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IEEE EAST-WEST DESIGN AND TEST SYMPOSIUM 2012 COMMITTEE

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10th IEEE EAST-WEST DESIGN & TEST SYMPOSIUM (EWDTS 2012)

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The main target of the **IEEE East-West Design & Test Symposium** (EWDTS) is to exchange experiences between scientists and technologies of Eastern and Western Europe, as well as North America and other parts of the world, in the field of design, design automation and test of electronic circuits and systems. The symposium is typically held in countries around the Black Sea, the Baltic Sea and Central Asia region. We cordially invite you to participate and submit your contributions to EWDTS'12 which covers (but is not limited to) the following topics:

- Analog, Mixed-Signal and RF Test
- Analysis and Optimization
- ATPG and High-Level Test
- Built-In Self Test
- Debug and Diagnosis
- Defect/Fault Tolerance and Reliability
- Design for Testability
- Design Verification and Validation
- EDA Tools for Design and Test
- Embedded Software Performance
- Failure Analysis, Defect and Fault
- FPGA Test
- HDL in test and test languages
- High-level Synthesis
- High-Performance Networks and Systems on a Chip
- Low-power Design
- Memory and Processor Test
- Modeling & Fault Simulation
- Network-on-Chip Design & Test
- Modeling and Synthesis of Embedded Systems
- Object-Oriented System Specification and Design
- On-Line Testing
- Power Issues in Design & Test
- Real Time Embedded Systems
- Reliability of Digital Systems
- Scan-Based Techniques
- Self-Repair and Reconfigurable Architectures
- Signal and Information Processing in Radio and Communication Engineering
- System Level Modeling, Simulation & Test Generation
- System-in-Package and 3D Design & Test
- Using UML for Embedded System Specification
- CAD and EDA Tools, Methods and Algorithms
- Design and Process Engineering
- Logic, Schematic and System Synthesis
- Place and Route
- Thermal, Timing and Electrostatic Analysis of SoCs and Systems on Board
- Wireless and RFID Systems Synthesis
- Digital Satellite Television

The Symposium will take place in Kharkov, Ukraine, one of the biggest scientific and industrial center. Venue of EWDTS 2012 is Kharkov National University of Radioelectronics was founded 81 years ago. It was one of the best University of Soviet Union during 60th - 90th in the field of Radioelectronics. Today University is the leader among technical universities in Ukraine.

The symposium is organized by Kharkov National University of Radio Electronics and Science Academy of Applied Radio Electronics http://anpre.org.ua/ in cooperation with Tallinn University of Technology. It is technically co-sponsored by the IEEE Computer Society Test Technology Technical Council (TTTC) and financially supported by Trades Committee of Kharkov National University of Radioelectronics and Trades Committee of Students, Aldec, Synopsys, Kaspersky Lab, DataArt Lab, Tallinn Technical University.

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CONTENTS

A WSN Approach to Unmanned Aerial Surveillance of Traffic Anomalies: Some Challenges and Potential Solutions

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Abstract—**Stationary CCTV cameras are often used to help monitor car movements and detect any anomalies—e.g., accidents, cars going faster than the allowed speed, driving under the influence of alcohol, etc. The height of the cameras can limit their effectiveness and the types of image processing algorithm which can be used. With advancements in the development of inexpensive aerial flying objects and wireless devices, these two technologies can be coupled to support enhanced surveillance. The flying objects can carry multiple cameras and be sent well above the ground to capture and feed video/image information back to a ground station. In addition, because of the height the objects can achieve, they can capture videos and images which could lend themselves more suitably for the application of a variety of video and image processing algorithms to assist analysts in detecting any anomalies. In this paper, we examine some main challenges of using flying objects for surveillance purposes and propose some potential solutions to these challenges. By doing so, we attempt to provide the basis for developing a framework to build a viable system for improved surveillance based on low-cost equipment.**

I. INTRODUCTION

With the cost of cars decreasing, more and more people are opting to use cars as their main means of transportation. In cities with large populations, the exponential rise in the number of cars on the streets can lead to many issues (e.g., accidents, congestions, etc.). Governments are spending large amounts of resources in order to improve means to help monitor the movement of cars and in the process enable enforcement officers detect any existing anomalies and prevent potential ones.

One widespread technology used to monitor the flow of cars is CCTVs. These can be seen placed on top of street light posts, traffic lights and/or specialized street structures. Although useful, these types of structures are limited in their height, and this limitation can constraint severely the kinds of images and videos can be captured. Similarly, the type of images and videos can determine to a large extent how well they support computer vision and image analysis algorithms.

We believe that the use of unmanned flying (or aerial) vehicles (UAV) embedded with video cameras and wireless devices to be used in conjunction with normal CCTVs can support enhanced monitoring of car movements. Unmanned flying objects have become inexpensive and so have video cameras and wireless devices. In this paper, we explore some challenges of using these technologies for automatic monitoring of car flows and suggest some potential solutions for researchers to consider.

II. UNMANNED AERIAL SURVEILLANCE: CHALLENGES AND SOLUTIONS

The wireless vision sensor network (WSVN) [4] is suggested as a means to providing better framework to ensure proper aerial surveillance than other traditional methods. This network is composed of one or several small flying drones (e.g., 30-50 cm x 30-50 cm; see Figure 1) that can be controlled to continuously track moving objects whilst providing live video feeds or mission awareness data [4]. There is on-going research in the areas of cognition and efficient wireless sensor network (WSN) to improve communication among different drones and between drones and command center. We survey some advances made in WSN to identify challenges and possible solutions.

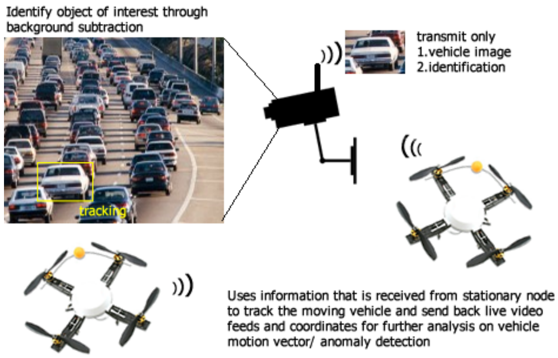

Figure 1. Aerial surveillance through coordination of multiple devices on the wireless network.

A. *Data collection*

Temperature, location, and acceleration sensors provide scalar data and are usually non-directional; therefore collection of data from these sensors is relatively easy. Vision sensors, on the other hand, introduce a challenge because they are directional sensors. In addition, the field of view is important because as the vehicles being tracked are not stationary, it can steer off the view. Furthermore, the amount of data generated by this type of sensor could potentially be massive, and this is an important factor to consider in a wireless system network with limited bandwidth, processing power, memory, and battery power. Our approach is to use inexpensive devices, particularly the flying object (see Figure 2 for an example), which will suffer from the cited limitations.

Figure 2. A quadrocopter with a payload of solar charged batteries to increase flight time.

Developments in CMOS (complementary metal-oxide semiconductors) technology and powerful embedded systems have led in improvements on signal processing, communication, and control. These improvements have made the cost of deployment of these systems cheaper and lighter than the existing wall-powered camera systems [4]. When deployed on flying drones, these advancements can enable some complex computation such as vehicle type/number identification. The video data can be stored in the drone's memory and only the identification information is then sent back to the base station to reduce the amount of data transmitted. That is, the stationary elements (such as streets, buildings, trees, etc.) do not need to send back but only certain types of selected objects. This approach can dramatically reduce the amount of data that needs to be transmitted. Once the data is received by the ground center, a more powerful system can be used to reconstruct view. Also, further details can be sent by the aerial drone, but upon request from center.

B. *Coordination among drones*

The limited sensing and communication range of the current system possess a problem in the number of drones/nodes needed to cover a particular region of interest (ROI). The maximum range of the IEEE 802.15 for reliable data transfer rate is 70 meters in an outdoor scenario [7]. Therefore an efficient node deployment that can give full area, point, and barrier coverage is important to reduce the overlap and increase connectivity. The grid deployment based on equilateral triangle provided maximum coverage area with the least amount of nodes [1] compared with the square grid or hexagonal grid (see Figure 3).

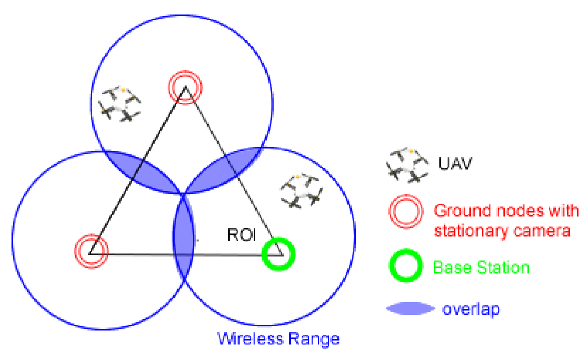

Figure 3. A triangular grid deployment of the node and base stations.

Cooperation and integration amongst the wireless sensor network nodes and the unmanned aerial vehicles can increase the performance in surveillance mission. A possible technique to support cooperation and integration involves a WSN middleware that incorporates an agent-oriented approach. It uses a Mission Description Language (MDL) to provide intelligent communication in UAV to UAV, UAV to Base Station, UAV to ground nodes, ground node-node, and ground node-base station (sink) [2]. As described in [2], the middleware services provided are:

Local resource management, network resource management, mission interpreter, decision-making engine, and context awareness database. In a WVSN system, it is important to find an optimal partitioning of functions between hardware/software and local/central processing and among many UAV. For example, certain UAV could have low resolution cameras to save energy and are used in fixed flying positions and in the initial monitoring phases. When an anomaly is detected a signal can be sent automatically to active a more powerful UVA, with a higher resolution camera(s), to capture more details or conduct a pursuit of an object.

C. Continuous tracking of objects

Because our object of interest is non-stationary, finding an effective tracking method is paramount in WVSN. Continuously tracking objects as they move from node to node can be improved by the awakening mechanism of sensor node describe in [5]. Similar to the context of coordinating multiple UAV, in this model the sensors are in a periodical state of hibernation and waking up, until one sensor detects an object of interest and then sends a wakeup call only to neighboring sensor nodes. The nodes are kept awake for the needed periods and they go back into hibernation if they do not detect the object of interest or it is outside of its field of view. This approach ensures that resources are not wasted by nodes which are not within the vicinity of the tracked object. Furthermore, if these nodes are fitted with GPS radios, it will increase the speed required to pin point the area in which the object can be located, thus aiding quick aerial reconnaissance by the drones. In addition, it is possible to use the stationary cameras in such a manner that UAV are used when needed. For example, one can follow these steps, as shown in Figure 4.

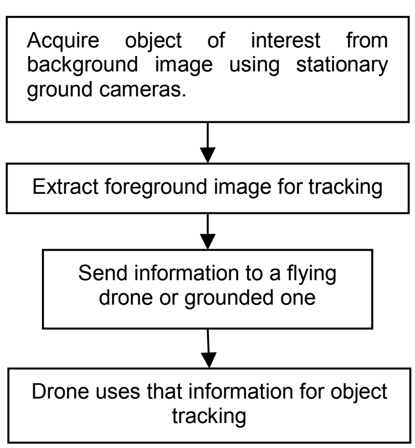

Figure 4. Steps in using both aerial drones and grounded cameras.

Most vehicle detection algorithms are based on background subtraction techniques which involve capturing an image of the area of interest and comparing new images from the live feed to detect changes in the pixels. For these techniques to work, it is required that the camera remains stationary to achieve that high rate of accuracy at 90% as reported [9]. In the case of aerial surveillance, it is not possible to use the same method since the drone may have to follow the vehicle in an unpredictable path or, depending on wind speed and/or other environmental factors (e.g., rain), cannot remain stationary. To overcome this challenge, the foreground image (i.e. the image of the vehicle without the background) can be sent over the WSN to the nearest drone to track the vehicle's pattern regardless of the environment's background image [8].

III. SUMMARY AND FUTURE WORK

In this paper, we have proposed the use of unmanned aerial vehicles to support the monitoring of traffic irregularities or anomalies from a wireless sensor network (WSN) approach. We highlight some potential challenges with this approach and propose some solutions. These challenges are in terms of connectivity and communication coverage, coordination and integration between different parts of WSN (base station, nodes, and flying drones), continuous object tracking within a region of interest, and background/foreground detection. The solutions proposed include utilizing triangular lattice coverage for full area connectivity with minimum overlapping, agent based approach to managing surveillance missions, efficiently partition hardware/software and local/central processing. Such system can be used not only for traffic monitoring, but also for other monitoring purposes as well, e.g. health-support, crime-reduction, disaster identification, and so on.

We plan to implement a working prototypical system based on our described solutions. Once the system is in place we aim to develop efficient algorithms for effective detection of traffic anomalies based on a classification of vehicle movement patterns.

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