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Detecting Moving Targets Using Remote Sensing Techniques

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Abstract

In this research, we investigated the potential for developing the use of thermal cameras mounted on drones. We used a Chinese drone, and used a rabbit as the target to study the thermal changes occurring in the rabbit's body and track its movements. The Green Belt area near the Fourth Intifada was chosen as a site to study rabbit movement. The thermal changes emitted from the body were monitored by monitoring the infrared thermal emissions emitted by the rabbit's body. First, the temperature changes in the rabbit's body were monitored while it was in a state of rest, i.e., not moving. The lowest temperature of its body was recorded at 22 ˚C, while the highest temperature was around 34 ˚C. Secondly, thermal changes were monitored during the running process, as pictures were taken of the rabbit during the running process and then processed within the FLIR Tools program, and so thermal emissions were obtained. Thermal changes ranged between 24 ˚C as the lowest temperature of the body, while the highest degree was around 40 ˚C. The reason for this increase was the result of the increase in blood flow inside the body as a result of the increase in vital activities during running, which increases the rate of heat emissions emitted from it. In this study, remote sensing techniques were combined with thermal imaging techniques from the Landsat 8 satellite, and the images were converted to raster format for processing within the Arc Map 10.2 program. The results were close to those of thermal imaging cameras, where a controlled classification was performed on the thermal image, and the body's thermal changes were recorded, with a low of 22°C and a high of 42°C. This study concluded that it is possible to use thermal cameras and integrate them with remote sensing technologies to track moving targets. This study can be generalized and developed to track the movements of military vehicles, in addition to the movement of people, and to determine their locations and monitor all their movements during the night search and photography process.

Keywords

Thermal camera, Arc map 10.2, Rabbit, Satellite of Landsat 8, Drone, Remote sensing.

Introduction

Thermal imaging is an advanced technology that allows locations to be imaged based on thermal differences between objects without relying on visible light [1]. This technology works by detecting infrared radiation emitted by objects, which is directly proportional to their temperature [2]. When combined with remote sensing technologies, thermal imaging becomes a powerful tool for monitoring and observing various phenomena over long distances, whether from the air via drones or satellites [3]. The use of thermal cameras to detect moving targets provides innovative solutions to surveillance challenges in complex environments. Thermal imaging cameras are a vital tool for monitoring moving objects, especially in conditions where traditional optical cameras fail, such as low light, fog, or dust [4]. These cameras rely on detecting thermal radiation from objects (MWIR or LWIR medium infrared), making them ideal for military, security and industrial applications [5]. The smallest object that can be detected is the smallest dimension that can be determined by a pixel (a pixel is an element in a thermal camera detector that records infrared radiation and converts it into an electrical signal)[6]. A thermal imaging camera has an infrared detector inside that is sensitive to infrared radiation. Depending on the intensity of the infrared radiation, it determines the temperature on the surface of the object and makes it visible to the human eye thanks to the thermal image. This process is called thermal imaging[7].

Material And Methodology

In this research, a drone equipped with a thermal imaging camera was used to track a moving target. This drone is Chinese made. A rabbit was used as a target and was tracked using infrared rays. The tracking data was recorded to identify the moving target at night. It was used in the desert behind the green belt in the holy Karbala province.

DJI Air 2S Drone

This professional drone from the Chinese company DJI is a favorite due to its advanced capabilities. It features a thermal imaging camera with a 20-megapixel CMOS sensor. It records 5.4K video at 30 frames per second. It also features a wide-angle lens for high-resolution photos and videos [8], as shown in Figure (1).

Figure (1): DJI Air 2S Drone

The drone's flight time is up to 31 minutes on a single charge, and its range is approximately 12 km using OCUSYNC 3.0 technology. It is equipped with front, rear, upper, and lower sensors for obstacle avoidance. It is controlled via a remote controller linked to a mobile phone app. This aircraft is considered one of the remote sensing technologies [9].

Thermal imaging

Thermography is based on the basic physical fact that all objects with a temperature above absolute zero emit thermal radiation in the infrared range of the electromagnetic spectrum [10]. Using a high-resolution FLIR T1030sc thermal camera [11], a natural photograph was captured by the drone camera, in addition to the thermal image of the uncooled infrared thermal sensor, the rabbit, which is the study sample, was captured in the Fourth Intifada area in the holy Karbala Governorate. As shown in Figure (2).

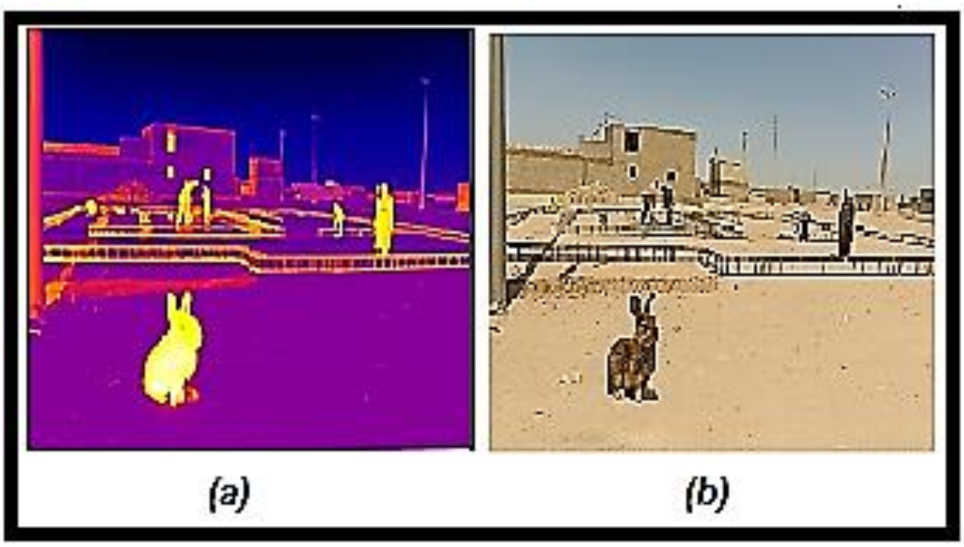

Figure (2):(a). Thermal image of the study sample.(b). photograph image

Thermal classification of the study sample

The thermal imaging camera captures the infrared radiation emitted by the rabbit and converts the thermal differences into electronic signals to form an image known as a heat map of the rabbit. The image was then processed using FLIR Tools [12] to analyze the image quality and analyze the data extracted from the image, as well as to clarify the contrast between the rabbit's body temperatures. Two images were processed, the first of which was of a rabbit in motion, and that image was processed to obtain a thermal contrast, as in Figure (3) and table (1). In another case, the image of the rabbit during the running process was processed and the temperature contrast was also recorded, as in Figure (4) and table (2).

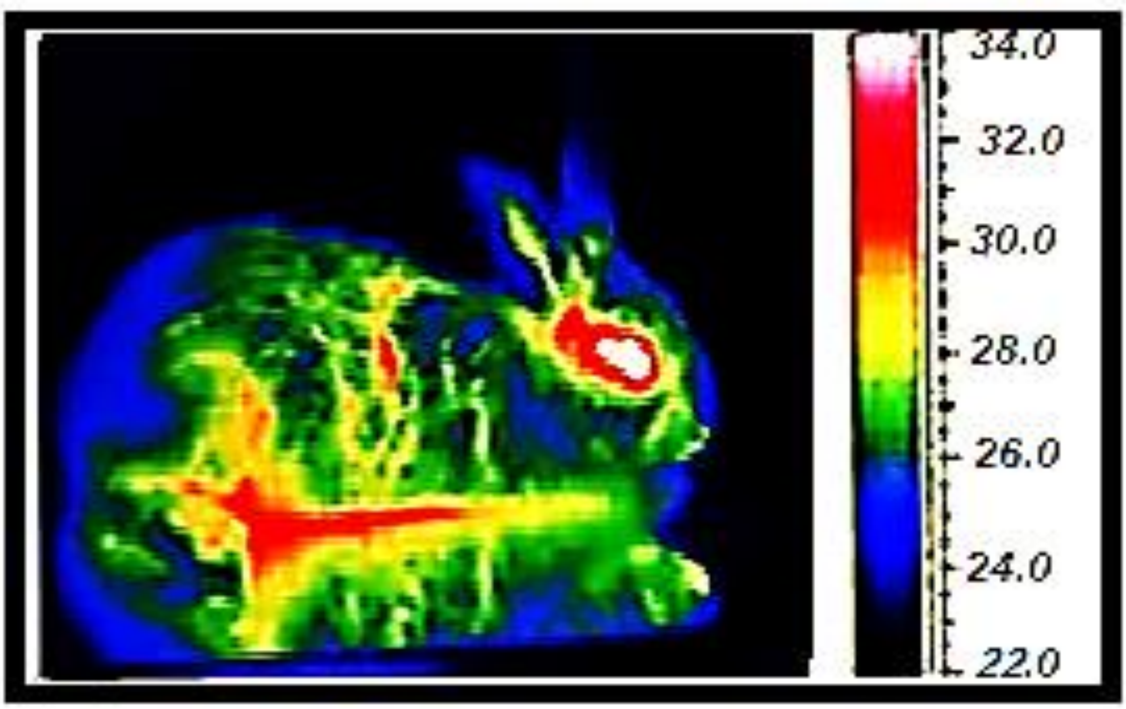

Figure (3): Thermal classification of a sedentary rabbit.

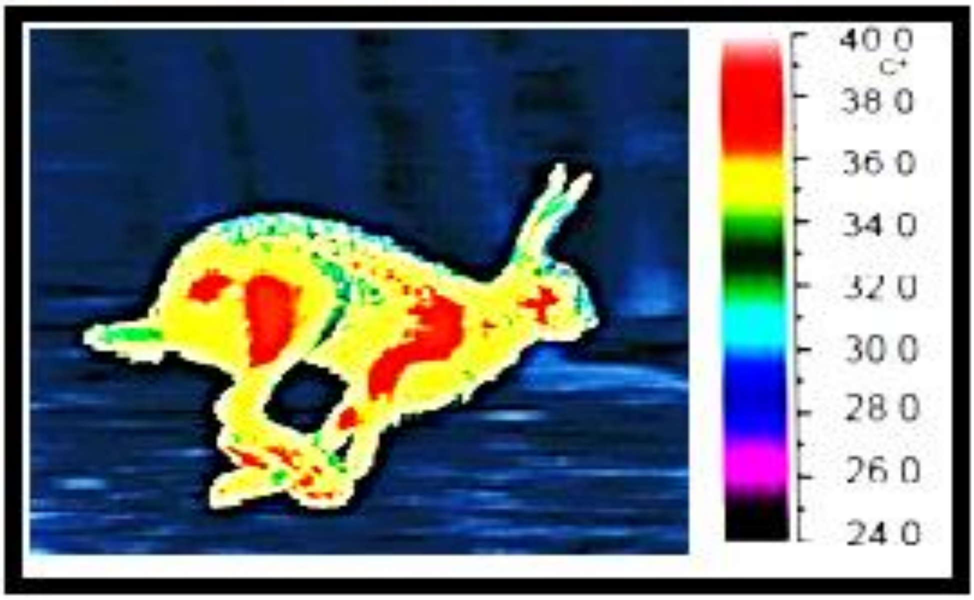

Figure (4): Thermal classification of a moving rabbit.

Using Arc map10.2 in image analysis

Using Arc Map 10.2 techniques to analyze image data, that is converted within GIS techniques to a raster image [13] using the thermal band of the Landsat 8 satellite and converted into layers as a database that is dealt with in this program as in Figure (5).

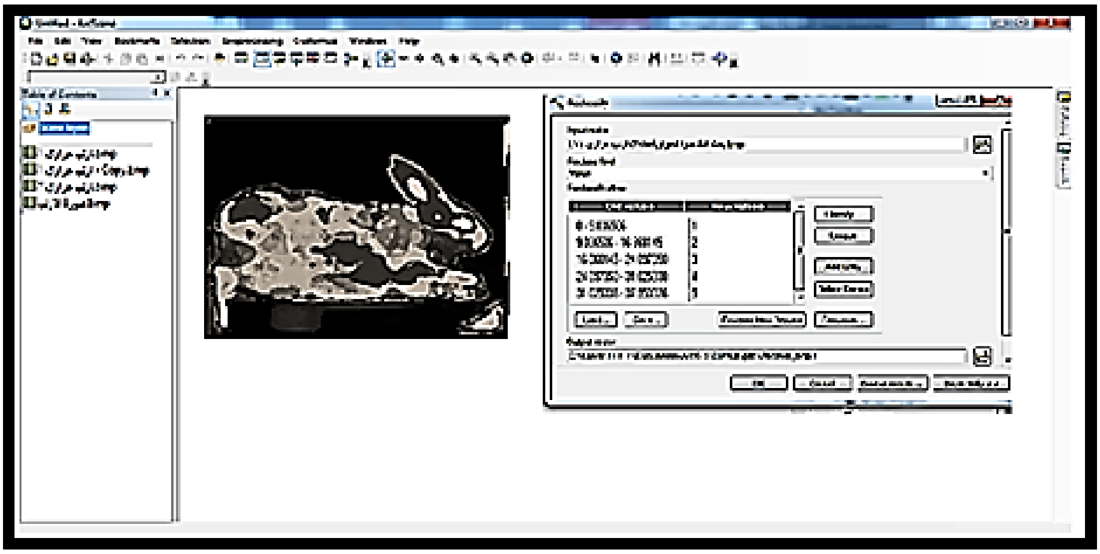

Figure (5): Image of a rabbit after converting it to raster using GIS techniques

Then we use the supervised classification [14] by using thermal banding techniques to classify the study sample of rabbits, and thus we obtain a database for the thermal gradient of rabbits according to the supervised classification as shown in Figure (6) and Figure (7) and table(3).

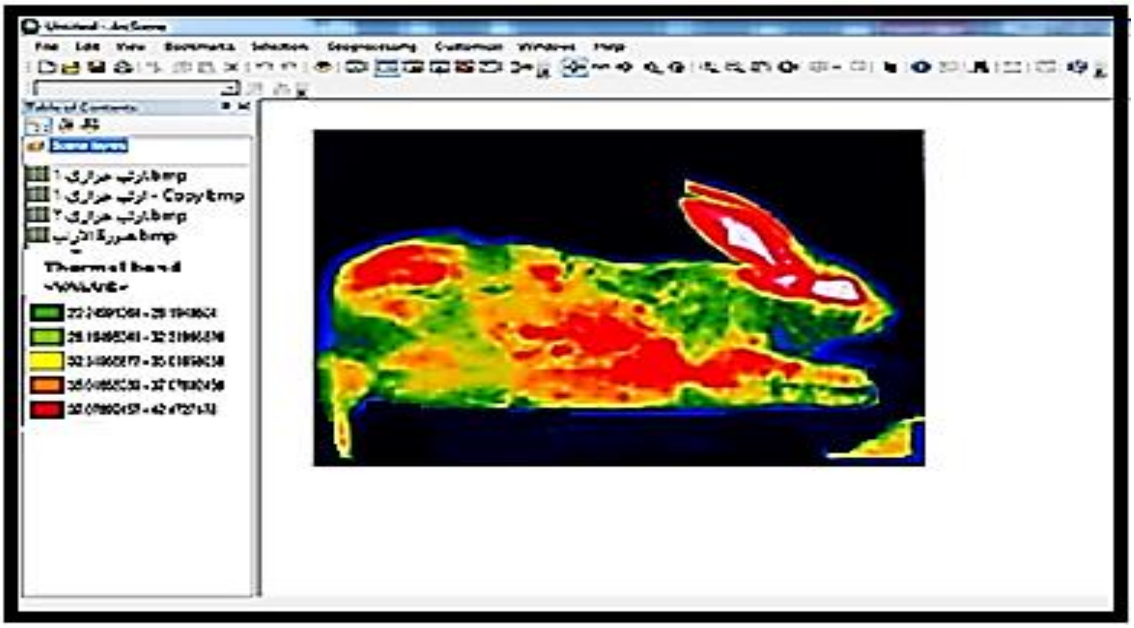

Figure (6): Thermal classification within Arc Map 10.2 technologies

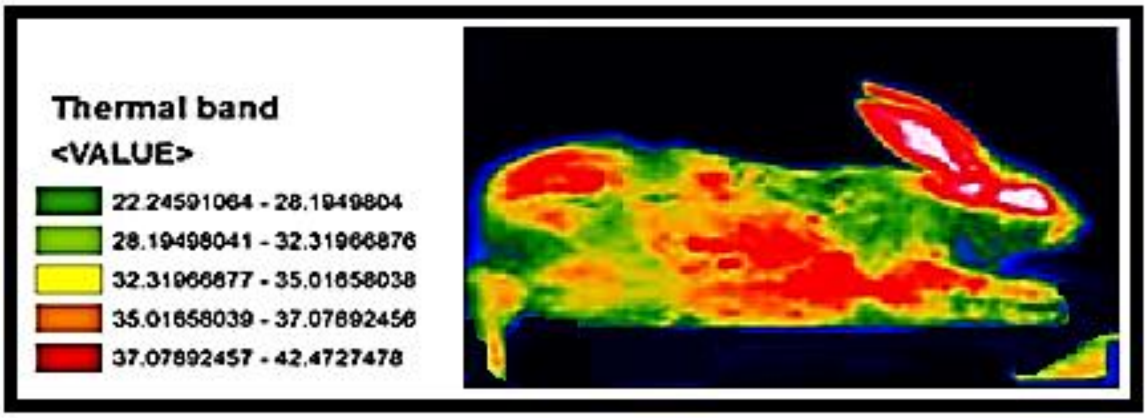

Figure (7): Thermal gradient of the rabbit's body using GIS

Table (1): Thermal variation of the rabbit's body at rest	
low temperature	22 °C
High temperature	34 °C

Table (2): Thermal variation of the rabbit's body at moving	
low temperature	24 °C
High temperature	40 °C

Table (3): Thermal variation of the rabbit's body by thermal clasification for Arc Map 10.2	
low temperature	22 °C
High temperature	42 °C

RESULTS AND DISCUSSIONS

Using thermal imaging via the thermal camera installed on the drone, the rabbit's movements were monitored in two cases. The first case was a state of rest, where the image was processed in the FLIR Tools program. Variations in the rabbit's body temperature were observed, with the lowest temperature being at 22 °C and the highest temperature being at 34 °C, as shown in Figure (3). The rabbit's movements were also monitored during the filming process, as the body temperature was recorded during the running process. The lowest temperature was at 24 °C, while the highest temperature was at 40 °C, as shown in Figure (4). The reason for this is that when the running process continues, the blood flow inside the body increases, and thus the heat emissions increase. Therefore, these temperatures were observed and recorded. In order to compare these images and results with the use of remote sensing and GIS techniques, a thermal image of the rabbit was obtained by the eighth thermal band of the Landsat 8 satellite, and this image was treated and converted into Raster data to be processed within the spatial analytics channels of the program, and then it was classified using Supervised Classification, where the image was treated as a database that was treated in Arc Map 10.2 program, and thus a thermal image of the rabbit was obtained and the body temperature was classified as follows: A thermal image of the rabbit's body was obtained with temperatures ranging between 22 °C as the lowest temperature and 42.4 °C as the highest temperature, and the reason for this difference between thermal classification according to arc map techniques and thermal camera classification is due to the influence of the spectral footprint emitted by the body in addition to other weather and climate factors, and is affected by thermal emissions from objects adjacent to the target concerned, and thus a difference in degrees was recorded estimated at 8 degrees Celsius for the rabbit while in a state of immobility.

CONCLUSIONS

1. A rabbit at rest has a body temperature of 34 °C for the highest emissivity value emitted from its body.
2. The target's temperature rises as it continues to move, with a recorded temperature rise of 40 °C.
3. Remote sensing technologies, including the arc map program, are supportive and supportive programs in tracking and pursuing the target by determining the location of the target by identifying the radiation spectral signature emitted by the target.
4. The use of thermal cameras mounted on the drone is a suitable technique for tracking moving targets, as the results have proven to be accurate.
5. When used in conjunction with aerial or satellite remote sensing systems, thermal cameras can cover large areas in a short time.

RECOMMENDITIONS

1. We recommend the use of thermal imaging through remote sensing techniques in the study of the environment, as well as in the security aspect, as these techniques can detect fires early, especially for field crops and forests, in addition to the possibility of following up and monitoring border points and following up infiltrators through those points.
2. These techniques can also be used in the fields of industrial maintenance and infrastructure, in detecting specific faults in electrical systems by identifying high thermal points, as well as inspecting buildings by examining their thermal insulation by identifying areas of energy loss.
3. The Ministry of Agriculture can also adopt the use of these technologies by evaluating agricultural crops through thermal distribution analysis, as well as monitoring changes in vegetation.
4. These technologies can be used in the medical field to detect diseases that cause changes in a patient's body temperature.

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