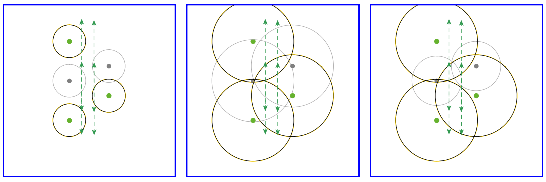
Self-aware Camera Networks: The Challenge of Going Mobile

Lukas Esterle*, Peter R. Lewis*, Xin Yao† and Richie McBride‡
*Aston Lab for Intelligent Collectives Engineering (ALICE), Aston University, UK
†Centre of Excellent for Research in Computational Intelligence and Applications (CERCIA), University of Birmingham, UK
‡Edesix Ltd, Edinburgh, UK
{l.esterle, p.lewis}@aston.ac.uk, x.yao@cs.bham.ac.uk, r.mcbride@edesix.com

The last fifteen years have seen an evolution in camera technology. By combining image sensors, processing units, and communication interfaces in one device, *smart cameras* observe the physical world, process images on-board, and communicate extracted knowledge rather than simply video feeds. Smart cameras operate autonomously, but when networked, they can cooperate in order to carry out more complex tasks and achieve collective goals [1], [2], [5], [8]. As with other types of cyber-physical system, more recently, *self-awareness* [4], [6] has been introduced in smart cameras, enabling them to reason about their own behaviour, and adapt accordingly in changing environments [3], [7]. Figure 1 depicts one example of this, where cameras collectively coordinate their zoom levels to adapt their priorities during operation.



(a) (b) (c)

Fig. 1. Cameras adaptively coordinate their relative zoom levels at runtime, in order to prioritise (a) object detection quality, (b) redundancy through overlap, or (c) proportion of objects covered. Source: [2]

However, these efforts have so far been restricted to static and pan-tilt-zoom cameras, and have neglected the emergence of mobile cameras, which have rapidly developed in terms of both technology and growth of the market. These systems allow cameras to relocate within their environment, for example being worn by humans or mounted on mobile robots. Edesix's *VideoBadge* technology, depicted in Figure 2, is one example of this. In the SOLOMON project[1] we are tackling the challenges that must be overcome in order to build self-aware networks of mobile smart cameras. We are extending recent research in static smart camera networks, while taking advantage of mobility.

Challenge 1: Existing large mobile camera deployments are not networked, and operate without interaction between the cameras. Conversely, networked deployments are smaller, and centrally controlled, introducing a bottleneck and a single point of failure. We address this issue of scalability by introducing self-organising capabilities and distributed coordination.

Challenge 2: Mobility introduces the necessity to account for changing goals, resources, and rapidly changing environments. This requires the control of the system to be highly adaptive, robust, and flexible. In order to achieve this, we introduce individual and collective online learning, runtime evaluation of ones own and others' performance, and self-adaptation to changing goals, resources, and the environment.

[1]SOLOMON: Self-Organisation and Learning Online in Mobile Observation Networks, https://alice.aston.ac.uk/solomon

Challenge 3: Current approaches do not consider the relationship and interplay of different goals and available resources. To increase the efficiency of mobile smart camera systems, we model trade-offs during runtime and consider multiple objectives in our learning approaches.

Fig. 2. Edesix's VideoBadge. Source: http://edesix.com/

Building self-awareness into networked deployments of the latest generation of low-cost, lightweight mobile camera technology will break down barriers to wider adoption of smart cameras across industry and society. This will allow highly scalable deployments to meet changing requirements associated with unfolding situations, faster and with higher quality than is currently possible. This will improve safety and security where traditional surveillance is currently not possible, enhancing transparency and privacy, and lowering costs. In addition to surveillance, other targeted applications include smart transportation, assisted living, and intelligent sports coverage.

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