

Numerous Applications with FPGA and Gesture: A survey

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Abstract: *There are different approaches to control any application by effectively manipulating Gestures. Gesture based method can doubtlessly deliver innovative and automatic techniques by combination of hardware and software tool. In this paper, we provide a survey on distinctive application controlled through gestures. There are specific forms of Gesture like hand, head, arm, face, fingers, chest, lips, eye, thigh; each with significant sign language of motion by way of a human. It is crucial in designing a smart and coherent utility. To understand gesture and to assign exceptional functionality to the pre-defined gesture role, the controller is used that is field programmable gate array (FPGA). The main intention of this survey is to provide researchers with details of gesture-based social application with an outline of progress accomplished up to now and to assist areas where additional studies are needed. Gesture based robotic system will lift up social application one step ahead.*

Keywords: *Gesture Recognition, Hand Gesture, FPGA, Robotics.*

1. INTRODUCTION:

Until now to offer commands to any software or computer, we use tangible devices including switches, keyboard, mouse. Then after rather than switches, contact pad control can offer commands. However, beyond this, the following step within the improvement of human-computer interaction (HCI) application is a non-tangible manner of conversation. On this path gesture based control is the new approach. Gestures were considered as an interplay method that can deliver more creative techniques for interacting with our computer systems or programs. With the usage of the gesture popularity; human can talk with a system and communicate without any mechanical gadgets. Gestures are demonstrative, meaningful body movement related to bodily moves of the palms, hands, fingers, head, face, or body with the purpose of 1) showing significant facts or 2) communicating with the surroundings [1]. The usage of different -exclusive role of frame elements or combination of frame components are used to offer gesture and that can be varied by means of specific software.

Vast areas of Gesture popularity based applications are,

- Robotic manage
- Industrial automation
- Army
- Medical
- Entertainment
- Smart home
- Human-computer interplay

In theoretical issue, there are various algorithms to deal with gesture popularity, like hidden Markov model (HMM), Kanade Lucas Tomasi (KLT), support vector machine (SVM), haar cascading classifier, etc. In practical issue, gesture recognition requires the use of different sensors; marker based tracking and electronic gloves. The downside is that

user has to wear those sensing tools while giving input otherwise gesture cannot be recognized so to triumph over this, camera and set of rules that understand gesture without using any outside wearable device needs to be implemented.

To understand gesture and assign capability to the gesture, few controllers are available like Arduino, ARM7, percent microcontroller, MSP430, raspberry pie, FPGA. Specifically, FPGA has turned out to be a better platform to perform extensive video processing undertaking in real time software [2].

In this paper, we offer a survey on control of application using gesture recognition. section 2 present the form of gestures include contact primarily based and imaginative and prescient based totally, different technique to understand the gesture, utility area, hardware, and software program. Sooner or later, section 3 present conclusion and discussion.

1.1 Types of gesture

Gesture recognition is the terminology that discusses the system of monitoring human gesture and converts it to a few meaningful commands. There are approaches to recognize gesture: contact based totally and imaginative and prescient based.

Contact based tool manner the bodily interaction of a person with software. contact based gadgets are based totally on technology like a glove, one-of-a-kind sensors along with an accelerometer, IR sensor, ultrasonic sensor, EMG sensor. In this form of gadgets length and runtime must be cautiously balanced in opposition to different feature [3].

Many cell telephones can be determined these days fitted with gadgets inclusive of accelerometers, gyroscopes, cameras, etc., so by using extracting the characteristic from this in [4] , the author made such a machine that could understand movement with the aid of the usage of cellular. They made a utility that could come across human function from an accelerometer on a mobile device.

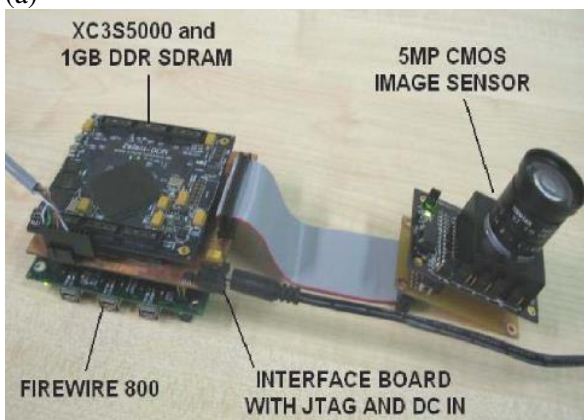
To recognize the gesture any other way is to apply glove technique, in that specific sensors are placed or the shade based popularity is used. In [5], they use a glove with five flex sensor that is connected to the controller. In [6], as a gesture input they use human's created gesture by bear robot through hand and arm movements.

vision based totally gesture recognition includes distinctive sort of camera used to capture photo and in comparison with the perfect picture. to implement this, one-of-a-kind algorithms are used like support vector machine (SVM), hidden Markov model (HMM), AdaBoost face detection etc. there are an integrated and fully self-governing smart camera, capable of tracing and stalking an object with a full spinning around the vertical axis (pan) and 90 degree around the horizontal axis (tilt) [7].

Figure 1 indicates the example of contact based totally and imaginative and prescient primarily based device. The bracelet present in fig. 1(a) is composed with the aid of an accelerometer, an infrared receiver, a microcontroller and a transceiver, used to capture the movement of hand and person vicinity [8]. this sort of system is commonly used to investigate the human everyday activity. in fig. 1(b) the smart camera extract information from images and generate specific facts for other gadgets. CMOS picture sensor gives a high decision and occasional noise output [9].



(a)



(b)

Fig. 1 (a) the bracelet [8] (b) smart camera prototype [9].

In comparison among both contact-based and vision based, contact based totally structures haven't any information affiliation hassle and still have much less information to the method, imaginative and prescient based systems examine gesture via images so it has records connection problem and the managing of massive size of information[10]. Contact based gadget is intolerable and glaring to the person if there are many wearable sensors at the human body [10]. Additionally, the drawback is that the individual ought to put on the sensing device even as giving input otherwise application cannot understand gesture input. in one of this system, human must put on contact-based device whole day if so it causes an allergic reaction, the hazard of cancer and so forth. Imaginative and prescient based totally device even though is consumer friendly, however, be afflicted by configuration complexity and occlusion troubles. Additionally, It has a preliminary venture of complex configuration and implementations [11].

There are one-of-a-kind forms of gesture that we will use to present exceptional enter gesture like arms, hands, fingers, head, face, chest, lips, eyes, component or any combination of this. To apprehend all this gesture the unique algorithms are used that defined in section 2.2.

1.1.1 Hand gesture

Normally, when we engage with different human beings, our hand movements play a critical role and therefore the records they carry is also wealthy in several strategies. We tend to use our arms for inform at someone or at some item, transference information regarding area, type, and temporal traits. We continuously use our arms to have interaction with items: circulate them, regulate them, and transform them and many others. Hand movements are for this reason a median of non-verbal exchange, starting from easy actions (pointing at gadgets as an example) to extra complicated ones (along with expressing feelings or speaking with others). Also, the speechless character can bring their feeling by way of the usage of different hand gesture without problems. So in a maximum of the gesture based totally software the hand gesture in used. Through using this there is a greater possibility of giving input for any application, so we will manipulate extra functions of any software. Together with this, we will use face, figure or any gesture. For commercial application, robot manage, military application most of the hand gesture is used. The exceptional programs that are used hand gesture as input along with its platform, sensor, a set of rules are shown in table 1.

1.1.2 Face gesture

To express our feelings on certain occasions; we use some face gestures. Facial expression is the excellent way to bring a few message. So right here, to offer enter to any application we use face gesture. In some application, the mixture of different face and

hand gesture can be used so that we will manage extra capabilities of any software. In face gesture also we are able to use lip, eye or a combination of this gesture. In [12], they made such type of robot that can recognize human face expressions and can interpret it. In table 2, a few applications are proven that uses face and a combination of face gesture.

1.1.3 Voice gesture

All man or women can talk with each different via the usage of voice gesture. It is the easiest manner to express our feeling. However, till now we can't communicate with a few application by voice gesture. There is a few combination of gesture along with voice. Like voice and mobile, voice and hand. But, there is some limitation of voice gesture. When giving input voice gesture the extra noise from the environment was involved so sometimes the system

cannot recognize the voice gesture. By using this Here in table 3, a few programs are shown in that human can communicate with a machine by voice gesture or mixture with the different gesture.

1.1.4 Other gestures

To give input gesture we can use all the frame elements of a human. Some are defined above. Another gesture we will use like the thigh, chest and so on, as an input gesture. This thigh or chest gesture is used to a maximum of the medical utility. But in this user have to wear the sensor module all the time for continuous analysis. In [13], they propose a mobile robot architecture based on LTE (Long Term Evolution) techniques that robot can control using mobile phone with Bluetooth. A few utility based totally on which might be proven in table 4.

Table 1- Hand Gesture Applications

AUTHOR	SENSOR	PLATFORM	ALGORITHM	APPLICATION
Zhang Xu et al (2009)	EMG Sensor, Acceleration	-	hidden markov model(HMM)	In Mobile Phone, Medical Rehabilitation, Game Control
Po-Chuan Cho et al(2012)	-	Altera Cyclone II EP2C70 FPGA DE2-70	kalman filter tracking algorithm, median filter, hidden markov model, skin color detection	Entertainment or Medical Application with Non-touch Control Equipment
Stefan Oniga et al (2012)	Accelerometer, Infrared	Atmega168, Spartan 3E FPGA	Artificial neural network	Intelligent Human-Machine Interface
S.M.Alex Raj et al(2012)	-	FPGA Board, Xilinx DSP tool	lucid albeit efficient algorithm	Gesture Recognition for Device Control
A. Batool et al (2014)	-	Rasberry Pi	Haar cascade classifier	Gesture Based Action for Smart Home
U. Rajkama et al (2014)	Flex	PIC Microcontroller	-	Mobile Robot Control
Shirke Swapnali et al (2014)	Accelerometer	ARM7 microcontroller LPC2138	Thresholding algorithm	Traffic Light Control System
Wang Ran et al (2014)	-	Xilinx Genesys Board, Ov7670 Camera	clustering algorithm	Real Time Hardware based Gesture Recognition System
Zhiyuan Wang et al(2015)	-	Altera DE2 kaicong CCD camera	YCbCr color space, region growing algorithm, morphological operation	Real Time Hand Recognition System
Lucas F. S. Cambuim et al (2016)	-	FPGA	Extreme Learning Machine (ELM)	Real time system for hearing impair persons

Table 2- Face Gesture Applications

X	SENSOR	PLATFORM	ALGORITHM	APPLICATION
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Melanie Po-Leen Ooi et al (2005)	-	Xilinx Virtex-II FPGA	Color space detection algorithm	Non-Critical Face Detection, Simple Video and Image Coding App.
Hye Sun park et al (2005)	-	PIC16F873A	Kanade Lucas Tomasi(KLT)	Gesture Recognition for Robot Control
Pei Fia et al (2007)	Ultrasonic	DSP TMS320LF2407	Adaboost face detection & Camshift object tracking	Hands-free Control of an Intelligent Wheelchair
Yean Choon Ham et al (2009)	Image Sensor	Virtex II pro FPGA	Support vector machine	Human Computer Interaction (HCI) Application
Swapna Agarwal et al (2015)	-	-	Support vector machine	Media Player Control
Gopinath Mahale at al (2015)	-	Virtex 6 FPGA	Weighted modular principle component analysis and Radial basis funeral Network	Face Recognition In Crowd
Mitsuhiro Kawamura et al (2003)	-	FPGA	hidden mokov model(HMM)	Wearable System for personal person

Table 3- Voice Gesture Applications

<u>YEAR</u>	<u>SENSOR</u>	<u>PLATFORM</u>	<u>ALGORITHM</u>	<u>APPLICATION</u>
R.Vivek Krishna et al (2015)	-	Arduino	hidden mokov model(HMM)	Voice and Gesture Controlled Robotic Vehical (Quad-Coptor)
Andrej Škraba et al (2015)	-	ARM GK802, Arduino	-	wheelchair for disabled persons

Table 4- Applications using other gestures

<u>YEAR</u>	<u>SENSOR</u>	<u>PLATFORM</u>	<u>ALGORITHM</u>	<u>APPLICATION</u>
Bijan Najafi et al (2003)	Kinematic	-	-	For elderly person-Monitoring Of Daily Physical Activity
Chun Zhu et al (2010)	Inertial, Accelerometer, Wearable Motion Sensor	-	Viterbi algorithm, Bayes' theorem, hidden mokov model(HMM)	Human Daily Activity Recognition in Indoor Environment
D. Fuentes et al (2011)	Accelerometer	-	machine learning algorithms	Patient Daily Activity Recognition
Dwaipayan Biswas et al (2015)	Accelerometer	DEZ-115 FPGA	Orientation Detection, Sequence Detection, Action Detection	Making a Cup Of Tea Useful For Stroke Person

1.2 Technique for gesture recognition

There is an exclusive technique for gesture recognition, primarily based on the computer imaginative and prescient, pattern reputation, image processing, and so on. Imaginative and prescient based totally gesture reputation gadget includes 3 phase: detection, monitoring, popularity. In this studies survey, gesture recognition strategies

Utilized by most of the researchers through categorizing under detection, tracking, and reputation. In a maximum of the software algorithms used for hand, reputation is YCbCr color space, region growing algorithm, morphological operation ,clustering algorithm, Kalman filter tracking algorithm, median filter, hidden Markov model(HMM), skin shade detection, artificial neural network ,Haar cascade classifier , thresholding algorithm. For face and hand - Kanade Lucas Tomasi (KLT), support vector machine (SVM). For the thigh-Viterbi algorithm, Bayes'

theorem, hidden Markov model (HMM). For face reputation- AdaBoost face detection & Camshaft object tracking algorithm, weighted modular principle and Radial basis function, Reversible component transformation, color space detection algorithm, support vector machine (SVM).

1.2.1 Detection

The first step in gesture recognition is that the detection of any gesture position. Various kind of visual capabilities is skin color, form, motion and anatomical model of hands. In color-based detection the choice of the color space to be used. Numerous color area had been projected in conjunction with RGB, normalized RGB, HSV, YCrCb, YUV, and so on. Color segmentation could be a famous approach used for face detection due to its low procedure necessities and its easy implementation [14]. The color of a human pores and skin varies by a human so, color-primarily based processes to gesture detection need to rent some approach for compensating for this variability. As for the skin color-based face detection methodology, an exact skin color region is separated from the whole image by using the skin color region classifier, then the face is detected by using the sliding window-based face detector, that is one in every of the appearance-based face detection methods [15]. In a few utility in preference to pores and skin coloration, specific shade band is used to discover gesture. However this pores and skin color-based detection is more feasible.

In shape primarily based gesture detection, records can be acquired by way of just removing the outline of objects in the picture. An example of shape based gesture is fingertip of the user. To discover the pixel cost of any photograph AdaBoost set of rules is used [16]. AdaBoost is the latest face detection approach with each excessive accuracy and rapid speed. It extracts the Haar-like capabilities of photos that incorporate photo frequency records. This manner could be very rapid due to the fact that most effective integer calculation is implemented. Then a set of key capabilities is selected from those extracted functions. After being looked according to the significance, this set of functions can be used as a cascade of classifiers which are very robust and capable of stumble on various faces below various illumination situations and extraordinary face color. Also, Adaboost is capable of coming across profile faces. Haar-like are fixed-size images that contain a tiny low range of black and white rectangles. Edge characteristics or line characteristics in an images are often detected by them. The computation of a haar-like feature involves calculating the sum of the pixel values in the white rectangles of the feature minus the sum of pixel values in the black rectangles [17]. In 3-D based detection they could attain view- impartial detection. 3D model ought to have sufficient degrees of freedom to evolve to the dimensions of the gesture present in a picture. In movement based totally, gesture detection needs for a completely controlled setup.

1.2.2 Tracking

After rapid detection of a photo, that is used for tracking. Monitoring gesture is difficult due to the fact it may pass very speedy and it's appearance adjustments inside some frames. Monitoring way body-to-frame reassemble of the segmented gesture areas or features towards knowledge the discovered moves. Monitoring can be finished in one of a kind approach, Correlation-based tracking, contour based tracking. Kalman filter is a common monitoring algorithm and it is suitable to implement on FPGA [18]. Some other is CONDENSATION algorithm that is used to learn to track curves in opposition to cluttered backgrounds, famous higher performance than Kalman filters and operates in actual-time [16]. Some other set of rules defined under:

a) Camshaft algorithm: Camshaft object monitoring algorithm [16] is based on the precept of mean shift algorithm. The Camshaft is a completely color tracking technique based totally on image hue and is, in fact, a classical optimization algorithm. It makes use of a robust non-parametric method for claiming density gradients to discover the mode (height) of chance distribution referred to as the mean shift algorithm. Every generation, Camshaft goals to find the suggest window center the usage of a fixed window length. If both the window middle and the window size is volatile, both values want to be adjusted accordingly till convergence.

b) Kanade-Lucas-Tomasi (KLT) algorithm: Kanade-Lucas-Tomasi (KLT) function tracker algorithm [2] is used for tracking module. As compared with different function detectors, KLT feature tracker algorithm is strong and dependable. For item monitoring, we need to have some accurate functions which can be used to track our target. With true features approach that the feature which high-quality distinguishes the goal itself with its surrounding environments. The capabilities decided on with the aid of Harris keyword detector, that's used to discover hobby points in pictures which have an expressive texture of their corresponding localities. By tracking these keywords, the target can be tracked smoothly and firmly using the whole video sequences. The goal of Harris Keyword Detection is to produce a degree of the probability of a pixel being an aspect or corner. Object monitoring module will track those keywords of hand/face over time by localizing its function in each frame of the video. In other phrases, maintain figuring out every keyword in term of time from a body to border and this could ultimately generate to symbolize motion vector. Finally, based on the generated trajectory, object category module will inform the movement's course of hand/face or maybe different useful statistics that represented by means of the motion of gesture consisting of characters, numbers, or diverse sort of entering information.

1.2.3 Recognition

After detecting and tracking the picture, now the time is to recognize an image. There are exclusive techniques for recognition of gesture, and can be categorized from statistical modeling, computer vision and pattern recognition, image processing, connectionist systems and so on. A number of the common techniques used for gesture recognition are as follows:

a) Hidden Markov model: The HMM [1] is highly accurate in mathematical systems and have been discovered to efficaciously version spatio-temporal statistics. The model is recognized as "hidden" because all that can be observed is simplest a sequence of observations. It also involves stylish and efficient algorithms, including Baum-Welch and Viterbi, for evaluation, learning, and decoding. But, the Viterbi algorithm is expensive, both in terms of memory and compute time. Due to their Markovian nature, the time spent in a given state is not captured explicitly. HMM [18] is a statistic version that's widely known for application in temporal popularity which includes activity popularity, speech or handwriting. The primary spirit is to calculate the opportunity of a specifically discovered collection and is expecting the hidden level with the very best rear probability. Its bendy function is appropriate for series conduct reputation together with a gesture. Non-stop pose stream is used as an input of HMM, then the pose is described as a vector to signify the positions of the face, left and proper fingers. The pose is extracted from every frame within the circulation by three steps: skin-color region extraction, connected-component labeling and template matching [19].

b) Support vector machine: The concept beyond the technique is to non-linearly map the input statistics to some high extent area, in which the statistics may be linearly divided, which results in supplying overall top notch category (or regression) performance. One of the congestion of the SVM is a large number of aid vectors used from the schooling set to carry out type (regression) responsibilities [11]. SVM is a two elegance classifier, in [20] they undertake one-versus-all type approach. They teach 7 and 4 i.e. 11 SVM model, one for recognizing every of the seven hand-gestures and 4 facial expressions. For hand gesture recognition, linear SVM is used as it is miles faster. The non-linear patterns of facial expressions have classified the usage of non-linear SVM. But there is some disadvantage with SVM, it lacks in transparency of results. Since the dimensions may be very high, SVM might not be able to show the companies score as a parametric function based on financial ratios or any other functional form.

c) k-means: k-means is a widely used algorithmic rule for segmentation because of its inherent simplicity and potency. It is conjointly used for locating subsets of knowledge, known as clusters, with similar options [21]. The k-means algorithmic rule is parallel in nature thus, it can be efficiently mapped onto completely

different hardware platforms like Field Programmable Gate Array (FPGA), without affecting its performance and responsibility [21]. Mean and fitness modules are further unfolded to further enhance the speed of k-means clustering algorithm. The unfolding factor has to be selected by keeping the area of the target device in check [21].

d) Wearable sensor-based recognition: Wearable sensor application are typically obvious and awkward to the human concern, especially when there are many wearable sensors. But, lowering the wide variety of sensors will boom the problem of distinguishing the primary day-to-day activities due to the inherited ambiguity. Inertial sensors are widely used to capture human movement records. As an example, in [22] they have used kinematic sensor connected to the chest. They might detect body postures like sitting, standing, laying, etc. The wavelet transform, in conjunction with a simple kinematics model, changed into used-to hit upon unique postural transitions (PTs) and strolling intervals for the duration of daily physical activity.

2. APPLICATION USING GESTURES:

At present, there are such a lot many applications which we're using right here and there. So we're in that segment wherein we cannot imagine our lifestyles without all the utility as it makes our lives so easy. Not most effective in our ordinary lifestyles but in different domains like robot manipulation, business automation, military, clinical, entertainment, smart home and many more, the diverse application takes a massive role. All the applications make our work so smooth, only we must give a few commands to the application. To operate the utility, we use a tangible device like remote, keyboard, mouse and so on. But it could be smarter, if we could manipulate it in a non-tangible way; non-tangible manner i.e. without any physical interplay with the application. We can manipulate it with the aid of the usage of any gesture function. In each area, we can use this gesture based control.

In medical application, computer information technology is more and more penetrating. In [23], author broadens a gadget for stroke survivors to control their arm movement in real time using information from the wrist-worn accelerometer. The affected person is monitored by analyzing picture records taken from various types of sensors that acquire an entire perspective, approximating the fitness status of an aged man or woman. This gives the patterns of conduct and execution of an affected person's activities of daily living (ADL) [24]. In [3, 22, 25-27], the affected person monitoring gadget evolved the use of sensor and wide area network that could screen human regular pastime without stress in their day-to-day life. In [28], they introduce a brand new approach to enforcing a movement popularity method, the usage of a cellphone fitted with an

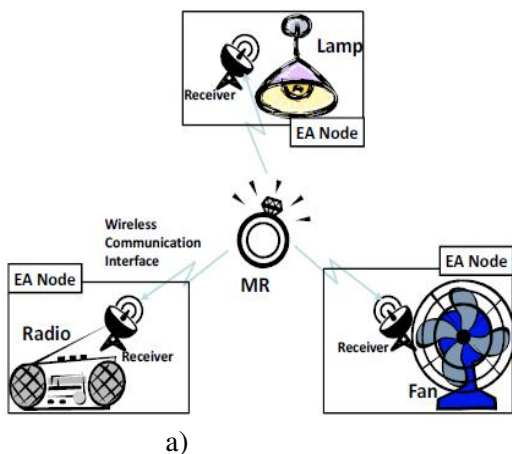
accelerometer to correctly apprehend unique human activities with a high-level accuracy. Apart from this, gesture based primary application utilized in a hospital so that a medical doctor can perform exceptional activities without physical intervention. In [29], they verify an Autonomous Robotic Surgery (ARS) to perform simple tasks without the presence of surgeons. To enhance the quality of lifestyles for elderly and disabled humans, in [16] they introduce sensible wheelchair totally based on a visual reputation of head gesture. Another way to interact with robot is the use of brain-computer interface using EEG signal that can automatically control the robotic arm [30].

In entertainment sector, we can play many kind of games without the use of a keyboard or remote. In [31], they made cube sport which is managed via the hand gestures and is used for comparing the performance of hand gesture popularity system. Additionally, to control television, the non-touch manipulate based machines are introduced. A child toy can also be controlled using these gestures. In [20], they layout a media participant device controller by way of facial expression and gesture. In [32], they made a robot for lexical entertainment in which robot explains about some product or anything, or follow the commands given by user. In [33], a multi-modal

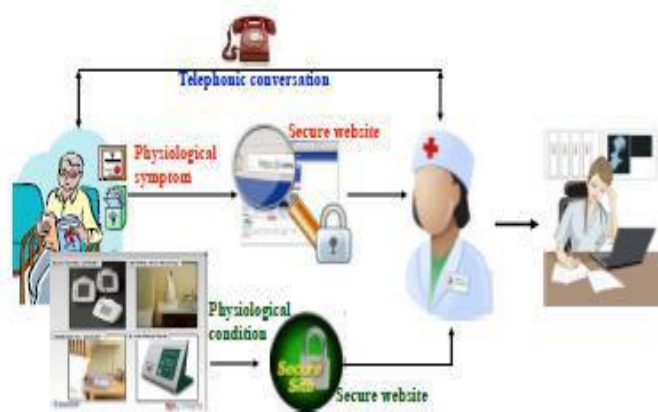
interaction game with robotic platform based on signs to interact with the children and motivate them to learn these signs.

Numerous electrical home equipment's have become part of human's every day existence consisting of televisions, video and audio device, and other family home equipment. For a smart home in [34], they developed a one-for-all gesture-based totally remote manipulate device by which human can control distinct home equipment in nature and in a unified manner.

There are many robots or machines used in industry. Industry automation has undertaken many tough and dangerous tasks for human beings within the discipline of industrial production, including welding, painting, meeting, product inspection and checking out. In industrial sector as well, gesture control is viable. In [19], they developed a gesture recognition gadget for the interplay between a person and robot. In [2], they evolved a Gesture-Changeable underneath-Actuated (GCUA) Humanoid robotic hand for top limb. In [35], they made an industrial mobile robotic application with the use of emotions. Additionally, there are a lot many robot packages deployed in industries that are solely controlled based on gestures.



a)



b)



c)



d)

Fig 2a - control of household appliances [34], 2b- remote monitoring system [25], 2c- hand gesture to control cube game [31], 2d- robotic learning using hand gestures [11]

3. HARDWARE AND SOFTWARE DESIGN:

While imposing a technique/set of rules for developing a utility which will have functionality to detect, track and understand hand gestures, the major difficulty is to recall the methodology which is used to apprehend the gestures. In this section, we discuss the structures which support gesture popularity in various strategies and similarly in implementation of small to medium scale software and hardware packages.

There is an application that manage the usage of gesture recognition. To control the gestures, different platforms are used like Altera FPGA board, Arduino, DSP TMS320, MSP430, LPC2138 and so forth. The evaluation of distinct platforms is shown in table 1. Among all of these, we select Altera FPGA board. The advantage of using FPGA [2] as a development platform is FPGA has a higher computing platform than PC to perform data-intensive video processing responsibilities with real-time requirements. Even though FPGA works at slower clock frequency than regular PC, however, it calculates faster than a computer because of its feature of parallel computing. Every frame can be computed at the same time with FPGA, but only sequentially with PC, as a result, the PC calculates slowly. Further, there might not be need for additional bandwidth between camera and computer, because the result from the digital camera can be as simple as merely an index of a gesture amongst pre-defined gesture database. Furthermore, FPGA presents a better overall performance and flexibility than DSP for parallel processing and pipelined operations in order to process high resolution and high frame rate video processing. Additionally, it has in-built clock source, different inbuilt ports, ease of person compatibility. In table 3 the FPGA board is shown.

Along with the hardware, the software program is used to recognize the gestures. On this exclusive platform, there are many software programs that are supported. In software element, we can put into effect special algorithm to come across gesture. Some of the software programs are described below:

Altera Quartus II

Altera Quartus II is a programmable logic design software program rolled out by Altera. Quartus II

allows analysis and synthesis of HDL designs, which enables the developer to bring together their designs, perform timing evaluation, take a look at RTL diagrams, simulate a design's reaction to special stimuli, and configure the target tool with the programmer. Quartus includes an implementation of VHDL and Verilog for hardware description, visual modifying of good judgment circuits, and vector waveform simulation. SOPC Builder, a tool in Quartus II software program that gets rid of manual system integration task by using automatically generating interconnect logic and creating a test bench to confirm functionality. By use of this software, we can practice any algorithm that we come across gesture control. For FPGA's coding purpose this software is useful.

OpenCV: OpenCV (Open Source Computer Vision) is a library of programming functions especially aimed at the actual time PC vision. OpenCV's software areas are Facial reputation device, Gesture recognition, Human-computer interaction (HCI), mobile robotics and so forth. It was initially advanced in C but now, we also have full libraries for C++, Python and supports for Android platform. It is also compatible hardware for Linux, MacOS X and home Windows structures supplying massive cross-platform compatibility. OpenCV Eclipse IDE, C++ Builder, DevCpp IDE support provides developer's easy access for constructing programs with any of the above mentioned IDEs.

MATLAB

Matrix laboratory (MATLAB) [11] is a numerical computing environment and fourth-generation programming language. This software is a product by MathWorks. MATLAB permits implementation of algorithms, matrix manipulations, plotting of capabilities and statistics, the arrival of person interfaces and interfacing with applications written in other languages including C, C++, Java and FORTRAN. It also supports hardware for Linux, MacOS X and windows structures supplying considerable pass platform compatibility. MATLAB gives Image Processing Toolbox which gives a comprehensive set of reference-fashionable algorithms and graphical equipment for image processing, evaluation, visualization, and a set of rules development.

	<u>DE1 FPGA BOARD[49]</u>	<u>LPC2138 MICRO-CONTROLLER[46]</u>	<u>DSP TMS320 [47]</u>	<u>MSP430 [48]</u>
SRAM	512 KB	8/16/32 kb	544 words	128 B–10 KB
SDRAM	8 MB	-	-	-
ROM	-	-	4k words	1–16 KB
Flash Memory	4 MB	512 Kb	-	1–60 KB
Clock Source	24 MHz , 27 MHz , 50 MHZ oscillator	60 MHz	10 MHz	32768 Hz
Operating Voltage	9 V	3 to 3.6 V	5 V	2.5 V to 5.5 V
Port	Expansion Header, audio CODEC VGA video port, USB	UART	Serial Port	JTAG,UART
Language	HDL	Embedded C	C,C++,Assembly Language	Embedded C & C++

LEDs & Switches	18 LEDs, 10 toggle switches	-	-	2 LEDs
Processing	parallel	parallel	parallel	Parallel

Table 5 - comparison between different platforms



Fig 3 – Altera FPGA DE2 board [49]

4. CONCLUSION AND DISCUSSION:

In human-computer interaction (HCI) application, gesture recognition lured vital position. The application that makes use of sign language as an input was everyone's attraction. This sort of utility may be relevant in business automation, robot manipulation, medical, etc. This paper affords a survey on one-of-a-kind gesture recognition application with the algorithm used to recognize gesture like HMM, SVM, Kalman filter and so forth. Additionally, extraordinary platform and software program are used to understand the gestures. Specific gesture positions are used to provide input like a hand, face, arm, chest and so forth.

There are a few existing devices that understand gestures, however there are specific ways to apprehend it. But the accuracy of hand gesture is better among all the gestures. The shade marking or glove based or sensor based reputation approach has some disadvantage. So to overcome that, simple body posture is used and a camera is used to apprehend that gesture. Spotting gesture via digital camera uses extraordinary algorithms. For that, hidden Markov model and support vector machine algorithm is very useful. But for accurate response time, the more flexible camera is used to capture input gesture.

The main challenge to recognize gestures involves handling a number of signals, a degree of freedom (DOF), and a variety of gesture speed. Moreover, it needs also to balance the accuracy-performance-usefulness trade-off consisting with the sort of application, the cost of the solution and several other criterions such as real-time performance, robustness, scalability and user independence.

Future studies in the area of gesture popularity systems offer an opportunity for the researchers to

provide you with coherent systems overcoming the drawbacks related to the middle technology inside the contemporary state of artwork, for permitting technologies gesture portrayal and gesture recognition structures as an entire. The industrial programs also require precise advances within the human to machine and machine to machine interactions.

How FPGA and our robot will help the society i.e. how this study is helpful in context of society and robotics. From this literature review, the derived block diagram of robotic system is shown in fig 4. At the application side, we can use different social application.

- Real-time application for an elderly person to detect their daily physical activities by using FPGA board with camera or sensor. The Advantage of using FPGA board is that it works at 50MHz clock frequency and it recognizes the gesture movement in 41.2 microseconds [23].
- Lexical application that is used for deaf mute person to communicate with other people by the use of robot with FPGA platform. Person communicate with robot in sign language and robot speaks up what deaf mute person trying to speak. FPGA response time is faster than other platforms. Also, it is compatible board with so many input-output port so we can inculcate more functionality in application.
- Gesture based robot control is used in surgery task where a doctor cannot operate small things. In this type of application, the accuracy of the robot matters a lot. So for that we use FPGA board with three types of inbuilt clock source and it consumes lesser power.

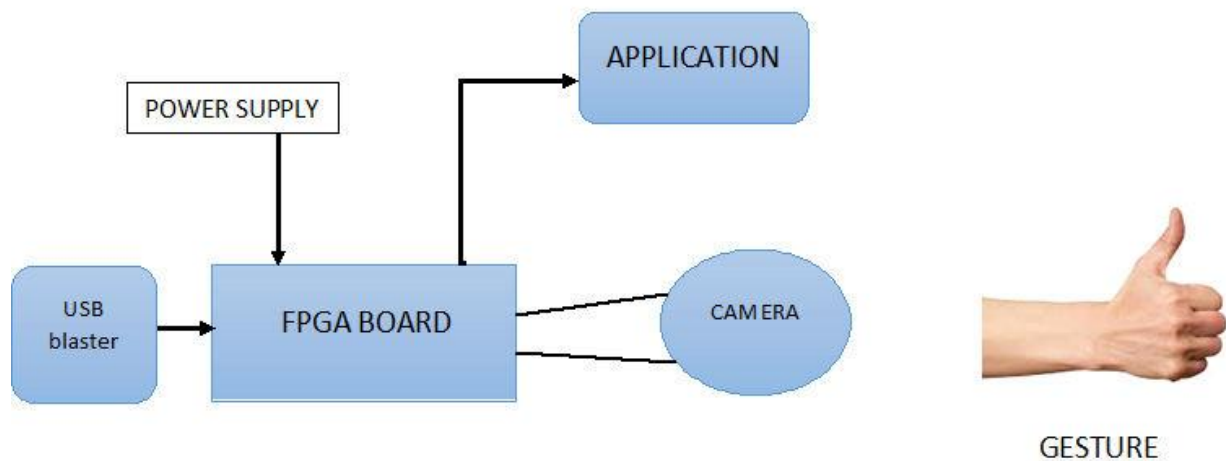


Fig 4 block diagram of gesture based robotic system

- Real-time virtual game - we can play by using different gesture movement without physical intervention. Another type is we can play with the robot using different sign language.
- In industry to control huge machines, we can use a robot. So by simply sitting at one place we give a command to the robot and it will work with all machine.

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