Human Posture Detection in Always-on Body Worn Cameras

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***Abstract*—Internet of Things (IoTs) is the emerging Technology as the third wave in the development of the internet. IOT is accepted to have massive impact sensors, surveillance devices; wearable's and body area networks with advanced interface technique. This leads to the need for a hardware-software co-design approach. We present a highly parameterized hardware design allowing configurability and the ability to evaluate different design choices in a short amount of time. This paper aims to analyze the use of Deep learning algorithm for building such reconfigurable low power devices. We develop the hardware architecture for such a system and provide experimental results obtained for the case study of Posture detection for body worn cameras used for law enforcement. Our proposed system, implemented on a Raspberry picamera platform uses minimal power consumption with an accuracy of more than 90% for the selected case study of Posture Detection.**

***Index Terms*—IOT, deep learning algorithm, human posture, picamera**

I. Introduction

Technology and innovations makes police organizations to achieve their goals, whether to prevent crime, or to make day-to-day processes and practices more efficient. However, at the same time, new technology is also impact on police practice in ways that are unintended or unanticipated. Additionally, technological change is rarely straightforward and deterministic, but it also ongoing and emergent. Therefore, it is important to research new police technologies beyond their impacts on outcomes regarding effectiveness and efficiency to understand fully how they might change existing organizational structures and practices. This is particularly the case for technologies, such as Body-Worn Cameras (BWCs), which are diffusing rapidly, in a "low information environment" where much information also still unknown about their intentional and unintentional effects.

Technology plays an important role in policing, which was true in the past with the adoption of automobiles and two-way radios, and now, as police organizations continues to adopt technology to meet their needs. Some recent technologies are License-Plate Recognition technology (LPR), gunshot recognition, body armor, CCTV systems; fingerprint identification records management systems, mobile data centers, computer aided dispatch systems, and automated field reporting systems. Some of the technology like BWC is used in many crime activity deterrents such as in mesa, United States [1] and also in United Kingdom [2]. But BWC act as a limited Wide spread technology because of Short Battery life [3] and also there is a need for Human Operator.

For implementing the Body Worn Camera (BWCs) they have used ASIC to extract the background from the video [4]. Later on they have used a dense network [5] which is not suitable for the real time application. Where we are going to use a simple algorithm which result with the reduced complexity and 90% of accuracy

In some cases, new technology can even be the cause of adverse effects or unintended consequences. Thus, it is important to be aware of the comprehensive effects when adopting new technology, an observation that provides the general premise for this study on a new technology that is becoming increasingly popular.

The rest of the paper is organized as follows. Section II presents a brief review of Human Posture Dataset and there methods. Section III discusses the Architecture of the System. Finally we discuss the result of the DLA and also accuracy amount in Section IV.

II. Human Posture Dataset

The procedure is carried out from Weizmann human silhouette [6] based on human posture. This database consists of video sequence with consist of different actor performing ten different human actions such as "Running", "jogging", "walking", "Hand Waving". Background and object are extracted. Object and background subtraction algorithm with hardware implementation are described. These postures are aligned and the training of the neural network is performed using these aligned silhouettes. This dataset are used in BWCs, to achieve a simple and accurate human posture. Different human postures from the Weizmann database correspond to basic human postures detection and are cable to BWCs. For example, 'putting both hands up' is treated as a defensive posture while 'running' is treated as aggressive behavior. Once proper human posture

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identification is enabled, the output can be used for further action as the situation and usage demands. (See Fig. 1)

Figure 1. Human postures database

However, posture identification is a key primitive that can enable 'always-on' BWCs for law enforcement. Other primitives such as sound may also be combined with posture identification to provide indications with better confidence. Algorithm is discussed in [5], [7], [8].

A. IOTs (Internet of Things)

The "Internet of Things" leads to a inter communication among human and devices. These devices normally possess enough intelligence to evaluate and process data. Necessity of battery life, transmission cost and storage capacity causes significant intelligent device capable of making decision with reference to the application of image, before processing [9].

B. Artificial Neural Network

Artificial Neural Networks Experiment the process of neural system. Every node in ANN provided with the input and its weights processed to get output. ANN provided with high capability and be an active research for last few decades. Artificial neural network comprises the large number of parallel computing and this leads to the Graphics Processing Units (GPUs) or Field Programmable Gate Arrays (FPGAs) and they are mainly used for computation. In this paper neural network is used to simplify the work of "always on" systems, it also provide with the least energy by using least resources. This module is reused for making accurate classifications once the suitable image has been filtered out. This leads to the meet the requirement of low power consumption.

C. Deep Learning Algorithm

Shallow networks such as Support Vector Machines with Gaussian kernel machines and single hidden layer Neural Networks have been shown to be able approximate any function with arbitrary precision [10]. For determining just the relevancy of an image such a network can prove useful and efficient. We opt for Deep learning Algorithm (DLA) and Hardware to achieve low energy human posture detection. Deep Learning Algorithm based recognizers are probabilistic graphical models (which form the basis of deeper networks). DLA are portable for embedded hardware memory. DLA allow us to re-use the same resources via time multiplexing because of their modularity and Single Instruction Multiple Data (SIMD) nature. We provide the high accuracy of network by storing different weight for every layer and making using of reusable resources. DLA is fully connected with visible and hidden units; it does not connect with hidden-hidden and visible-visible units. Deep Network can be accomplished in many methods like greedily Layer by Layer as given in [11]. (See Fig. 2)

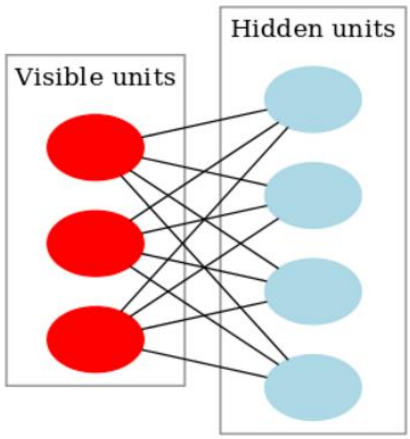

Figure 2. Deep learning algorithm

We can select DLA compared to the support vector machine [12] to allow such configurability, allowing deeper network with the near best in class precision.

D. Demerits of Exixting System

Existing system consists of limited battery life which has to be charged with in the particular time period, the device can only be accessed in offline perspective and also with limited storage capability, the storage capacity of the existing system is very low, it can only use once the data is transferred .In the existing system the human have to operate and analyze the situation according to that the device the operated which take extra time to operate , sometime human will forgot to operate the device.

In the existing system, there will be a inaccessible alerting law enforcement, it does not provide an efficient confidential for criminal activity [13].

III. Overview of the Proposed System

A. Deep Learning Algorithm Based Human Posture Detection

Video format data is taken input by using RASPBERRY PI with PICAMERA. Picamera is used to capture the live video. This video data is given into to MATLAB code which makes this into number of frames until the accurate object position is detected. Number of frame depends on the video data. In feature extraction, from the video frames background image and object image is extracted. This image is given as a input to DLA based with Artificial Neural network to process the output. By using DLA steps the accurate human posture is detected. From Weizmann human silhouette based action dataset particular posture human is made for comparison. Multiple inputs are given to Neural Network

which process to give a single output. The accuracy of the network output can be reduced by the training dataset but can be improved by using specified training dataset. Our target is to achieve the accuracy of more than 90% real time requirement with the low power consumption. By using neural network algorithm different posture of one image is taken which is processed to make accurate position and direction of the posture for example "Hands-up", "Running", "Waving Hands", etc. Dataset and resulted posture is compared by using neural network. Once the compared posture is detected then the device automatically makes a decision. (See Fig. 3)

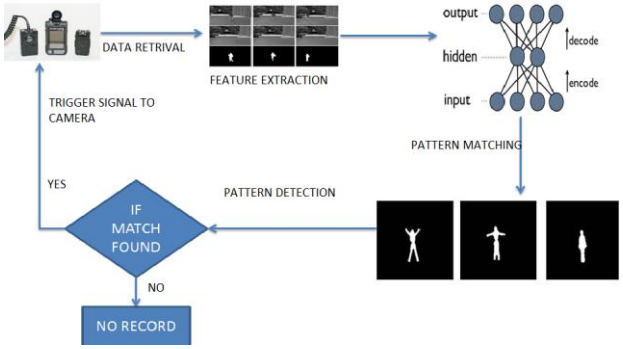

Figure 3. System architecture

B. *Merits of Proposed System*

The first advantage of this system is "always-on" Sensing smart device, it does not require any human to operate the system, the system automatically recognize the human posture by using Deep Learning Algorithm based on neural network. Then it start to record the situation and the video is streamed. It works on the online process so it does not need any storage space. The alerting law enforcement is achieved in this system.

By this system the automatic decision can be made by the smart device without the need of external operator. The device will make an intelligent and judicious decision.

C. *Hardware Implementation and Results*

The Raspberry picamera (Fig. 4) [14] module can be used to take high –definition video, as well as stills photographs. It's easy to use for beginners, but has plenty to effort advanced users if yours looking to expand your knowledge. There are lots of examples like online people using it for slow motion video, time-lapse and other video cleverness. You can also use the libraries we bundle with camera to create effects.

If you're interested in the nitty-gritty, you'll want to know that the module has five megapixel fixed-focus cameras that supports 1080p30 and VGA90 video modes [15], it also a stills capture. It attaches via a 15cm ribbon cable to the CSI port on the Raspberry pi. The camera works with all models of Raspberry pi.

The camera module is very popular in home security applications, and in wildlife camera traps. This used as the front end to capture the video and followed by the other processes.

Figure 4. Raspberry PiCamera

The device should be an 'always-on' where raspberry picamera will be a high effective towards that. It also provide with the low power consumption with low cost [16]. Fig. 5 shows object detection from video and Fig. 5 shows object and background subtraction.

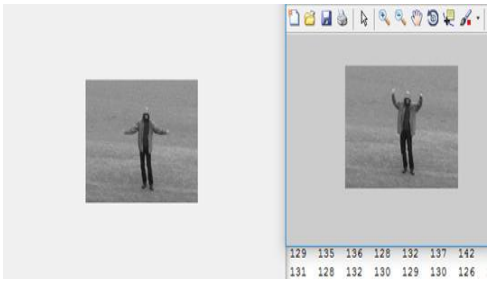

Figure 5. Object detection from video

Figure 6. Object and background subtraction

IV. Conclusion

This paper describes the design of an DLA based reconfigurable low power hardware engine and 'human posture' identification in 'always on' Body-Worn-Cameras. Background and object images are extracted using MATLAB coding and also final human posture are detected which is related with dataset. We spend least energy consumption with 90% of accuracy with the limited training dataset and shallow network.

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