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**RESEARCH ARTICLE**

# Keyless Car Entry through Face Recognition Using FPGA

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## *Abstract*

In this paper, a modular, configurable and versatile hardware platform for real-time video and image processing is presented. The hardware platform is based on the Altera DE2 development board which is completed with a Camera interface for video acquisition and a VGA interface for image restitution. A facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame fro m a video source. A number of defense, security and commercial applications demand real time face recognition systems, especially when other biometric techniques are not feasible. Using it in our project fulfils the need of ca r security so as to prevent car thefts which is easier in case of ca r locking systems. An FPGA (Field Programmable Gated Array) based novel design has been developed which provides real time face tracking of the respective person and if found the respective persons op en the lock of the car. The whole system is developed on Altera DE2 board using Verilog HDL (Hardware Description Language) as a coding language. We have not used any of the basic algorithms for the project; we developed our own algorithm by using DE2_TV core provided along with the Altera DE2 board. In our project a fixed background of black color is used and when the pixels of background are distorted by incoming person the corresponding pixels are saved in the SRAM of the board and then later retrieved for face detection and recognition. If the distorting pixds are same with the already saved then the lock of the car opens.

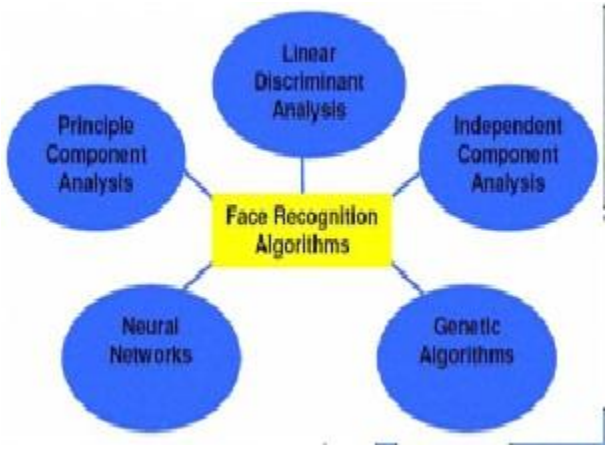


## I. INTRODUCTION

Face recognition is a form of biometric identification that relies on data acquired from the face of an individual. Now a day's face recognition systems are a need of a number of defense, security and commercial applications. Growing numbers of applications are starting to use face-recognition as the initial step towards interpreting human actions, intention, and behaviour, as a central part of next-generation smart environments. Finding a face from a video frame is one of the situations where face recognition may help reasonably. Human can easily and quickly identify this variance while machine is slower and error prone. There are numbers of standard algorithm for biometrics recognition used these days. Majors are implemented using MATLAB (Matrix laboratory), Open CV and other dedicated software's using C or some other coding language. Maximum number of already developed face recognition system on FPGA uses soft core processor NIO S of Altera for implementing the system

Our system is totally different; we didn't use any of the standard algorithms for this purpose and nor uses soft core processor and implemented the system on FPGA using Verilog HDL by using DE2_TV core. FPGA does not needs an external processor for execution of its program as Open CV and MATLAB required. This is its major advantage

in implementing this system in Cars. The system is developed for working in real time and the pixels are saved in SRAM (Static RAM) and then retrieved for further execution. The motor of the car lock is connected with the GPIO of the board and in case of authentication form the system a logic I is send to the GPIO ports and locks are unlocked.




## II. WHY FPGA?

Over the last decade, the popularity of Field Programmable Devices to implement digital circuitry has seen a significant increase. The FPGA is the most spectacular programmable device and it has a several advantages, such as their fast manufacturing turnaround time, low start-up costs and conception easiness. With increasing device density, audacious challenges become feasible and the integration of embedded architectures is significantly improved. In video application, and especially in video processing, the impressive evolution of algorithms and the emergence of new techniques dramatically increase the complexity of algorithms. This computational aspect is crucial for many real-time applications and in the most cases; programmable devices become the best option.

## III. HARDWARE AND SOFTWARE DESCRIPTION

Face recognition system is composed of three units which are input, processor and output unit. The input unit is a digital camera having NTSC (National Television System Committee) video format as standard, as the core DE_TV is only applicable to NTSC format. Now available cameras in market have both PAL and NTSC format so we can switch between them The processor used is Altera Cyclone® II 2 C35 of FPGA device. The processor unit deals with the video decoding, detection of the face, recognition and data transmission to the output unit. The processor process the incoming signals from the input units and send the processed data to the output units which is the motor and VGA in our projects. DE2 board has VGA DAC (lO-bit high-speed triple DACs, AD71 23 240 -MHz) with VGA-out connector and TV Decoder circuit (Multi format SDTV Video Decoder, ADV718IB) [7] which decode the incoming video from the camera. For software part of the project, Quartus II 9.1 service pack 1 web edition is used. This software is available at Altera site for free use [6].

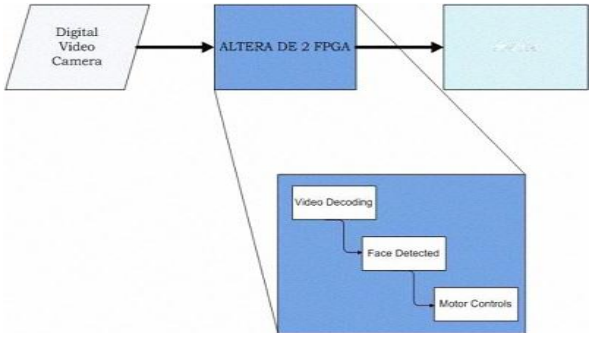



Fig # 2 hardware units of the systems

## IV. DE2 BOARD SPECIFICATIONS

The DE2 board includes a 16 -pin D- SUB connector for VGA output. The VGA synchronization signals are provided directly from the Cyclone II FPGA, and the Analog Device ADV7123 triple lO -bit high-speed video DAC is used to produce the analog data signals (red, green, and blue) and can supports resolutions up to 1600*1200 pixels at 100MHz. The DE2 board is equipped with an Analog Devices ADV7181 TV decoder chip. The ADV7181 is an integrated video decoder that automatically detects and converts a standard analog baseband television signal (NTSC, PAL, and SECAM) into 4:2:2 component video data. The board is also equipped with 512 KB SRAM.

## V. VIDEO CAMERA DECODING

We uses CANON digital camera with a standard NTSC video output as our video camera input. The data is read in from the Video-In plug on the DE2 board and goes through a set of hardware modules that convert the input data to a standard RGB format for display on a VGA monitor. The data that is read in directly from the camera is in the ITU 6 56 format, and must first be converted to a more standard YUV 4:2:2 formats, more commonly referred to as YCbCr. The YCbCr format is a color display format in which the different components are Y, Cb, and Cr, which represent the luma component, blue-difference and red-difference chroma components respectively. This format is not an actual color space of its own, but a way of encrypting RGB data. As the data input is converted to this format, the system simultaneously down samples the signal from 720 to 640 horizontal pixels. After being converted, the data is then fed into an SDRAM FIFO which acts as a frame buffer. The output of the FIFO is then taken through another conversion process, transforming the data from the YUV 4:2:2 formats to the YUV 4:4:4 formats. Finally, the new YCbCr formatted data is converted once more to the standard lO-bit RGB format.

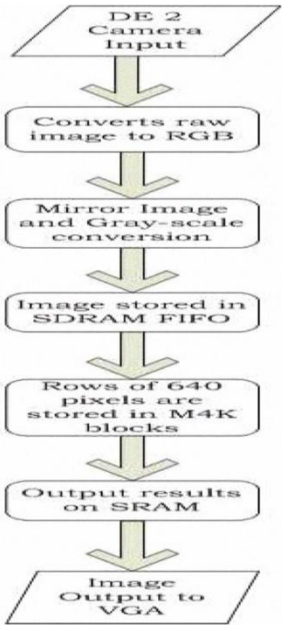



Fig # 3 Flowchart of the DE2_TV

## VI. DE2 TV CORE

All of the modules which do these various data conversions were provided for us through the DE2_TV example code that comes with the DE2 board provided by Terasic. In the standard core, the RGB data is fed directly into a VGA controller so as to be displayed on a standard VGA monitor.

There are two major blocks in the circuit, called I2 C_A V_ Co n fig and TV_ TO_ VGA. The TV_TO_ VGA block consists of the itu_r656_decoder, Dual Port Line Buffer , HsyncX2, YCrCb2RGB, and VGA Timing Generator. The figure also shows the TV Decoder (ADV7181) and the VGA DAC (ADV71 23) chips used. The I2C protocol communicates with the TV Decoder chip. The itu_656_decoder block extracts YCrCb (4:4:4 ) video signals from the 4:2:2 data source sent from the TV Decoder. YCrCb2RGB block converts the YCrCbx2 data into RGB output.

## VII. MODIFIED DE2 TV CORE

For our purposes, however, we wanted to actually examine the image that is to be displayed, and this is the place in the data flow where we were able to read the data in a format we are familiar with. As such, instead of going directly to the VGA controller, the RGB data goes through one more module, face detection, which scans the data as it passes through pixel by pixel and if the background pixels distorted it means that the distorting thing is a face. Thus a face is detected and if wants to make clear the face we can change the color of the face by simple changing the pixel value of face. The image below shows the flow diagram of the video decoder hardware:

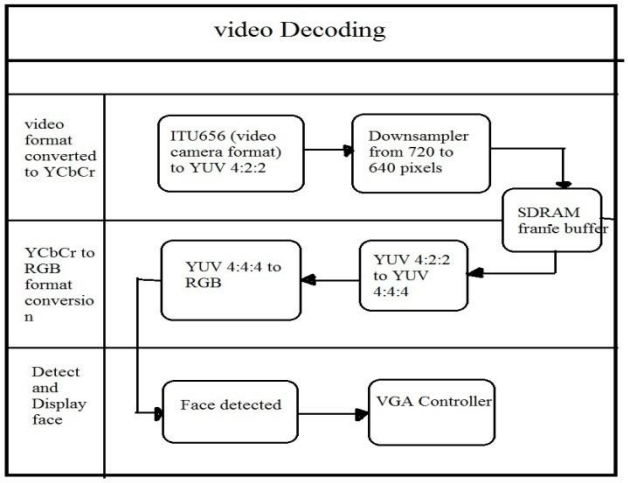



Fig # 4 Flowchart of modified DE2_TV

## VIII. PIXEL INFORMATION OF THE IMAGE

First of all we take the picture of black back ground and check its pixel value in MATLAB software in unit 8 format that has minimum 0 and maximum 255 pixel value. It is understood that black constitute of RGB=O but in real condition it is not true therefore the limits for RGB is 0 < RGB < 50. The pixel value for RGB is 12 but we multiply it with 4 to scale it for 10 bit VGA. Now a picture of a person is taken and again mnge of the pixels value for his face is checked and found to be 300 < RGB < 4 50 .

## IX. FACEDETECTION

In our video and image processing application, the chain contains modules of acquisition, processing and restitution of a video signal coming from the video source. Therefore, for us the real-time is the fact that the acquisition and the processing should not introduce delay which leads to the loss of useful data for the video restitution. For our project we use a black back ground. As we know that for black RGB sums to zero and Y (Iuma) also equals to zero. So for input without any face the VGA shows black color and have RGB=O but when a face comes in the range of the camera the black color of the back ground distorted with the incoming face and the camera scans from where the black color distorted. After scanning the camera found the starting pixel which will be in the range of the already saved pixel limits that is 300 < RGB <450. From here a new module named sram started which saved the distorting pixel value in the SRAM. After detecting the face the color of the face will be masked with white color. Saving these values in SRAM is done at real time. The values are converted in a matrix of 1* 1 dimensions by Verilog HDL coding. Saving 1* 1 matrixes is easier as compared to saving the whole matrix. Like if we have a matrix of ixj (where i and j are number of rows and columns respectively). SRAM starts saving the value from row 1 and

proceeds toward right and after saving row 1 it will start saving row 2 from column 1. In this sense it will save all the pixel value of the image. SRAM saves value in addresses and we can retrieve the addresses and also their values to check what is saved at what address. For the data base we take a picture of the respective person and converted it in mw data by using Imagconv.exe [8] tool available in CD attached with the DE2 board. The tool converts the image in to a mw data containing the pixel value of each location. These pixel values are already saved in the SRAM. When the same person comes again in the environment its picture is again taken by the camera and its pixel value a re compare w ith the already saved value if it is same the car lock is opened otherwise remain locked. The system is not much accurate and the person has to show the same pose and appearance as it shows for the raw data image. Otherwise system does not detect the person.

## X. MOTOR CONTROL O F THE CAR LOCK

For the prototype we use window power motor and attached the lock of the car with it and connected it with the GPIO of the DE2 board. The motor works on 12 volt but the GPIO supply 5 volts so we put the 5 volts on to IC number Lm2577 - 12 or LmI57 7-12 [9] which converts 5 volts into 12 volts or we can make H- Bridge to supply the needed current and voltage. H-Bridge is a circuit that is used to drive the motor in both direction and also to provide needed current and voltage. The GPIO pins also have two VCC supplies that is of 3.3 and 5 volts and two grounds for them

## XI. LIMITATION OF THE SYSTEM

The proposed system is not much accurate and the person has to show the same pose at the time of recognition as it shows atthe time for database. Because pose difference and light intensity creates much differences for the system to recognize.

## XII. CONCLUSION/FUTURE WORK

Face recognition is a both challenging and important recognition technique. It has been shown that the proposed system can be implemented at any types of automobiles and can be used at any place where face recognition or detection is needed. The proposed system can be used to detect any other thing with some amendments. Among all the biometric techniques, this approach possesses one great advantage, which is its non-intrusiveness. In this paper, we have developed a new algorithm from which we have been able detect, store, recognize and differentiate among human faces using pixel distortion. However the results are not 100% reliable due to certain limitations of system based on facial recognition such as illumination, background conditions, changes in facial expressions and features. This algorithm is far from perfect thus we need to develop system that is more reliable. In addition to provide authorized access to the car, system can be used to estimate driver status from the facial expressions like drowsiness and distraction. The facial recognition system that we have designed is portable and reconfigurable therefore it can be programmed and deployed at security systems for law enforcement at airports and international borders customized according to their requirements. We are doing to make this system much more accurate and make it to work in any condition where light intensity differs. The system will be made much more applicable for domestic use and inexpensive. This can be done by using SDRAM instead of SRAM, because for that we can upload much more detailed information of the pixels. For the proposed system we have just entered the pixel information of the face only.

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