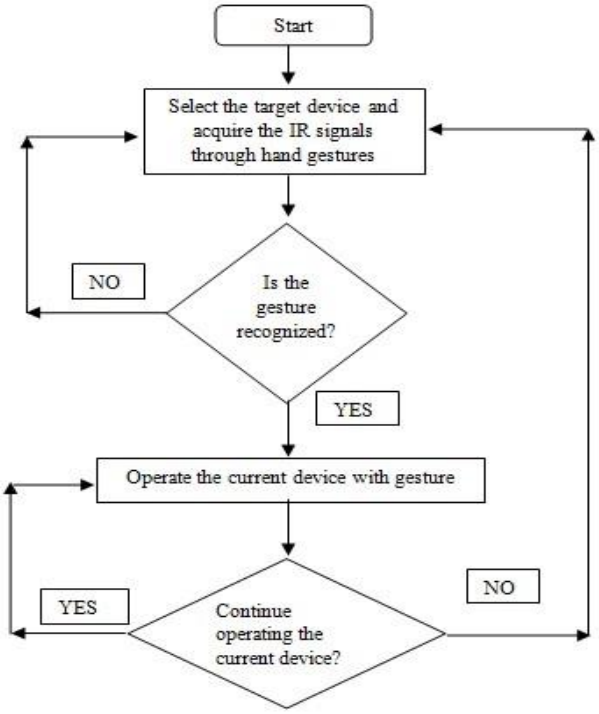

Fig. 4: Flowchart

4 SOFTWARE DETAILS

MATLAB Millions of engineers and scientist worldwide use MATLAB® to analyses and design the systems and products transforming our world. MATLAB is in automobile active safety systems, interplanetary spacecraft and health monitoring devices, smart power grids, and LTE cellular networks. It is used for machine learning, signal processing, image processing, computer vision, communications, computational finance, control design, robotics, and much more. MATLAB is the easiest and most productive software for engineers and scientists. MATLAB window, whether you're analyzing data, developing algorithms, or creating models, MATLAB provides an environment that invites exploration and discovery. It combines a high-level language with a desktop environment tuned for iterative engineering and scientific workflows. The desktop environment invites experimentation, exploration, and discovery. These MATLAB tools and capabilities are all rigorously tested and designed to work together.

a) Key Features of MATLAB

1. High-level language for scientific and engineering computing.
2. Desktop environment tuned for iterative exploration, design, and problem solving.
3. Graphics for visualizing data and tools for creating custom plots.

4. Apps for curve fitting, data classification, signal analysis, and many other domain-specific tasks.
5. Add-on toolboxes for a wide range of engineering and scientific applications.
6. Tools for building applications with custom user interfaces.
7. Interfaces to C/C++, Java®, .NET, Python®, SQL, Hadoop®, and Microsoft® Excel®
8. Royalty-free deployment options for sharing MATLAB programs with end users.

b) Software Implementation

The software implementation part of gesture recognition based home automation system implemented using the Microcontroller. It consists of training of Hand Gesture recognition module. The Hand Gesture recognition module needs to be trained first with the Gesture commands before it can be put to recognizing function. This section explains the methods used for Gesture recognition. These methods are training phase and testing phase.

c) Advantages of MATLAB

MATLAB is the easiest and most productive software for engineers and scientists. As shown in figure 4.1 MATLAB window, whether you're analyzing data,

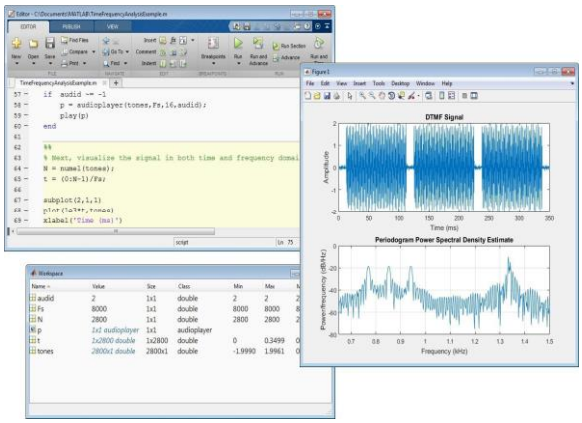

Fig. 5: MATLAB Window

Developing algorithms, or creating models, MATLAB provides anenvironment that invites exploration and discovery. It combines a high-level language with a desktop environment tuned for iterative engineering andscientific workflows. MATLAB Integrates Workflows. Major engineering and scientific challenges require broad coordination to take ideas to implementation. Every handoff along the way adds errors and delays. MATLAB automates the entire path from research through production. With the help of MATLAB we can do the following task:

1. Build and package custom MATLAB apps and toolboxes to share with other MATLAB users.
2. Create standalone executables to share with others who do not have MATLAB.
3. Integrate with C/C++, Java, .NET, and Python. Call those languages directly from MATLAB, or package MATLAB algorithms and applications for deployment within web, enterprise, and production systems.
4. Convert MATLAB algorithms to C, HDL and PLC code to run on embedded device. 4 Deploy MATLAB code to MATLAB is also a key part of Model-Based Design, which is used for multi domain simulation, physical and discrete-event simulation, and verification and code generation.

5. CONCLUSION

The objective of this seminar is to develop such a system which will help physically impaired to control home appliances by hand gestures using accelerometer. This provides comfort and convenience for common users as well, especially in home system. Wireless technology is used for home automation for physically impaired. In this system physical impaired people are use the home appliances very easily or they are comfortable for using the devices this system is simple for operating the devices, this will be replace by the remote-control instate of pushing the button there for this system will be very suitable for operating the home appliances.

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