



# Novel HMI Technique for Contactless Free Hand Gesture Device Control

N. Nenkaresh<sup>1</sup>

Sri Indu College of Engineering & Technology, Sheriguda, Ibrahimpatnam, RR.Dist. HYD

P.Prashanth<sup>2</sup>

Sri Indu College of Engineering & Technology, Sheriguda, Ibrahimpatnam, RR.Dist. HYD

Ashok<sup>3</sup>

Sri Indu College of Engineering & Technology, Sheriguda, Ibrahimpatnam, RR.Dist. HYD

**Abstract:** Gesture based (Non-contact) operation of electrical appliances is becoming increasingly desired technology. Various kinds of domestic appliances are used in households, industries and offices. These devices are mostly controlled by human hand with manual switches. This work is focusing on study of electric field (E-field) for advanced proximity sensing which are distorted through hand movements in detecting movements. While compared to the other systems this technology can be employed unobtrusively, work through various materials and do not have a high computational burden also. It allows realization of new user interface applications by detection, tracking and classification of the user's hand or finger motion in free space.

**Keywords:** ARM , Gesture Pad , RF module

## I. INTRODUCTION

Gesture based (Non-contact) operation of electrical appliances is becoming increasingly desired technology. Portable Sensor based touch less solutions become more popular after the recent success of touch screen technology. Presently Gestures are not often used to control domestic appliances in a modern infrastructure. This project discuss on the current use of gestures in domestic appliances and possible usage for various other domains.

In recent years, several remote hand-gesture control systems for home-media systems have become commercially available. These include Microsoft Kinect, Nintendo Wii, and the Kymera Magic-Wand. Such systems aim to augment the living-room media experience and enhance user enjoyment. In this regard, scenarios that call for user identification include interface customization (i.e., facilitating a personalized gesture vocabulary), content adaptation, and parental control. Traditionally, TV-remote content adaptation and parental control are facilitated by the use of numerical passwords.

To meet security and media-control needs of gesture-based home-media systems, we have developed an unencumbered system for identifying individuals during the performance of a free-hand signature-gesture.

Various kinds of domestic appliances are used in households, industries and offices. These devices are mostly controlled by human hand with manual switches. The overview of products is given with varying input methods. A

perfect example is the television control by hand gesture. This idea made it possible to switch channel, change the volume with the use of hand gestures. Present technologies available to recognize gestures in free air which uses Common methods include cameras, depth sensors or capacitive systems. This work is focusing on study of electric field (E-field) for advanced proximity sensing which are distorted through hand movements in detecting movements. While compared to the other systems this technology can be employed unobtrusively, work through various materials and do not have a high computational burden also. It allows realization of new user interface applications by detection, tracking and classification of the user's hand or finger motion in free space.

## Block Diagram:

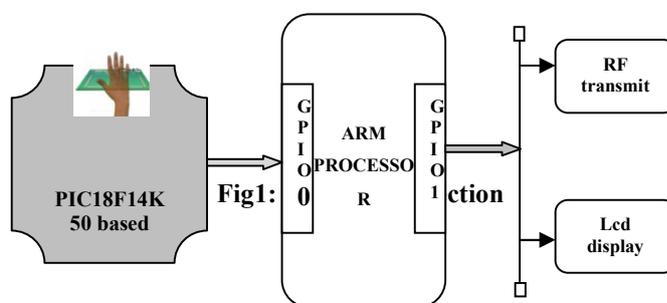


Fig1: gesture Pad section

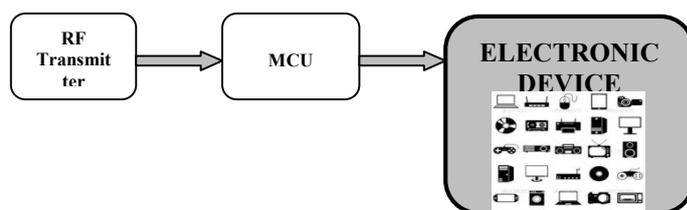


Fig 2: Device section

## II. DESIGN AND IMPLEMENTATION

The objective of the project is to control a device based on free air hand gesture motion technology. This process is going to be done

with a hand gesture pad interfaced with a microcontroller. Hand gesture pad will work based on electric field variation.

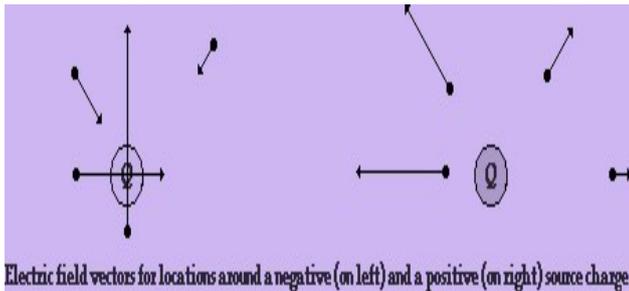


Fig 3: E-Field

The magnitude or strength of an electric field in the space surrounding a source charge is related directly to the quantity of charge on the source charge and inversely to the distance from the source charge. The direction of the electric field is always directed in the direction that a positive test charge would be pushed or pulled if placed in the space surrounding the source charge. Since electric field is a vector quantity, it can be represented by a vector arrow. For any given location, the arrows point in the direction of the electric field and their length is proportional to the strength of the electric field at that location. Such vector arrows are shown in the diagram below.

From the theory, it is confirmed that an electric field generates based on a source charge. These positive charges will be received by a negative source. So, in the gesture pad, the electrodes will act as positive charge receivers. These positive charges will be converted into the digital value by the signal processing IC, present inside the Gesture Pad kit and continuously will be checked by the threshold values. If any value crosses the threshold value set inside the Gesture Pad, it will generate the digital outputs. For the device control application we are going to work with four digital outputs. The output of the hand gesture is connected to general purpose input and output pins. In port 1, we have to configure four pins as input pins and we have to read the status of those pins through IOPIN register. These gesture output pins are active high. So, if there is any state change in the IO pin, then as per the program it will enable an appropriate RFID pin.

The first output of the hand gesture board is connected to the port 1 of 16<sup>th</sup> pin. Second output to the port 1 of 17<sup>th</sup> and third output to the port 1 of 18<sup>th</sup> pin. Fourth output of the hand gesture board is connected to the port 1 of 19<sup>th</sup> pin. RF transmitter is connected to the 24<sup>th</sup>, 25<sup>th</sup>, 26<sup>th</sup> and 27<sup>th</sup> pin of the ARM microcontroller. Based on the input received in

the GPIO pins from the hand gesture, the RF transmitter pin connected to the ARM microcontroller will be high. RF transmitter receives serial data and transmits to the receiver through an antenna which is connected to the 4<sup>th</sup> pin of the transmitter. The transmitted data is in 12 bit format containing 8 address bit and four data bit. The encoder will convert the 4 bit parallel data given to pins D0 – D3 to serial data and will be available at D<sub>OUT</sub>. This output serial data is given to RF Transmitter. Status of these Address pins should match with status of address pins in the receiver for the transmission of the data. Data will be transmitted only when the Transmit Enable pin (TE) is LOW. It operates at a specific frequency of 433MHz.

RF Receiver receives the data transmitted through RF Transmitter. Decoder will convert the received serial data to 4 bit parallel data D0 – D3. The status of these address pins in the decoder should match with status of address pin in the encoder of the transmitter for the reception of data. In that RF receiver is input to the ARM controller and device is act as a output to the controller. The RF receiver pin is connected to the ARM microcontroller in the GPIO ports. RF receiver contains four data pins are connected to 16<sup>th</sup>, 17<sup>th</sup>, 18<sup>th</sup> and 19<sup>th</sup> pin of microcontroller. Based on the input received to the controller from the RF transmitter, the device connected to the controller will be operated. The device is connected to the 24<sup>th</sup>, 25<sup>th</sup>, 26<sup>th</sup> and 27<sup>th</sup> of the ARM microcontroller. Based on the RF receiver data and flag, the device will be performing operation.

## III. SYSTEM HARDWARE

### 1. ARM Processor:

The ARM7 family includes the ARM7TDMI, ARM7TDMI-S, ARM720T, and ARM7EJ-S processors. The ARM7TDMI core is the industry's most widely used 32-bit embedded RISC microprocessor solution. Optimized for cost and power-sensitive applications, the ARM7TDMI solution provides the low power consumption, small size, and high performance needed in portable, embedded applications. The ARM7TDMI core uses a three-stage pipeline to increase the flow of instructions to the processor. This allows multiple simultaneous operations to take place and continuous operation of the processing and memory systems. As the processor is having a high speed it is easy to make the communication between the RF module and the Image acquisition module

### Operating modes

The ARM7TDMI core has seven modes of operation:

- User mode is the usual program execution state
- Interrupt (IRQ) mode is used for general purpose interrupt handling
- Supervisor mode is a protected mode for the operating system
- Abort mode is entered after a data or instruction pre fetch

abort

The interrupt settings of ARM support the DHLS to response to the interrupt coming from the server section.

## 2. Lcd display

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

### Gesture Pad:

This gesture pad Utilizes Electrical Near Field (E-field) sensing for advanced proximity sensing. E-Field is generated by electrical charges.

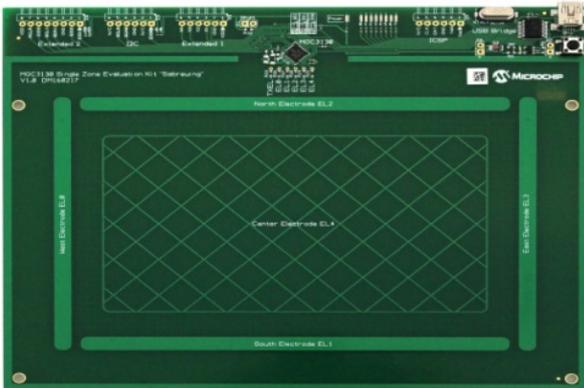


Fig4: Gesture Pad Outlook

The magnitude or strength of an electric field in the space surrounding a source charge is related directly to the quantity of charge on the source charge and inversely to the distance from the source charge. The direction of the electric field is always directed in the direction that a positive test charge would be pushed or pulled if placed in the space surrounding the source charge.

The gesture Pad consists of five electrodes. The transmitter electrode transmits the charge from the source. The remaining five electrodes receives those positive charge. If a hand interrupted in the E-Field then the amount of negative ions falling on the rx electrode will change. This makes a signal variation inside the

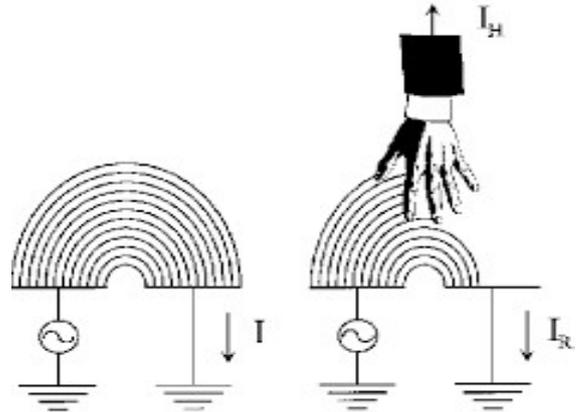


Fig5: Gesture pad E-Field distortion

MGC3130 processor and it will generate a digital output. Field distortion translated into 3D hand tracking and gestures. Very low power consumption since nearly no energy is transported.

### Gesture Pad Features:

- Frame shape electrodes
- 1x Transmitter electrode Tx
- 4-5x Receiving electrodes Rx
- 2-Layer stack-up
- Optional GND layer
- Microchip MGC3130 MCU
- I<sup>2</sup>C™ to USB bridge (PIC)
- USB powered

### Wireless communication:

#### RF communication:

**Radio Frequency**, any frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. Many wireless technologies are based on RF field propagation

#### Transmitter

The TWS-434 extremely small, and are excellent for applications requiring short-range RF remote controls. The TWS-434 modules do not incorporate internal encoding. If simple control or status signals such as button presses or switch closures want to send, consider using an encoder and decoder IC set that takes care of all encoding, error checking, and decoding functions

The transmitter output is up to 8mW at 433.92MHz with a range of approximately 400 foot (open area) outdoors. Indoors, the range is approximately 200 foot, and will go through most walls. The TWS-434 transmitter accepts both linear and digital inputs can operate from 1.5 to 12 Volts-DC,

and makes building a miniature hand-held RF transmitter very easy



Fig6: RF Transmitter

## RF receiver:

RWS-434: The receiver also operates at 433.92MHz, and has a sensitivity of 3uV. The WS-434 receiver operates from 4.5 to 5.5 volts-DC, and has both linear and digital outputs. A 0 volt to Vcc data output is available on pins. This output is normally used to drive a digital decoder IC or a microprocessor which is performing the data decoding. The receiver's output will only transition when valid data is present. In instances, when no carrier is present the output will remain low.

The RWS-434 modules do not incorporate internal decoding. If you want to receive Simple control or status signals such as button presses or switch closes, you can use the encoder and decoder IC set described above. Decoders with momentary and latched outputs are available

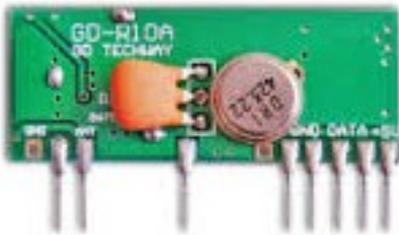


Fig7: RF receiver

## IV. CONCLUSION

This project has been done to control a device based on free air hand gesture motion technology. It uses the Hand gesture pad which works on a principle of e-field distortion. Hand gesture pad will works based on electric field variation. With this technology , any devices can be controlled from the user spot. It can able to bring a reliable assistance and security in electronics sector.

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