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NIGHT TIME DETECTION OF UAV USING THERMAL SENSORS

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ABSTRACT

Considering the significant number of non-military unmanned aerial vehicles that can be purchased in market to operate in unregulated air space the potential for security and privacy problems to arise is significant. This can lead to consequent harm for infrastructure in the event of these UAVs being used for criminal or terrorist purposes. Further, if these devices are not being detected, there is a privacy problem to be met with as well. In this paper we test a specific UAV such that by placing a thermal sensor on the ground these UAVs can be detected and alerted to the respective authorities to take necessary action.

Keywords –Unmanned Aerial vehicles, Thermal Sensors, Security, FOV, Detection.

I. INTRODUCTION

In recent years the number of small Unmanned Aerial Vehicles available to general public has largely increased due to low price and ease of use. These UAVs are mainly used for leisure and filming, but also for applications such as agriculture and environmental monitoring, surveillance, and disaster response. However, small UAVs can be also misused to perform anti-social, unsafe, and even criminal actions, such as privacy violation, collision hazard and even transport of illicit materials and explosives or biological agents. As a result, there is an increasing interest in developing sensor systems that can detect and track UAVs.

[1] Detection and tracking of UAVs with radar poses significant challenges, as small UAVs typically have a low radar cross section and fly at lower speed and altitude in comparison with conventional larger aircraft. Small UAVs are also capable of highly varied motion, such as hovering. Also the high maneuverability of small UAVs makes the tracking problem more difficult, as it is not possible to make strong assumptions about the expected UAV motion.

[2]Misuse of UAVs is a threat to critical infrastructure due to the wide range of damaging payloads that could be carried onboard. Worse, the UAV itself could be used to inflict damage. Given that many small UAVs have on-board HD cameras for guidance purposes, misuse of the camera can raise privacy concerns, because UAVs can traverse property boundaries easily and quickly.

[3]An unconventional method of UAV detection is thermal imaging. By acquiring thermal signature via thermal camera it is possible to detect and identify foreign UAV. Beside detecting the UAV for purpose of air traffic surveillance, thermal imaging can also be used for collision avoidance during night-time operations. To prove that UAV detection using thermal imaging can be used as a viable detection system, this paper presents analysis

of thermal images obtained micro thermal camera which was mounted on a Microcontroller Processing unit.

II RELATED WORK

1)Use of Thermal Infrared camera for detection of Unmanned Aerial Vehicles

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With the rapid increased use of Unmanned Aerial Vehicles (UAVs), a series of safety and security challenges has emerged. In recent years there have been numerous safety and security incidents with UAVs which prompted an increase in research of surveillance and interdiction methods tailored for UAVs. Detecting UAVs in flight can become very difficult in some circumstances such as during the night, in low visibility, or in urban environments. Thermal infrared cameras can detect small variations in heat on the level of tens of mK. In this paper we have tested the applicability of a lowcost long-wave infrared sensor for detection of various UAVs in flight.

2)The use of Acoustic cameras which uses (vibration technique to detect objects around its surrounding) in this case UAVs.

Recent events of drones flying over city centers and official buildings and nuclear installations stressed the growing threat of uncontrolled drone usage and the lack of real countermeasure. Indeed, detecting and tracking them can be difficult with traditional techniques. A system to acoustically detect and track small moving objects, such as drones or ground robots, using acoustic cameras is presented. The described sensor uses microphone arrays which actsas key sensor in detecting UAVs, which is completely passive, and is composed of a 120-element microphone array and a video camera. The acoustic imaging algorithm determines in real-time the sound power level coming from all directions, using the phase of the sound signals. A tracking algorithm is then able to follow the sound sources. Additionally, a beamforming algorithm selectively extracts the sound coming from each tracked sound source. This extracted sound signal can be used to identify sound signatures and determine the type of object.

III. INDENTATIONS AND EQUATIONS

Test track

In order to test the ability of low-cost thermal infrared sensor to detect small airborne UAVs, we flew three UAVs of different sizes and configurations over a 10m long test track (Figure 1). The goal was to determine at what distance the UAVs could be detected without trying to identify them. UAVs were flown at approximately 10 m above ground level and at a steady velocity of around 2 m/s. The test was performed on a relatively warm summer night (26 °C) against a clear sky and with no wind. The terrain of the polygon was grassy, without significant thermal sources and without any sources of light. The test was performed more than 2 hours after nautical twilight.

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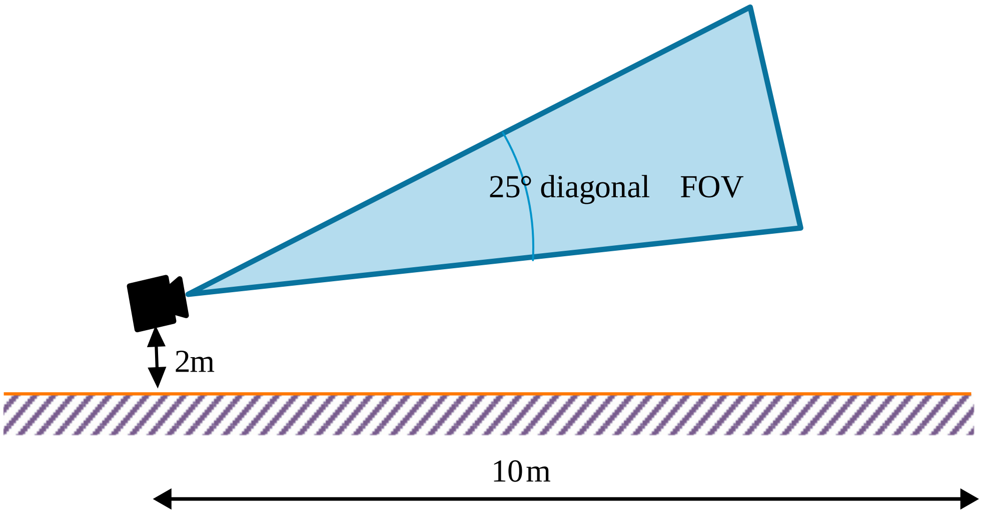
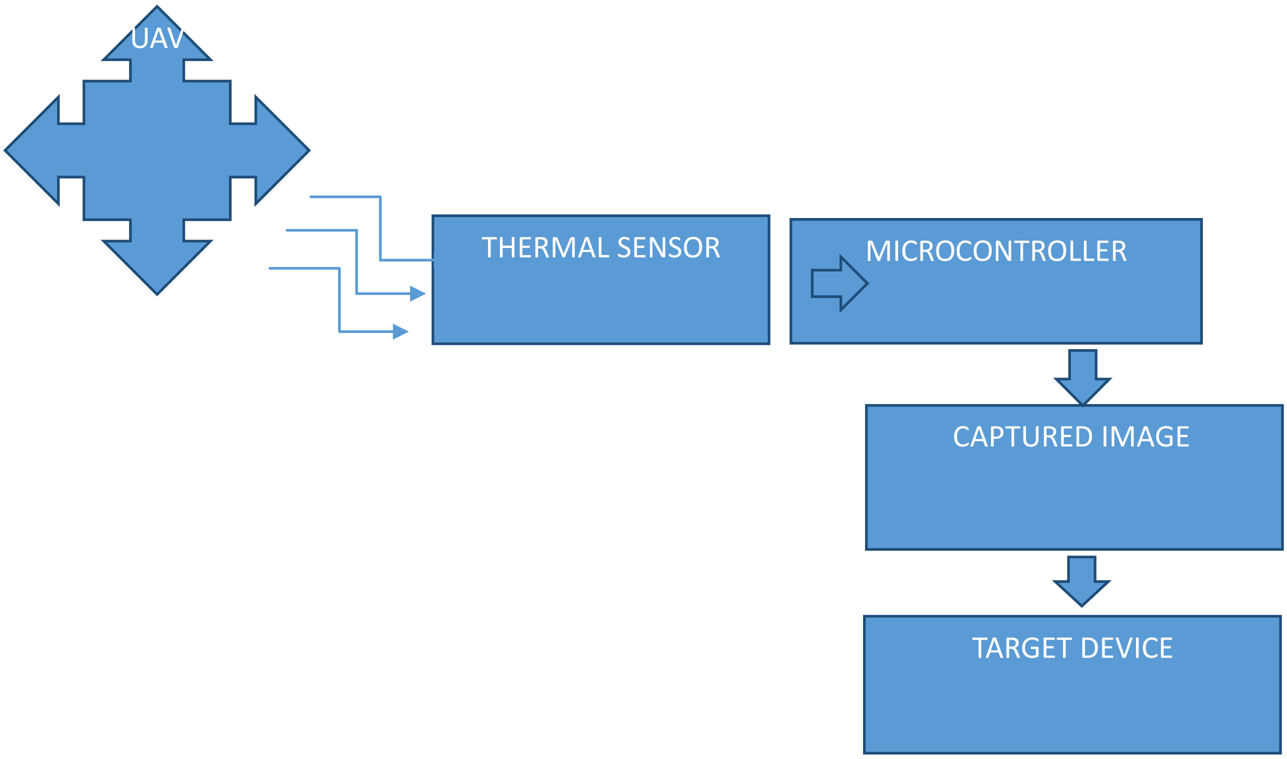


Fig . 1. Test Track

IV. FIGURES AND TABLES

4.1 BLOCK DIAGRAM



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4.2 DATASHEET OF THERMAL SENSORS

Specification	**Description**
Function	Passive thermal imaging module for mobile equipment
Sensor technology	Uncooled VOxmicrobolometer
Spectral range	Longwave infrared, 8 µm to 14 µm
Array format	80 × 60, progressive scan
Pixel size	17 µm
Effective frame rate	8.6 Hz (exportable)
Thermal sensitivity	<50 mK
Temperature compensation	Automatic. Output image independent of camera temperature
Non-uniformity corrections	Automatic
FOV - horizontal	25°
FOV - diagonal	31°
Depth of field	10 cm to infinity
Lens type	f/1.1 silicon doublet
Solar protection	Integral
Electrical	
Video data interface	Video over SPI
Control port	CCI (I2C-like), CMOS IO Voltage Levels
Input supply voltage (nominal)	2.8 V, 1.2 V, 2.8 V to 3.1 V IO
Power dissipation	Nominally 150 mW at room temperature (operating), 4 mW (standby)
Mechanical	
Package dimensions – socket version	8.5 × 11.7 × 5.6 mm (*w*× *l*× *h*) `
Weight	0.55 grams

4.3 FIGURES

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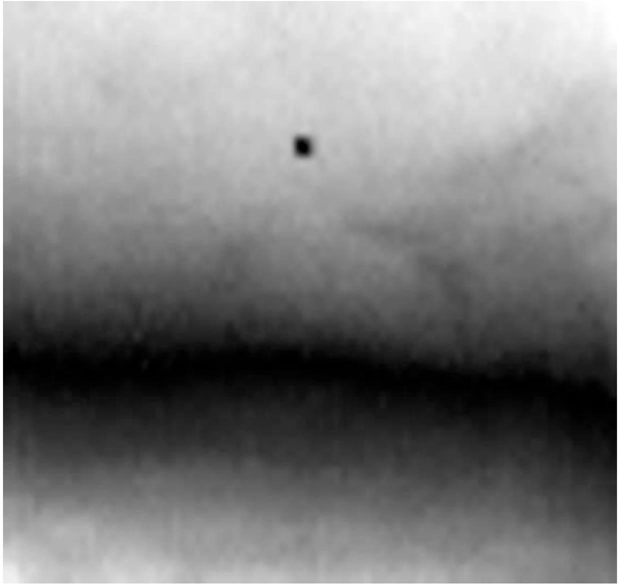

V. CONCLUSION

In summary, we performed a small-scale detectability test of commonly used and most prevalent UAV types. Our goal was to determine whether very low-cost and extremely mobile thermal sensor could be used to detect electrically powered multirotor UAVs for the purpose of air traffic surveillance or night-time collision avoidance. To achieve this, we have flown three different UAVs over a test track and recorded their movement with infrared long-wave sensor.

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