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# A Review Paper on Object Detection using Zynq-7000 FPGA for an Embedded Applications

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**Abstract -** *Object detection is basically detecting the instances of relevant objects of certain class in digital image. With the deeper research on object detecting more and more complex algorithms are presented. This paper represents review on Object detection using Zynq-7000 FPGA for an embedded applications such as autonomous vehicles, military reconnaissance, and robotics. For embedded applications FPGA's are promising approach. Xilinx Zynq-7000 FPGA is used in various applications which includes dual package that is dual core ARM Cortex-A9 based Processing System (PS) and Xilinx Programmable Logic in a single device.Zynq-7000 FPGA is a good platform, it has good processing speed, and time required is less and reduces the cost. It offers flexibility and scalability, meanwhile it provides high performance, and low power. Most of these applications demand low power consumption, compact and lightweight design, and high speed computation platform for processing image data in real time.*

***Key Words*: FPGA (Field Programmable Gate array), Zynq-7000, Object Detection, Vivado HLS, computer vision, CNN (Convolutional Neural network)**

## 1. INTRODUCTION

Computer vision is very important for the object detection techniques. It makes computers and other devices take the place of the human eyes for object detection and do further image processing. Image processing and computer vision are the new trend of research, for further use of building artificial intelligence systems to obtain information from images [2].

With the development of computer vision various methods came into the picture such as deep learning a convolutional neural network is a class of deep neural network, the deep learning model has also been widely used in pedestrian detection. Deep learning has great advantages over traditional target detection. The traditional method is to manually extract features of particular region and require experts in related fields to manually design and process them through years by continuous iterations. The method of deep learning can learn the difference between features and gives response through data and is more representative. The deep learning model simulates the human brain's visual perception system. It extracts features directly from the original image, and the features are passed through the layer by layer to obtain the high-dimensional information of the image, making it a great success in the field of computer vision[3].Recent advances in camera sensor technology have led to an increasingly larger number of pixels being assembled into smaller spaces. [4]. various deep learning algorithms are there such as CNN which takes input image assign important to various objects and final classifies it into different categories. For some object detection algorithms CNN is widely used. Generally they consists of two major steps: bounding boxes regression and inner object classification. Traditional approaches like sliding window and region-based algorithms suffer from low accuracy and long execution time.

## 2. LITERATURE SURVEY

Since in embedded applications used platform and object detection techniques are mandatory part, where major focus need to be given. Hence comprehensive of review here is presented. Following are the few literatures explaining the various methods that are being used for object detection and platforms on which this methods are to be performed.

Abdelkader BEN AMARA [2018] [1] presented, an FPGA based mobile feature detection and tracking solution is for complex video processing systems. Presented algorithms include feature (corner) detection and robust memory allocation solution to track in real-time corners using the extended Kalman filter. Target implementation environment is a Xilinx Zynq SoC FPGA based.In this paper they have used Harris corner detection and Kalman filter w.r.t non max suppression algorithm. The temporal performances of their approach is roughly 50% better than these of classic implementations. Also this application is being used for visually impaired persons so typically they only detected corners but not the whole object such as trees. Many obstacles can be their but this approach is only good for corner detection. [6] *Wenchao Liu* presented an FPGA-based moving object detection and tracking system is introduced for image processing application. The algorithms presented include object detection based on dynamic background difference, Kalman filter for object tracking. The target device for the implementation is a Xilinx Zynq-7000 FPGA.

In the dynamic background, the system realized various objects but while at tracking we have to differentiate between the objects that are important and are necessary for any application this is time consuming. There are various limitations of the Kalman filter - It assumes that both the system and observation models equations are both linear, which is not realistic in many real life situations. Also it assumes that the state belief is Gaussian distributed. [7] In this paper, Hanaa M. Abdelgawad shown how HLS constraints and optimization directives were applied for timing and area optimization. The implementation of stream-based canny edge detector processing using C-based HLS is presented. The results show that hardware accelerators enhance the complex computation of the processing functions. The hardware accelerators on FPGA enhance the computational performance: the CPU utilization drops down and the frame rate increases, in ZYNQ platform it is up to 60 fps for a resolution of 1280 x 1024. There are many computer visions application which can take advantage of hardware accelerators to enhance performance of real-time highly computational applications. When targeting HLS design flow, the implementation of C/C++ code is rapidly developed for hardware accelerator. In the Future work, besides improving the quality of edge texture map result by distributed canny edge detection algorithm. Implementation of augmented reality (AR) pipeline is considered to make use of the cooperation between CPU and FPGA. Highly computational video and image processing operations of augmented reality will be as hardware accelerators. This will enhance the real time performance of AR applications

## 3. PROPOSED SYSTEM

The proposed system can be Object detection using Zynq7000 FPGA for various embedded applications. Object detection is basically detecting the instances of relevant objects of certain class in digital image. With the deeper research on object detecting more and more complex algorithms are presented which leads to the larger calculation and throughput. The target device for implementation of this algorithms and over-all procedure is Xilinx Zynq-7000 FPGA. Zynq-7000 includes dual package that is dual core ARM Cortex-A9 based Processing System (PS) and Xilinx Programmable Logic in a single device.Zynq7000 FPGA is a good platform, it has good processing speed, and time required is less and reduces the cost. It offers flexibility and scalability, meanwhile it provides high performance, low power. Vivado Design Suite has been used for analysis of HDL designs, perform timing analysis and examine RTL diagrams and also configure the zynq-7000 FPGA with a programmer. Earlier versions of Xilinx ISE are also their but Vivado consists of tool chain that converts C code into Programmable logic. Also many processors can be integrated and lots of peripherals can be dumped into it. Considering all these advantages, Xilinx Zynq-7000 FPGA is chosen to be supreme platform for this work.

After studying of algorithm we found that its implementation is little tricky but in accuracy and speed these are better. Various object detection algorithms are introduced now. Comparison chart of object detection algorithms is shown in Table 1, also given that how Yolo is fast and its accuracy is better than other algorithms. Some are as follow-

- R-CNN ,
- SPP,
- Fast R-CNN,Faster R-CNN,
- Yolo

**Table -1:** Comparison chart of different object detection algorithms.

| Algorithm | Features | Prediction time |
|---|---|---|
| CNN | Divides the image into multiple regions and then classify each region into various classes. | - |
| RCNN | Uses selective search to generate regions. Extracts around 2000 regions from each image. | 40 to 50 seconds |
| FAST RCNN | Each image is passed only once to the CNN and feature maps are extracted. Selective search is used on these maps to generate predictions. Combines all the three models used in RCNN together. | 2 second |
| FASTER RCNN | Replaces the selective search method with region proposal network which made the algorithm much faster. | 0.2 second |

YOLO is an extremely fast real time multi object detection algorithm. YOLO stands for “You Only Look Once”. The algorithm applies a neural network to an entire image. The network divides the image into an S x S grid and comes up with bounding boxes, which are boxes drawn around images and predicted probabilities for each of these regions. The method used to come up with these probabilities is logistic regression. The bounding boxes are weighted by the associated probabilities. For class prediction, independent logistic classifiers are used. Yolo’s output can be seen from Fig 1.

**Fig -1**: Results of Yolo object detection technique

## 4. CONCLUSION

This review paper gives brief survey on various object detection techniques with FPGA platform. The basic detection methods are Harris detection, Kalman filter and canny edge detection. Most of the researchers prefer to use Kalman filtering. All this methods are time consuming and computationally complex. Also use of Kalman for both the system and observation models equations are both linear so this method cannot be used in real time object detection system implementation. From the literature review it can be concluded that there is prerequisite to implement image processing technique on FPGA in order to achieve object detection with accuracy and speed. So in order to develop precious and optimize system, object detection algorithms are preferable.

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