HAND GESTURE BASED HOME AUTOMATION

Athira C.P
Department of Computer Science and Engineering
Universal Engineering College
Kerala, India
athirapradeep.cp@gmail.com

Fathima Sithara P.A
Department of Computer Science and Engineering
Universal Engineering College
Kerala, India
Imafathin3@gmail.com

***Abstract*—In recent years, there has been an increase in the trend of converting standard homes into smart homes. The improvement of the standard of living for regular people is the foundation for smart home development. But many smart homes haven't been made to be user-friendly for those with disabilities, such the bedridden and immobilized. Instances where electrical gadgets are left on, regardless of necessity, occur as a result of carelessness and forgetfulness. The majority of residential energy waste occurs in situations like these. Our research exemplifies an upgraded smart home automation system that employs cameras to collect gestures and smart sockets to send gesture-driven outputs to household appliances in order to get around these problems. The system processes and records the user's gestures using the camera. Keywords.**

I. INTRODUCTION

. The process of automating a home entail integrating a number of gadgets into a centrally controlled home automation system with the intention of enhancing communication, security, welfare, and energy management. The user's contact with their home appliances is increasingly taken into account when designing new consumer products in order to increase their appeal to the general public. Enhancing user experience and handling simplicity is, in fact, the main objective. Natural gesture interaction is a very recent kind of user-device communication. A gesture is described as a mental concept of an idea connected to an action, a response, or a requirement that the user carries out with the goal of producing a result. Without utilizing words or noises, partners can communicate nonverbally by making gestures. For a computer to recognize a gesture, the data that it needs to represent the gesture must first be captured, and then this data must be processed to understand and recognize the motion. In this regard, numerous studies have attempted to record, process, and interpret gestures by having participants use their hands, eyes, faces, or even the entirety of their bodies. The HGCS will allow us to transparently manage autonomous home devices in a unified manner, define a simple gestural language to express actions on home devices, maintain a gestural library that can be configured and expanded by the user, provide a practical application to test the reliability and robustness of hand gestural interface, and determine the performance and responsiveness of the system. We propose a new Hand Gesture based home automation System that is valid to control several home devices with similar behavior using the same NUI-G

II. RELATED WORKS

In this paper [1], the 3d human pose estimation based on projection of depth and rigid data is an automation system proposed by using the convolutional neural network (CNN) to estimate human pose by analyzing the projection of the depth and ridge data, which represent local maxima in a distance transform map. To fully utilize the 3D information of depth points, we propose a method to project the depth and ridge data on various directions. This system uses a projection method which can reduce the 3D information loss, the ridge data can avoid joint drift, and the CNN increases localization accuracy. The proposed method proceeds as follows. We use depth data to segment the human from the background and extract ridge data from human silhouettes. This system can eliminate the 3D information loss and drift of joint positions that can occur during estimation of human pose. This paper proposes a method to identify the human joints . hence the system propose use of ridge data, which constitute a novel representation of the human body. The ridge data are more plentiful and scale-invariant than the existing skeletonization techniques.

This paper[2] proposes an idea that about that It’s not new to study on a remote control for home appliance such as air conditioner using human’s free hand gesture instead of cumbersome hand-held wireless remote controllers. Nevertheless, to the best of our knowledge, there exists no commercial remote controller that uses free hand gesture

because it requires high robustness to various illumination changes in living room and full automation without any constraint or direct intervention of users. Although there are some studies to satisfy the requirements, most researches on gesture recognition have been devoted to solve sophisticated problems such as understanding sign languages by interpreting sequences of 3D motion or shape of hands . In this paper, we present a very feasible remote control method using free hand gesture for real home appliance. We implemented and verified our method with a hardware embedded in an air conditioner on actual living room environment. The proposed method is implemented for an air conditioner with an embedded hardware consists of two CMOS cameras and an ARM9 processor. The strength of air flow for the air conditioner is controlled remotely using free hand gestures classified by the proposed method. proposed a fully automated method to control an air conditioner remotely using free hand gesture under varying illumination condition. The presented methods can also be employed to other home appliances that use remote controller.

In this paper[3], a Home Automation model is designed to provide ease of control of home appliances, using an android application. The elderly and physically challenged people can perform their day-to-day activities efficiently. The proposed system detects the gestures given as input by the user and controls the home appliance. The client interface is responsible for capturing the input gesture from the user, using an android application and uploading it on the raspberry pi server. Raspberry pi acts as an important pre-processor. Backend Processing involves image pre-processing, training the CNN model, and prediction of image class category of input gesture image. Based on this predicted class of image, the respectively assigned action takes place at the home interface. The objective of the proposed system is to create a system that can control home appliances using any one of the two assigned methods: - 1. Gesture-based 2. Web-based Disabled or old aged people who can't require an effortless way of accessing things around them which must be served systematically and efficiently. This idea integrates automation with technology. The primary goal of the system is to develop a tool that uses gesture recognition for reducing the barrier in communication between the deaf and dumb and normal people. Each gesture is assigned with a specific action. The accuracy of the CNN algorithm is found to be 98.12 % if the image is captured insufficient light. For instance, the ‘thumbs up’ gesture turns on the fan. The appliances are connected to the raspberry pi with the help of a relay module.

This paper [4] proposes a hand gesture extraction method. Based on motion detection and feature recognition, an intelligent hand gesture extraction method is achieved. It is possible to apply in most of homecare system, especially those patients without the ability to speak well. The system is also can apply in intelligent commercial devices control, such as television and light. The control methods for commercial products include using keyboard, remote controller, voice and speech recognition and hand gesture recognition. Hand gesture recognition is an important approach for human machine interaction, which is widely used in variety of areas such as gesture language service, intelligent human-machine interface, interfaces of virtual reality navigation, digital art and entertainment. . Hand posture is a static hand pose without involvement of movements. A hand gesture is defined as a dynamic movement referring to a sequence of hand postures connected by continuous motions over an interval. In vision based hand gesture recognition. This paper introduces a hand gesture interaction system based on a video camera. It combines many exist approaches to achieve command recognition goal. It is possible to be applied in any commercial products especially for home care application. In the future, realize it will be generate as an embedded system.

In this paper [5], we propose a Voice and Gesture Operated home automation system with a central controller that allows disabled people to manipulate household appliances with their own voice and gesture commands. he developed system consists of three main parts, such as Kinect Motion Sensor, Central Controller, and Network Coordinator. The whole system is based on a Wireless system shows over 80% accuracy with gesture and voice with external noise level is Sensor Network with a gateway to communicate with each device-controlling unit. This project aims to develop a system that helps users to interact with appliances using voice and gesture commands to provide a more interactive and user friendly home experience. voice commands through a microphone or gesture commands from the camera module and interprets them to manage appliances through the relay, which turns the house on and off based on the user’s request. This system could also be a perfect solution for people with disabilities who want access to home devices. For example, voice commands are useful for the visually impaired, and the dumb can use hand gestures to operate the appliances.

In this design [6] the project contains remote or switch to control the appliances and it cannot operate for longer distance The proposed design uses a gesture sensor instead of remote, the remote technology will be old and it consumes more power and operates in smaller distance. The system is developed using x-bee technology it can operates longer distance and Gesture interactive system is one kind of nature user interface that provides human a convenient remote control environment according to hand and finger. The gesture system is suitable for physically handicapped people, especially for feet handicapped people. In order to prove the performance of the proposed methods, we perform a series of experiments. The well performance of one finger click has proved the quality of the proposed method. This proposed multi-functional portable device for better human – machine interaction using hand gestures can be applied in the following applications: Replace the mouse as a more convenient and natural interaction peripheral, Interacting with 3D objects on computer screen. it aims at venturing into the field of physiological computing and permitting convenient interaction with the surrounding appliances through minimal hardware, as compared to complicated magnetic flux sensors ultrasonics

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Also, the use of hand gestures for interaction avoids the most prevalent injury due to continuous use of the keyboard and the mouse, the Carpal Tunnel Syndrome which occurs when the median nerve that runs from the forearm into the hand gets pressed at threads . The adapted method of this innovative approach allows user to flexibly and conveniently control multiple household appliances with simple gestures.

In this paper [7],Adopting a hand gesture based appliance control system would be a virtuous idea for smart homes. However, complexity of the home background makes it challenging to work such systems in real home environments. In this paper present developing a robust system which can practically be used in complex backgrounds. The users are required to wear neither wristbands nor long-sleeved garments. In order to achieve this, we use TRS moment invariants combined with Viola-Jones object detection framework. The main approaches in hand gesture identification can be classified as body sensor networks and computer vision based systems. In the former case, accelerometers fixed on a hand glove are used to identify the moments of fingers. Even though these data glove based methods yield high accuracy in recognition, obviously they are not appropriate for home appliance control purposes. Vision-based hand gesture recognition is a somewhat popular topic in sign-language interpretation However, hand gesture recognition paradigm for appliance control is different from that of sign-language interpretation. For the reason that is, in sign-language interpretation the user has the freedom of becoming accustomed to pre-defined specifications such as uniform and static background. However, appliance controlling has become more challenging due to its complexity.

According to this paper [8], the home technology is evolving along with advanced technology evolvement. One of the technology which is constantly evolving is a human-machine interface. Within this group, a gesture-based interface enables to change this movement becomes a command for computer systems without contacting any surfaces. A gesture is one of the most convenient and natural ways to control a smart home. This research discusses the development of hand gesture recognition using hand state combinations to control various electronic devices for a smart home to facilitate human activities in a home. The system is built by performing hand gesture recognition from a command received by Kinect v2 sensor with hand tracking process to get the desired request based on existing hand state combination. There are three hand states with nine hand state combinations. Each combination means different commands for different electronic devices. This study uses the hand state from Kinect v2 dataset, which are open, close, lasso, untracked, and unknown. Based on the experimental results, the system accuracy reached 87% with an optimal distance of three meters. Technological advances have allowed hand gestures to become an important research field especially in applications such as health care and assisting applications for elderly people, providing a natural interaction with the assisting system through a camera by making specific gestures. In this study, we proposed three different scenarios using a Microsoft Kinect V2 depth sensor then evaluated the effectiveness of the outcomes. The first scenario used joint tracking combined with a depth threshold to enhance hand segmentation and efficiently recognise the number of fingers extended this study explored the feasibility of extracting hand gestures in real time using the Microsoft Kinect V2 sensor under three scenarios: finger counting, the embedded system provided by the Kinect itself, and deep learning based on CNN. The proposed methods used the same practical circuit for each scenario, which reports that the correct SMS message sent to the care provider smartphone correlated directly with the results and accuracy of the recognition system. The experimental evaluation of the proposed methods has been conducted in real-time for all participants under three different scenarios. The experimental results were recorded and analyses using a confusion matrix which gave acceptable outcomes making this study a promising method for future home assisting care applications.

In this paper[9], the Mobile and ambient sensors provide a scalable platform for the integration of computing devices and smart appliances for smart home. In which mobile devices, such as smart watches and smart-phone commonly embedded with actuators and sensors i.e., accelerometers and gyroscopes, have opened up chances for the user to easily control home appliances. This paper proposes an integrated method and system that utilize several deep models and mobile sensors for hand gestures applicable for smart homes. The system consists of three components of actual smart home configurations: smart-watch worn on the user's wrist for capturing gesture patterns a recognition application that runs on the smart mobile phone and sends corresponding commands to the home automation platform; and home automation platform with connected smart devices instrumented with ambient sensors. In addition, we define a simple yet easy to-learn hand gesture vocabulary composing of 18 gestures to the user. With the F-score of over 75%, our experiment on our self-collected data-set consisting of 18 gestures from 20 subjects, demonstrates that the feasibility of the gesture recognition for controlling home appliances the proposed method and system for hand gesture recognition based on mobile sensors instrumented inside smart watch, smart phone, and home appliances. The set of gestures addressed in this work can be applicable for controlling appliances at smart homes and easily to learn for the user. In addition, we utilize two deep models for automatically learning and representing sensing features from multiple mobile sensors. An empirical experiment is conducted for verifying our proposed method. The evaluation results have shown that the feasibility of the gesture recognition for home automation.

This paper [10],describes about using hand movements for the operations of electrical equipment at home. With the use of the much-advanced algorithms - 3DCNN and ResNet50 to increase the accuracy in detecting the hand gesture to correctly predict the right motion for the functioning of the electrical

device. Eventually, the project focuses on the comparative study between different architectures so that we can determine the best-suited model for these kinds of image detection Home automation has been one of the farfetched ideas since the modern era for designing the house began. Since smart homes began as a project all of us started to wonder if we would have a fully functional operating home. After so many years of challenging work and advancement in technology, we have come to a point where we can automate the electrical device at home just by using simple hand gestures. This feature will not only ease out your movement across the room just to switch off the lights but also has a light for older people who have trouble walking or in case they forget to switch off a light, this can come very handy. For example, sliding hand increases or decreases the temperature of the heater or thumbs up, turn on all the lights or thumbs down turns off the lights in the room or pre-set settings for user depending on users' preferences of temperature or other controls. We use the technology of machine learning and artificial intelligence to identify the pattern and modify its corresponding control. Briefly, we can say, it is possible to control domestic appliances (connected over the internet) using just your smartphone. For deploying this project, we use ResNet50, which was first introduced in 2012 for an image classification contest along with Alexie. As a method of comparison, we also make use of the 3D-CNN model which makes use of spatial and temporal dimension that makes it good for action detection

III. PROPOSED SYSTEM

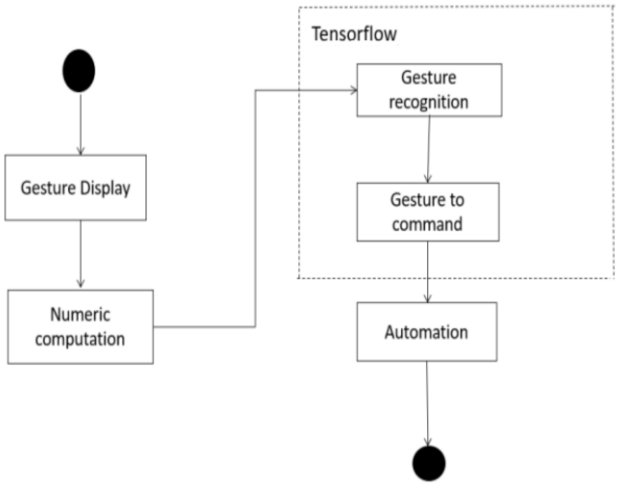
A Hand gesture based home automation system for the control of home appliances is a natural way to achieve Human-Computer Interaction is through the visual interpretation of hand gestures (HCI). In this proposed system, we outline a method for setting up a smart home with hands free appliance control using a hand gesture recognition system. To differentiate between pre-trained motions and correctly identify them to operate the appliances, this identification system especially uses Transfer learning, a Machine Learning approach.

The orders used to actuate the appliances are successively recognized as being represented by the gestures. Controlling a series of LED's that symbolize the appliances is used as the proof-of-concept. The LED's and fans are connected to an Arduino Uno, Relay Modules which is then connected to the computer where the actual gesture recognition is performed. In this proposed work we have implemented the gesture controlled home automation using a simulation software through the Arduino Uno. Taking in concern the day to day challenges in the world with growing technologies in normal life, the following proposed work was created. The problem of disability is gaining more and more importance all over the world. Therefore providing solution for the inabilities is the prime moto of this work. Gesture plays a major role in this proposed work.

A gesture is a form of non-vocal communication in that human body actions can be able to communicate the particular speech or communication or even messages. Gestures include movement of the hands, face, or other parts of the body. Gestures allow individuals to communicate a variety of feelings and thoughts, from contempt and hostility to approval and affection.

There are other applications which could be controlled by a gestures include media light, fan etc. Gesture recognition is the mathematical interpretation of a human motion by a computing device. In other words, interface with computers or other equipment using gestures of the human body, typically hand movements. In the gesture recognition technology, a camera reads the movements of the human body and communicates the data to a computer that uses the gestures as an input to control devices or applications. Gesture recognition using KNN (K-Nearest Neighbors) is an algorithm that uses a database of known gestures to identify an unknown hand gestures in an image. It works by measuring the similarity between the unknown gestures and gestures each in the database, and then selecting the closest match. The algorithm is capable of recognizing a person even when their facial features have changed slightly over time. KNN is a fairly simple and intuitive algorithm, making it a popular choice for face recognition applications.

It is also computationally efficient, requiring only a few calculations to identify a face. Additionally, the algorithm can be used in real time applications, as it only needs to compare the unknown face to a database of known faces and not the entire image. This makes KNN a powerful tool in face recognition applications, as it is accurate and fast.



IV METHODOLOGY

A. Hand Gesture Recognition

Hand gesture recognition is very significant for human computer interaction. hand gesture recognition is an important part of human-computer interaction (HCI). Gesture is a symbol of physical behaviors or emotional expression. It includes body gesture and hand gesture. It falls into two categories: static gesture and dynamic gesture. For the former, the posture of the body or the gesture of the hand denotes a sign. For the latter, the movement of the body or the hand conveys some messages.

Gesture can be used as a tool of communication between computer and human . It is greatly different from the traditional hardware based methods and can accomplish human-computer interaction through gesture recognition.

Gesture recognition determines the user intent through the recognition of the gesture or movement of the body or body parts. In the past decades, many researchers have strived to improve the hand gesture recognition technology. Hand gesture recognition has great value in many applications such as sign language recognition , augmented reality (virtual reality), sign language interpreters for the disabled.

Hand gesture recognition is one of the most viable and popular solution for improving human computer interaction. In the recent years it has become very popular due to its use in gaming devices like Xbox, PS4, and other devices like laptops, smart phones, etc .Histogram based approach is used to separate out the hand from the background image. Background cancellation techniques are used to produce optimum results. The detector hand is then processed and modelled by finding contours and convex hull to recognize finger and palm positions and dimensions.

Finally a gesture object is created from the input which is then used to recognize the count of fingers. Common gesture recognition methods include the hidden Markov model, dynamic time warping neural network and finite-state machine techniques . In one study researchers placed four cameras to capture hand images from different directions, followed by processing of the finger link structure and 3D surface structure.

The experimental results showed that 69% of the connection errors were less than 1 cm. Another study captured hand images with a single camera, resulting in reduced dimension feature vectors .A recent study applied hand gesture recognition for the operation of a TV. Skin color detection was used to extract the shape of the hand and a moment invariant method applied to describe the characteristics.

B. Deep Learning

Deep learning is a machine learning technique that teaches computers to do what comes naturally to humans: learn by example Deep learning is a key technology behind driverless cars, enabling them to recognize a stop sign, or to distinguish a pedestrian from a lamppost. It is the key to voice control in consumer devices like phones, tablets, TVs, and hands-free speakers.

Deep learning is getting lots of attention lately and for good reason. It’s achieving results that were not possible before. In deep learning, a computer model learns to perform classification tasks directly from images, text, or sound.

Deep learning models can achieve state-of-the-art accuracy, sometimes exceeding human-level performance. Models are trained by using a large set of labelled data and neural network architectures that contain many layers Deep learning models are trained by using large sets of labelled data and neural network architectures that learn features directly from the data without the need for manual feature extraction

C. Convolutional Neural Network (CNN)

A convolutional neural network (CNN) is a type of artificial neural network used in image recognition and processing that is specifically designed to process pixel data. CNN is always known for taking a greater number of highlights from given raw RGB picture and it is one of the best options for image processing.

Using CNN, the input image data is processed by extracting both simple and the complex information from the image thereby helping the system to work efficiently since image processing is the major part in the system.

Convolutional Neural Network (CNN, or ConvNet) is a class of deep neural network, most commonly applied to analyze visual imagery. They are also known as shift invariant or space invariant artificial neural networks (SIANN), based on the shared-weight architecture of the convolution kernels or filters that slide along input features and provide translation equivariant responses known as feature maps.

CNNs are regularized versions of multilayer perceptron. Multilayer perceptron usually means fully connected networks, that is, each neuron in one layer is connected to all neurons in the next layer. The "full connectivity" of these networks makes them prone to overfitting data.

The innovation of convolutional neural networks is the ability to automatically learn a large number of filters in parallel specific to a training dataset under the constraints of a specific predictive modelling problem, such as image classification. The result is highly specific features that can be detected anywhere on input images

V . EXPERIMENTAL RESULT

The established approach for operating a home automation system using hand gestures has been thoroughly tested in a number of real-world scenarios; the experiment's main focus was the reliability and efficiency of the underlying infrastructure.

The experiment's findings showed that the user considered the implementation of the home automation system to be

extremely intuitive even while utilizing hand gestures, which is easier than using hand gloves and voice-related gestures.

VI .CONCLUSION

With the aid of this technology, we can easily manage the appliance, which benefits old and physically handicapped people. The ability to replace standard switches not only benefits the aging and physically handicapped but also lessens personal contact, which slows the spread of disease and lowers the likelihood of pandemics, which are easily communicated through physical contact. Life quality is enhanced by this effort. Because the virtual button interacts with the physical world, it increases the efficiency of IOT technology. Compared to the standard switch method we employ every day, switching is far faster.

People who are physically disabled or elderly who require assistance from others to complete simple chores like using household electrical equipment would benefit most from this. This is especially true for the former group.

Any one of the three technologies (AR, AI, and IoT) can be utilized to control a specific household appliance in the proposed notion. Four channel relays, temperature sensors, and cutting-edge processors will all be used in the future.to manage a number of appliances and to switch on the fans automatically when the temperature rises. The production of items based on automation will increase in the future in order to reduce labor productivity, assist people with physical disabilities, and save time.

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