

Feature recognition of target discovery in modern area in internet of things

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Abstract. This paper offers a new method for discovering life in modern areas using an independent detector. The offered device uses a thermal image to discover the feature of life and an equipment to obtain photographs of the spot. The pictures are input to a linked Internet of Thing, analyzed to discover the feature of a life within a destructive area. This method demands a small amount of pictures to be obtained and handled during the treatment action, which properly decreases the expense of picture analysis, information processing. The conclusion of the implemented tests illustrated that this device has the capability to obtain high property in discovering life in destructive areas efficiently. The discovery veracity changed from 78% to 92% relying on several elements such as the human state, the brightness, and the contrast between the human and the background.

Key words. target discovery, user interface, independent systems, public port, internet of things.

1. Introduction

According to the field of Area Target Discovery (ATD), the probability of saving a victim is high within the first 36 hours of the treatment action, after that, the probability becomes nearly zero [1]. In light of recent catastrophes, which are either natural such as earthquake, hurricane, flood, and fire, or man-made such as wars, bombing, and terrorist attacks, the need for creating new ways to rescue the life who get trapped under rubble, in the fastest way possible, is a must. However, the attempt faced several critical problems due to the remotely-controlled nature of the detectors:

1) There was a continuous need for illumination due to the dark nature of these areas. Therefore, a continuous light source would be needed in order to be able to

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obtain and send pictures. This demands a relatively large power supply, which is not feasible in such situations.

2) A very high analysis expense is also incurred by the capturing, storing, and transmitting a large amount of pictures.

3) A very high communication expense was incurred due to the large amount of transmitted pictures to the operator, especially when the communication line is very error-prone.

4) More than 24% of the communications between the wireless detector and the control unit was extremely noisy and therefore was useless.

In order to prove the concept and the functionality of the system, the Independent detector was emulated by attaching a laptop PC (representing the brain of the detector)[1] to a large toy car (representing the query mechanism of the detector). The car was fully controlled by the laptop PC via an external interface electronic circuit that was designed and built for such purpose. The laptop PC was equipped with a low-expense, medium-resolution web camera and a TI detect, and was running the MATLAB software.

2. Related work

The obtained conclusion illustrated that this system performed significantly better than a similar full-life person discover [4]. Moreover, the system handles the variations in lighting and noise in a picture better than a full-life discover. Mohan et al. presented a hierarchical technique for developing a system that locates people in pictures [5]. In this Adaptive Combination of Classifiers (ACC) technique, the learning occurs in multiple stages. The system is first analyzed to find the four components of the life: the head, legs, left arm, and right arm separately from each other. After ensuring that these parts are present in a proper geometric configuration[6], the system combines the conclusion in order to classify a pattern as either a "person" or a "non-person".

Cavalcanti and Gomes presented a method for determining the presence of people in still pictures[7]. It starts with the segmentation of the skin areas in the picture using skin filter using a color space with a set of tested thresholds. Then, the discovered skin areas are grouped together to form life regions. This technique was been applied on a database of still pictures and obtained 78% correct classification. The advantage of this method is its simplicity and relative low analysis expense. However, higher-level analysis would be needed in order to obtain higher discover property. Ruo hu presented a simulation study for a multiple detectors foraging in a simulated area [6]. The detectors are awarded points for accurate mapping and victim discovered according to the predefined property metrics. Several research papers [8]-[10] were published regarding the property of the National Institute of Standard and Technology (NIST) Standards.

3. System Implementation

In order to emulate the offered target discovery modern system and evaluate its property, a laptop PC, which represents the main Analysis and Control Unit (ACU) of the system, was attached to a query mechanism (e.g. a large toy car) via a Query Control Unit (QCU).

The QCU consists of electronic circuitry that interfaces the detectors (as system inputs) and the query mechanism (as a system output) to the main analysis and control unit. The system was equipped with three types of detects:

- 1) An picture detect, which is a traditional web camera to obtain still pictures according to orders from the control program when a need arises.
- 2) A TI detector to discover the presence of a living human based on life radiation.
- 3) An Blue-Star (BS) change detector to discover the obstacles in the way of the detector.

The ACU consists of the following components (see Figure 1):

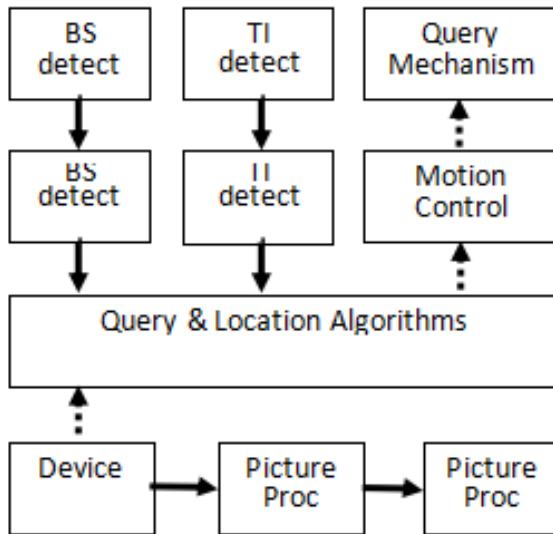


Fig. 1. ACU consists of the components

1) In our system, the laptop PC was equipped with a wireless local area networking adapter, which was used for communications. The wireless communication unit is responsible for providing reliable communication link with the rescue personnel in order to provide the locations of the life in addition to any other information the system may be designed to provide such as a photograph of the spot so that the rescue personnel may be able to assess the situation of the survivor and prioritize their rescue tasks.

2) The picture analysis and Internet of Things Unit (ITU), which is responsible for discovering a human being in a picture received from the camera. This unit is the core of this research and will be discussed in details in the following sections.

3) The location tracking algorithm, which is responsible for calculating the real-time coordinates of the detector in order to report the locations of the life to the rescue personnel. The real implementation of a target discovery detector is assumed to be equipped with a (GPS) or a GPS-like system for location identification.

4) The query algorithm, which is responsible for steering the detector throughout the search area and around obstacles, based on the readings of the TI and the BS detects while searching for life.

Therefore, simple obstacle avoidance query algorithm and simple step counting location identification were used in the system.

Figure 2 shows the diagram of the system operation.

Before the tests were implemented, the discover changes and coverage angles of the TI detect and the camera had to be well-tested and unified in order to make sure that the camera is capable of “seeing” the survivor that has triggered the TI detect with enough quality for analysis and discovering. The test conclusion was as follows:

The maximum discover change of the TI detect was found to be 5 m at 180.

The maximum distance between the camera and the object, max D , of which the picture is to be obtained with an acceptable picture quality, was found to be 2 m.

The radius, R, of the picture taken at 2 m by the camera was found to be about 1.12 m.

Based on the discovered changing measurements of the camera, the coverage angle, θ , was calculated as follows:

$$\theta = 2 \times \tan^{-1} \left[\frac{R}{D_{max}} \right] = 60^\circ \quad (1)$$

Therefore, sending a picture must be well justified. Otherwise, the battery life-time of the detector will be decreased significantly. The ACU may also have the capability to compress the picture before sending it, which may decrease the expense significantly, relying on the resources available at the ACU.

Due to the incompatibility in the discover change and the coverage angle between the TI detect and the camera, the following procedure was performed in order to obtain a unified coverage of both:

1) In order to decrease the coverage angle of the TI detect, an aluminum cap was used. The length of the cap, L, was determined as related to the diameter of the TI detect lens, d, which was 9.8 mm, as follows:

$$\tan \left(\frac{\theta}{2} \right) = \frac{d}{L} \quad (2)$$

$$L = \frac{9.6mm}{\tan(30^\circ)} = 16.6mm \quad (3)$$

2) In order to decrease the effective discover change of the TI detect from 5 m to 2 m, the TI detect was tilted down towards the ground by a calculated degree. Assuming that the TI detect is stated on the detector such that the far edge of the

cap is at a certain height, H , from the ground, the tilting angle, τ , of the detect is calculated as follows assuming that $H = 0.5$ m:

$$\alpha = \tan^{-1} \left[\frac{H}{D_{max}} \right] \quad (4)$$

$$\frac{\theta}{2} + \alpha \quad (\text{since } d \ll D_{max}) \quad (5)$$

$$\alpha = \tan^{-1} \left[\frac{0.5m}{2m} \right] = 15^\circ \quad (6)$$

$$\tau = \frac{60^\circ}{2} + 15^\circ = 45^\circ \quad (7)$$

4. The Picture Analysis and Internet of things Unit

As stated previously, when the TI detector is triggered, the ACU signals the camera to obtain a picture of the spot, which is passed to the ITU for analysis and discover. In this section, the ITU is discussed.

4.1. Internet of Thing Training and Testing

Before being used in the system, the IT had to go through an iterative training and testing phase. The training set, Tr , was divided into 12 groups of 50 pictures each. The testing set, Te , consists of 52 pictures that the IT never been analyzed on. The training and testing procedure was as follows:

- 1) Train the IT on a new set of 50 pictures from Tr .
- 2) Test the IT using Te by feeding the pictures of Te as inputs to the IT and recording the result for each.
- 3) Calculate the discover veracity of the IT, which represents the percentage of successful discovers.

Repeat the process until all training sets are used.

The discover veracity, $A(n)$, obtained as a function of the amount of training pictures, n . It is noticed that the discover veracity monotonically increases with the n . However, it slows down and starts to saturate for $n > 352$ to about 83% veracity at 500 pictures, which indicates a logarithmic behavior. Therefore, tested regression analysis was performed on the training conclusion and the trend of $A(n)$ was estimated as:

$$A(n) = 1 - e^{-\left[\frac{n}{180}\right]} \quad (8)$$

4.2. The Main Features

The type of IT used for the ITU is the linked with a supervised learning method [9] [10].

The process started by training the Internet of Thing on a large amount of pictures for human hands, feet, and bodies of different sizes and states as follows:

1) The set of training pictures, Tr, contained 512 RGB pictures of 174×142 pixels each.

2) At each training cycle (or epoch), six pictures were fed as input to the training stage, of which two are for hands, two for feet, and two for bodies.

3) Before feeding a picture into the IT, some simple enhancements were first applied in order to decrease the IT analysis expense as much as possible [7].

The IT used had three layers (see Figure 3):

5. Tests and Test Conclusion

In order to evaluate the property of the system, the rescue scenarios were performed by an amount of designed tests. Each test consisted of a combination of the following characteristics:

1) The color levels of clothes dressed by the human being rescued; ranging from very dark to very bright. The reason this element was added is to test the robustness of the system in recognizing the features of the life under different combinations of color contrast levels between the life itself and the background. The color contrast levels used are listed in Table 3.

2) The area characteristics around the life such as the lighting level and whether there are features or objects around it. The features and objects were emulated by pieces of furniture for indoor tests and rocks and trees for outdoor tests. The different types of areas used and their characteristics are listed in Table 2. This combination of features was used in order to test the robustness of the system in discovering the life when it is either surrounded or partially covered with debris or rocks or when it is laid in a dark area, etc.

The discover veracity test conclusion of all tests are listed in paper. For each test, the ITU takes a decision as either T, when a human is discovered, or F, when no human is discovered. For each Case/Area combination, the total amount of T and F decisions is listed.

1) The summary of the conclusion for each Case/Area combination is listed in paper. The conclusion of this part provides the following observations:

2) For Cases 5 and 6, where the system is expected to make only F decisions, as discussed above, the system made a relatively small amount of false-positive decisions with an error rate of 6.8% to 8.2%.

3) Cases 1 and 2 produced a relatively high level of discover veracity with 12% to 14% error rate since most of the life features were clearly visible.

4) For Cases 3 and 4, even though only the hand or the foot of the life was visible, the system performed relatively well in discovering them with 22% to 24% error rate.

5) Areas 3 and 4 provided very good conditions for accurate discover with about 8% error rate, while areas 1 and 2 provided moderate conditions for accurate discover with 16% to 22% error rate.

The summary of the conclusion for each Case/Clothes Color combination is listed in paper. The conclusion indicate that the very bright and very dark clothes color

contrast seem to provide the worst conditions for discover veracity with 23% to 25% error rate, while the medium to dark clothes color contrast provide the best conditions for discover veracity is all cases and area conditions with only 5.8% to 11.2% error rate.

6. Conclusions

This research demonstrates that using relatively simple picture analysis and internet of things techniques in critical applications such as the area target discovery is conceptually efficient and has the capability for playing a significant role in more sophisticated area target discovery systems. The tests illustrated that the offered system can obtain a relatively high discover veracity of up to 95% in certain conditions and an overall average discovery veracity of 88% for all tests and areas tested.

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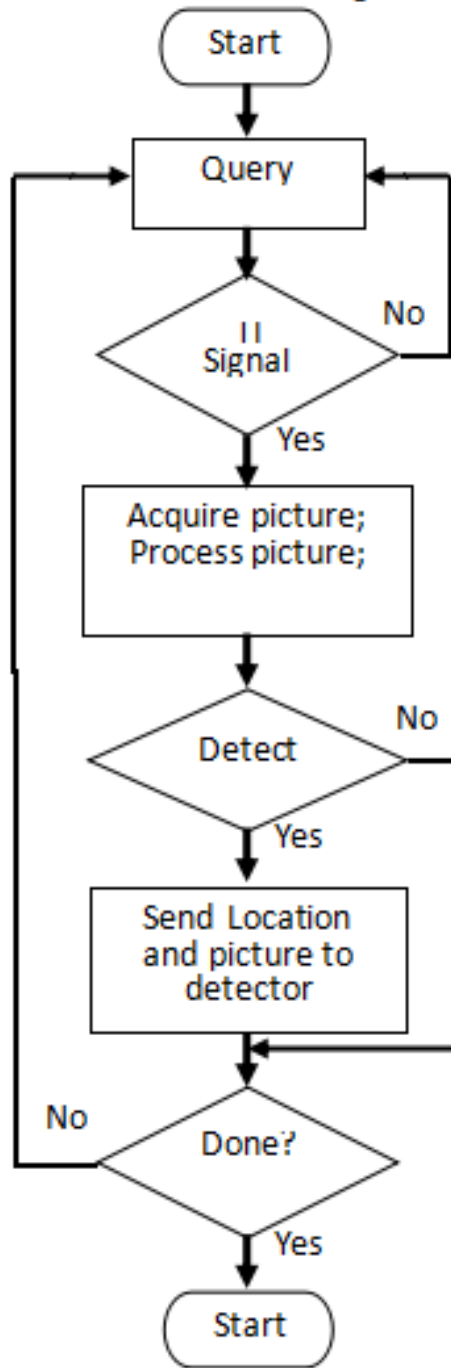


Fig. 2. The system operation diagram

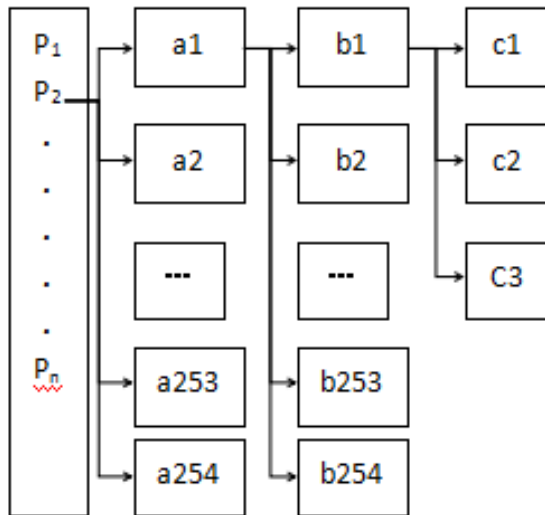


Fig. 3. The IT used had three layers used

