

Reviewer comments:

1. The author should give more discussions about the advantages and shortcoming with other approaches in literatures.

Answer:

In this new version we have further extended our discussions about the advantages and shortcoming with other approaches. We quote here some paragraphs from the new version of the manuscript:

“It is well known in research community that the literature review section should furnish old works, explore the related ideas and concepts, and discuss their possible limitations. Those limitations might be common to a bunch of papers. Eventually, the new proposed paper should address a solution to those limitations (taking into consideration the nature of the problem). And this is what we have done and considered in our new work.

We have addressed three major limitations: 1) the computational complexity, 2) effect of time lapse, and 3) enhancement of recognition rate. The computational complexity effects the time consumed and consequently the system speed. In page 4, lines [140 – 141] we addressed this issue of computational complexity. The same issue was noted in the same page - lines [153 – 154]. Moreover, the issue of time lapse can be studied by the virtue of having a database with images taken at different times. Most of the available works have used databases that do not address this issue, and we have stated this matter in our paper. For example, in page 3 lines (98 – 104): “Bhowmik et al. [14] introduced the role of different IR spectrums, their applications, and some interesting critical observations. In their experimental work, they fused both thermal and visible images to enhance the recognition rate, as it is expected that the fusion process improves the overall performance of the system. They have tested their method on IRIS and Terravic databases. In both databases, the images were taken in one time session. In other words, the effect of time lapse has not been taken into consideration.” As this paragraph reveals, we have mentioned the time lapse limitation clearly. With respect to performance issue, we have explained that some techniques did not show attractive performance. For example, Ref [15] page 3 – line 109, and Ref [18] page 3 – lines [121 – 122].

Now, we explain how we have mentioned the way to solve the limitations stated above. First, we have clearly stated in page 2, lines (49 – 56): “Decision level fusion finds a combination of multiple statistical patterns to produce an integrated result that is enhanced in terms of information content for pattern recognition and classification. Local representations offer robustness against variability due to the changes in localized regions of the objects. The features used in the local feature analysis methods are less sensitive to illumination changes, easier for estimating the rotations, and have less computational burden. Hence, the proposed system employs the advantages and the characteristics of: thermal images, component-based approach, the statistical features, and fusion.” As it is obvious from the paragraph, the new proposed technique solves these limitations by exploiting the characteristics of:

- i. thermal images,
- ii. component approach,
- iii. statistical features, and

iv. fusion.

Then, we further add:

- a) Computational complexity: this issue is studied by examining the amount of time consumed and the related speed, and we have shown this in Section 5, page 11 – lines (364 – 367): “An important advantage of our system is its speed and efficiency. Table 4 shows the time consumed by the system to complete the histograms of the different components. As can be seen from Tables 3 and 4, the system performance demonstrates its effectiveness when both the recognition rate and the time consumed are considered.” Table 4 shown in page 20 demonstrates an example of the time consumed (in second) needed to calculate the histogram for each component for different images of the same subject. The noticeably small amount of time taken by the system is quite obvious from this table. This reflects that the proposed system is not computationally greedy.
- b) Time lapse: we have indicated in Section 4, pages (7 – 8) – lines (261 – 264): “We have built a database of 570 images for 19 different subjects taken at different sessions. The database consists of male and female coming from various ethnic backgrounds. Acquisitions were held at different times and most subjects participated in multiple sessions across a number of different weeks.” So, when our method works effectively on a database characterized by this “time lapse” challenge then it shows that this method can solve an important limitation that was not previously solved or addressed.
- c) Enhancement of recognition rate: our technique shows very promising results with a recorded success rate of 96.4%. We have shown this clearly in the comparison made with other methods shown in Table 3 - page 19. ”

Further, we refer the reviewer to the paragraphs marked in yellow colour in the new version, which extends our feedback to the raised comment. Finally, it is worthy to emphasize that this work is not meant to be a comparative study or a literature survey paper. Rather, this is a theoretical paper that represents a new idea. So, there is a space limitation that should be considered.

2. The proposed method in novelty is not enough, but the author can summary the contributions in the context to enhance it.

Answer:

We have summarized the paper’s novelty and our contributions in the context as follows:

- a) Page 2 – paragraph marked in red: “First, it proposes a way to achieve thermal face image representation in a simple manner. Second, it utilizes the statistical characteristics of thermal components alongside the advantages of results fusion. Third, it provides a large number of experimental results that show that the proposed method is good enough to recognize a person in a competitive way, especially when considering consumed time and speed.”
- b) Further, the proposed feature vector is new and novel by itself. We quote the following from page 5 (also marked in red in the new version): “In this paper, we

propose a feature vector that consists of the following different feature parameters: first moment, second moment, and the thermal image histogram. The calculation of the first and second moments and the histogram distribution is implemented at the component level, beside the whole face image. The final decision results depend on the *local* mean, variance and histogram beside the computation of the *global* mean, variance and histogram over the entire thermal face image. These local parameters are more powerful in preserving the discriminant features in a neighborhood of a pixel in an image.”

- c) The same discussion applies to the way we divide the face image into smaller components. Please refer to pages 5 and 6, **the paragraphs shown in red**.

3. Please provide more compared figures to explain the advantage of yours against others.

Answer:

We are not quite sure if we have understood this comment correctly. It looks that this is an open-ended issue and a general request. But, to the best of our understanding, if the reviewer meant graphical figures that expose the advantages of the proposed method then we kindly ask him to refer to pages 10 and 11 for the paragraph **marked in green**. Also, please refer to figures 10, 11, 12, 13, and 14.

If, on the other hand, the reviewer meant “numerical figures” as successful recognition rates, then we have presented in Table 3 experimental results for eight different works from the literature where we have shown a comparison between the results of these eight works and our method. Please refer to page 11 (the paragraph shown in green) and Table 3 shown in page 19. Also, please note that we have provided 16 different figures to analyze the results and demonstrate the advantages of our method.