LobNet platform: Target tracking with a low resolution camera network

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Lobna Ben Khelifa[1], François Berry[1] and Jean Charles Quinton[2]

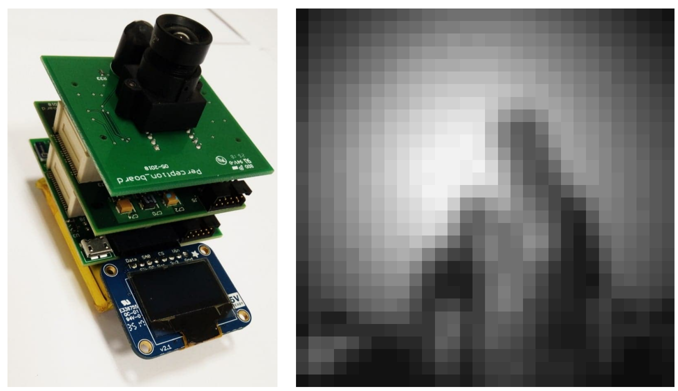
***Abstract*— In this paper, we present a new platform for environment monitoring using very low specification cameras. These latter are distinguished by their visual sensors offering tiny images (30*30 pixels), completely local processing thanks to the max10 FPGA and the SmartMesh IP technology offering a mesh network. The lack of information extracted by visual sensors is filled by intensive communication and data exchanged between cameras after each detection. Thus, a re-identification process is applied based on exchanged and extracted data after each target detection.**

I. INTRODUCTION

Most of the cameras used in Smart Camera Network (SCN) context have a sufficiently high resolution and require the input images to be noisy-free. Hence, algorithms dedicated to the use case have been proposed. However, their performance drastically degrades when we decrease the resolution specially if we have tiny images contaminated by noise. Different studies have suggested people re-identification methods from destitute images (16*16) [1]. However, all of them require to have a very large face dataset to achieve good results. In this work, we deal with cameras equipped with a mouse sensor offering a 30*30 pixels and we aim to track each target moving through the cameras. Although this sensor has been already used as a camera [2], its role is limited to a motion detector [3], [4]. The main goal of our model is to let the camera act as an autonomous agent, able to respond to external and internal stimuli. The external stimulus is target detection, while the internal one is the information exchanged between the cameras. Then re-identification is based on received prediction, observation and network history based on various parameters characterizing the target [5]. An association between camera pairs will next be created based on the events generated in the network and on the exchanged information. Therefore, camera pairwise re-identification is learned and evaluated after each detection [6].

II. ANT-CAM

Ant-Cam, as its name suggests, is inspired from the ant world, where ants accomplish complex tasks notably through collaboration and communication. Taking heed of their individual size and strength, we put forward Ant-Cam [7], defined by very low specifications. The sensing layer contains two sensors: a mouse sensor (ADNS3080 from Avago) generating 30*30-pixel images (Fig.1b). The second one is a PIR sensor, able to detect any target moving around the camera in a range of 5 meters. This sensor is used mainly to let the mouse sensor and the FPGA be in a sleep mode when nothing is moving in the environment. The processing layer houses an FPGA (MAX10 from Altera) used for its good ratio power consumption and efficiency, and operating at a clock speed of 16MHz. The SmartMesh IP protocol from Linear is chosen for communication due to its low power consumption and high data reliability. The camera is equipped with a monochrome graphic OLED display, and the whole system is powered by a battery.



(a) (b)

Fig. 1: (a) Prototype of Ant-Cam: 3 layers corresponding to sensing, processing and communication. This latter houses screen and battery, (b) Example of images broadcast by mouse sensor.

III. NETWORK

Our model is an event-based one [8] [9]. Each Ant-Cam starts a remit depending on the generated event. Hence, we suppose that a camera can autonomously detect targets appearing in its Field Of View (FOV) and extract a suitable description. Furthermore, in the absence of any neighborhood information at the beginning, the camera starts by broadcasting the information in the network thanks to the the communication technology.

We choose to focus on low computational effort which is simple and fast processing without the need of high-end hardware processors. Our Ant-Cam processing level renders sophisticated approaches for people re-identification, such as neural networks, unfeasible especially when we deal with such tiny images suffering from noise. As a consequence, any changes on the position or direction of the target change

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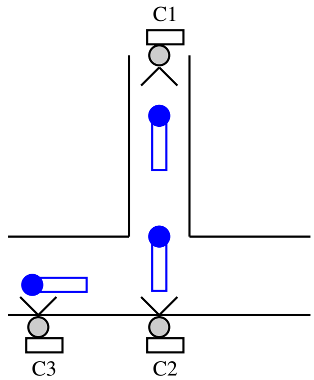

Fig. 2: Example of target moving through cameras c1, c2 and c3 where appearances differ completely between cameras.

completely the images as illustrated in Fig.2, Thus, we focus first and foremost on the extracted shape. In a smart camera network, specially when we choose to work with fully decentralized processing, we take into account the type of output we can have and how it can be used in another camera. As a result, we suppose that the shape of each detected target completely depends on its provenance and therefore on the information exchanged between the cameras. In Fig.3, the cameras detect different shapes depending on their positions, and focusing on this transformation between each pair of cameras can provide re-identification information. Hence, the goal is to create an association between the shapes and the cameras.

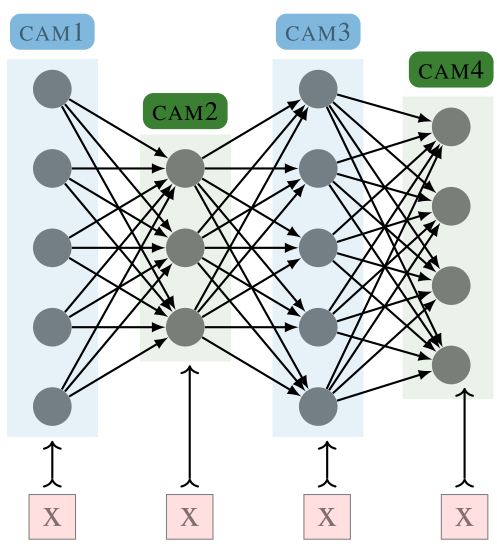

Fig. 3: Representation of sequence of cameras which detect target x. This latter is the external input of each camera after each detection. The output is its extracted characteristics which serve as an internal input for the next cameras.

The network is represented in Fig.3, the grey nodes represent the processing available in the camera, which may be similar or not different from one camera to another. The various layers represent the cameras which detect a target x in the environment. Each target moving through the network leads to its own representation depending on the cameras participating to its tracking. Consequently, the output of each layer is its own representation of the target in the network, which is in its turn the input of the next layer aside from its own detection. Depending on the results offered by the previous camera, the camera will analyze the situation and choose which processing to apply to better fit the situation.

IV. CONCLUSIONS

Our model aims to achieve a distributed tracking in a fully decentralized camera network. Thereby, each camera should be an autonomous and self-organized agent. Starting from an unknown environment, the cameras are able to organize themselves, coordinate their activities and build their own vision graph. Each camera will then choose which strategy to employ to better fit its own situation. A main question will be: How may the camera cope with an unknown situation or re-identification uncertainties?

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