JOURNAL ARTICLE EVALUATION OUTLINE

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TITLE : Finger Vein Recognition Algorithm Based on Lightweight Deep Convolutional Neural Network.

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A. INTRODUCTION

1. **Does the title of the research article give any indication of the type of study beingreported ; i.e., Descriptive, Correlational, or Causal — Comparative**

Ans:-

No, based on the title "A Lightweight Deep Network Finger Vein Recognition Algorithm," the type of study (descriptive, correlational, or causal-comparative) isn't indicated. It describes the method itself (lightweight deep network) and its application (finger vein recognition).

The title**, "A Lightweight Deep Network Finger Vein Recognition Algorithm,"** doesn't directly indicate the type of study (descriptive, correlational, or causal-comparative). It focuses on the core aspects of the research:

The method: "Lightweight Deep Network" suggests the development of a new approach.

The application: "Finger Vein Recognition Algorithm" clarifies the problem the method addresses.

While the title hints at an analytical approach (developing and evaluating a method), it doesn't reveal the specific study design used to assess the method's effectiveness.

2. Were the Independent and Dependent variables mentioned in the title?

Ans:-

No, the independent and dependent variables are not mentioned in the title "A Lightweight Deep Network Finger Vein Recognition Algorithm."

Titles typically focus on the overall concept or innovation of the research, and in this case, it highlights the method itself (lightweight deep network) and its purpose (finger vein recognition). Independent and dependent variables are more specific details used in causal-comparative studies where researchers manipulate an independent variable to observe its effect on a dependent variable. The title doesn't suggest any manipulation, so it wouldn't include these variables.

3. In what part of the article did you find what kind of statistical tools were being used?

Ans:-

The focus of the research seems to be on the development of a novel deep learning architecture for finger vein recognition using a lightweight neural network and triplet loss function. There might be underlying statistical concepts at play for the deep learning algorithms, but the paper itself doesn't delve into those details.

Deep learning algorithms themselves rely on statistical principles , They involve calculations of probabilities, distances, and error functions during training.

The paper mentions using a **triplet loss function.** This function inherently uses distance metrics to compare feature vectors, which is a statistical concept.

The triplet loss function uses three images (samples) for each training iteration:

1. **Anchor (A):** Represents the reference image for a specific identity.
2. **Positive (P):** Represents an image from the same identity as the anchor (similar).
3. **Negative (N):** Represents an image from a different identity (dissimilar).

Loss = max(||f(A) - f(P)||^2 - ||f(A) - f(N)||^2 + margin, 0)

However, **the paper doesn't explicitly discuss specific statistical tools** or go into the statistical underpinnings of the deep learning models. It focuses more on the architecture and performance of the proposed algorithm

B. Analyzing the Variables

1. What is(are) the independent variables, Be specific!

Ans:-

Based on the information provided in Sections IV and V of the case study, the independent variables are:

Preprocessing Techniques:

- **Mini-ROI feature extraction (presence vs. absence):** This refers to whether or not a region of interest (ROI) containing the core finger vein pattern is extracted before feeding the image to the deep learning model.
- **Pattern feature extraction methods (different algorithms used):** This refers to the specific algorithms used to extract relevant features from the finger vein image after (or without) applying Mini-ROI extraction. The details of these algorithms might not be explicitly mentioned in the summarized sections.

Deep Learning Model Architecture:

- **Network type (e.g., convolutional neural network):** The type of neural network architecture used for feature extraction and classification. The case study mentions a lightweight deep network, but the specific type (e.g., VGG, ResNet) might not be given.
- **Number of layers:** The number of layers stacked in the deep learning model. More layers can improve feature learning ability but also increase computational cost.
- **Type of activation functions:** The activation functions applied within the neural network layers to introduce non-linearity and improve model performance. Examples include ReLU, sigmoid, etc.

Loss Function:

- **Triplet loss function (with or without):** This refers to whether the triplet loss function is used to train the model. The triplet loss function influences how the model learns to represent finger vein features.
- **Hyperparameter settings (e.g., margin value):** Specific parameters within the chosen loss function that can be tuned to optimize performance. The case study might mention using a margin value in the triplet loss function, but the exact value might be in a separate table or section.

Training Parameters:

- **Learning rate:** The rate at which the model updates its weights based on the errors during training.
- **Batch size:** The number of images processed by the model before updating its weights.
- **Number of training epochs:** The number of times the entire training dataset is passed through the model for training.

These independent variables allow the researchers to explore how different configurations affect the performance of the finger vein recognition algorithm in terms of recognition accuracy and matching time.

A. What is(are) the nature of the measurements: i.e., Nominal, Ordinal, Ratio, Interval, aswell as whether or not they are continuous or discrete.

Ans:-

The nature of the Measurements..

Based on the information gleaned from Sections IV and V of the case study, here's the breakdown of the measurement types in the finger vein recognition experiment:

Variable	Nature of Measurement	Continuous/Discrete
Mini-ROI Feature Extraction	Nominal	Discrete (Presence/Absence)
Pattern Feature Extraction Algorithms	Nominal	Discrete (Specific algorithms used)
Network Type	Nominal	Discrete (Category of neural network)
Number of Layers	Discrete Ratio	Discrete (Integer number of layers, but represents ratio scale)
Activation Functions	Nominal	Discrete (Categories of activation functions)
Triplet Loss Function	Nominal	Discrete (Used/not used)
Hyperparameter Settings	Continuous Ratio	Continuous (Values like margin on a ratio scale)
Learning Rate	Continuous Ratio	Continuous (Float representing rate)
Batch Size	Discrete Ratio	Discrete (Integer number of images in a batch, but represents ratio scale)
Number of Training Epochs	Discrete Ratio	Discrete (Integer number of training iterations, but represents ratio scale)
Recognition Accuracy	Continuous Ratio	Continuous (Percentage, ratio scale 0-100)
Matching Time	Continuous Ratio	Continuous (Time measurement, ratio scale)

Here's a brief explanation for each category:

- **Nominal:** Categorical data with no intrinsic order (e.g., presence/absence, algorithm types, network type).
- **Discrete Ratio:** Integer-valued data representing a ratio scale (e.g., number of layers, batch size, epochs). Even though these are integers, they represent ratios or proportions (e.g., 2 layers is twice as many as 1 layer).
- **Continuous Ratio:** Real-valued data representing a ratio scale (e.g., hyperparameter settings, learning rate, recognition accuracy, matching time). These can take any decimal value within a range.

- **Discrete:** Categorical data or integer values with an inherent order (not mentioned in this case study).
- **Interval:** Continuous data with a fixed and meaningful difference between units (not mentioned in this case study, as the zero point might be arbitrary for these measurements).

2. What is(are) the Dependent variables, Be specific!

Ans:-

The dependent variables in the finger vein recognition experiment are:

Recognition Accuracy: This variable is continuous and measured as a percentage of correctly identified finger vein images. It represents the ratio of successful identifications out of the total number of attempts, typically expressed on a scale of 0% to 100%.

Matching Time: This variable is also continuous and measured in time units (e.g., milliseconds). It represents the time taken by the model to recognize a finger vein image. This is a ratio variable because it reflects the duration of the matching process.

- The case study mentions the concept of **generalization ability**. This refers to how well the model performs on unseen data (data it wasn't trained on).

While the summarized sections might not explicitly mention how generalization ability is measured, it's a crucial aspect to consider in evaluating the finger vein recognition algorithm.

A. What is(are) the nature of the measurements: i.e., Nominal, Ordinal, Ratio, Interval, aswell as whether or not they are continuous or discrete.

Ans:- This question is Repeated same answer as given above.

Nature of Measurements in Finger Vein Recognition Experiment

Variable Type	Variable Name	Measurement Type	Continuous/Discrete
Dependent	Recognition Accuracy	Continuous Ratio	Continuous (Percentage, 0-100 scale)
Dependent	Matching Time	Continuous Ratio	Continuous (Time measurement, ratio scale)
Dependent	Generalization Ability	Potentially Varies	May be continuous or nominal depending on measurement

			method (uncertain from summarized sections)
Independent	Preprocessing Techniques: Mini-ROI Feature Extraction	Nominal	Discrete (Presence/Absence)
Independent	Preprocessing Techniques: Pattern Feature Extraction Algorithms	Nominal	Discrete (Categories of algorithms)
Independent	Deep Learning Model Architecture: Network Type	Nominal	Discrete (Category of neural network)
Independent	Deep Learning Model Architecture: Number of Layers	Discrete Ratio	Discrete (Integer, but represents ratio scale)
Independent	Deep Learning Model Architecture: Activation Functions	Nominal	Discrete (Categories of functions)
Independent	Loss Function: Triplet Loss Function	Nominal	Discrete (Used/Not Used)
Independent	Loss Function: Hyperparameter Settings	Continuous Ratio	Continuous (Values on a ratio scale)
Independent	Training Parameters: Learning Rate	Continuous Ratio	Continuous (Float value representing rate)
Independent	Training Parameters: Batch Size	Discrete Ratio	Discrete (Integer, but represents ratio scale)
Independent	Training Parameters: Number of Training Epochs	Discrete Ratio	Discrete (Integer, but represents ratio scale)

The finger vein recognition experiment uses two main types of variables:

- **Measured Performance (Dependent):** These reflect the system's effectiveness and include:
  - Recognition Accuracy (continuous %, 0-100%)
  - Matching Time (continuous time units)
  - Generalization Ability (potentially continuous or nominal)

- **Configurable Settings (Independent):** These are manipulated to influence performance and include:
  - Preprocessing techniques (nominal categories)
  - Deep learning architecture (nominal categories & discrete/continuous ratios)
  - Loss function settings (nominal & continuous ratios)
  - Training parameters (discrete ratios)

By adjusting these settings, researchers can optimize the finger vein recognition system for both accuracy and efficiency.

✧ More Clarity between Dependent and Independent Variable in Case Study :-

Variable Type	Variable Name	Description	Measurement
Dependent	Recognition Accuracy	Proportion of correctly identified finger vein images	Continuous Percentage (0% - 100%)
Dependent	Matching Time	Time taken by the model to recognize a finger vein image	Continuous Time Units (e.g., milliseconds)
Dependent	Generalization Ability	Model's performance on unseen data (potentially)	Measurement method may vary (not explicitly mentioned)
Independent	Preprocessing Techniques: Mini-ROI Feature Extraction	Presence or absence of a region of interest (ROI) containing the core finger vein pattern	Nominal (Presence/Absence)
Independent	Preprocessing Techniques: Pattern Feature Extraction Algorithms	Algorithms used to extract relevant features (specific algorithms may not be given)	Nominal (Categories of algorithms)
Independent	Deep Learning Model Architecture: Network Type	Type of neural network architecture used (e.g., lightweight convolutional neural network)	Nominal (Category of network)
Independent	Deep Learning Model Architecture: Number of Layers	Number of layers stacked in the model	Discrete Ratio (Integer, but represents ratio scale)
Independent	Deep Learning Model Architecture: Activation Functions	Functions applied within the neural network layers	Nominal (Categories of functions)
Independent	Loss Function: Triplet Loss Function	Use of the triplet loss function for training	Nominal (Used/Not Used)
Independent	Loss Function: Hyperparameter Settings	Specific parameters within the chosen loss function (e.g., margin value)	Continuous Ratio (Values on a ratio scale)
Independent	Training Parameters: Learning Rate	Rate at which the model updates its weights during training	Continuous Ratio (Float value representing rate)
Independent	Training Parameters: Batch	Number of images processed before	Discrete Ratio (Integer, but

	Size	**updating weights**	**represents ratio scale)**
Independent	**Training Parameters: Number of Training Epochs**	**Number of times the entire training dataset is passed through the model**	**Discrete Ratio (Integer, but represents ratio scale)**

C. Hypothesis

1. Were the hypotheses clear and understandable?

Ans:-

About Statements ->

Based on the information provided in Sections IV and V of the case study, the paper does not explicitly state the research hypotheses. **These sections focus on the methodology and results**. Without a dedicated hypothesis section or clear statements indicating expected outcomes, it's difficult to definitively assess the clarity and understandability of the hypotheses in this summarized version of the research.

About Clues ->

The case study don't have a dedicated hypothesis section, the paper suggests that **the researchers might have been investigating the impact of [mention specific independent variables] on [mention specific dependent variables]. This suggests a potential hypothesis that [briefly state your understanding of the expected relationship between variables].** However, without a clear and explicit statement of the hypotheses, it's challenging to fully assess their clarity and understand ability.

2. What was the hypotheses? What was the Null hypothesis? Was it appropriate for the study?

The article likely doesn't explicitly state a statistical hypothesis or null hypothesis because it focuses on proposing a novel method for finger vein recognition and evaluating its performance. However, we can infer the general intent:

- **General Hypothesis:** The proposed finger vein recognition algorithm using Mini-Roi extraction, a lightweight deep network with channel stacks, and triplet loss training leads to superior recognition accuracy and efficiency compared to existing methods.

The null hypothesis would be the opposite:

- **Null Hypothesis:** There is no significant difference in recognition accuracy and efficiency between the proposed finger vein recognition algorithm and existing methods.

Since the study aims to demonstrate the effectiveness of the new approach, it wouldn't typically use a null hypothesis directly. Instead, they evaluate the algorithm's performance using metrics like accuracy, matching time, and comparison with existing methods. By showing significant improvements in these areas, they indirectly reject the null hypothesis and support their general hypothesis.

It's appropriate for this study not to use a formal null hypothesis because the main goal is to introduce and validate a new method, not to statistically test a specific claim against an existing one.

3. Did the introduction adequately set up the hypothesis?

Ans:-

The excerpt from the paper likely doesn't directly mention a hypothesis, but it does lay the groundwork for the introduction of a novel method for finger vein recognition. Here's how the introduction might have set up the hypothesis (without explicitly stating it):

- **Background:** The introduction likely discusses the importance of biometric identification and mentions finger vein recognition as a promising technology.
- **Limitations of Existing Methods:** It might discuss limitations of existing finger vein recognition methods, such as computational cost, accuracy issues, or challenges related to training data.

By establishing the need for improvement in finger vein recognition, the introduction indirectly suggests the hypothesis that a new approach can address these limitations.

The following sections (not included in the excerpt) would then introduce the proposed method and evaluate its performance:

- **Proposed Method:** This section details the Mini-Roi extraction, lightweight deep network with channel stacks, and triplet loss training, aiming to address the limitations mentioned in the introduction.
- **Experiments and Results:** This section presents the evaluation process, including datasets, training details, and comparison with existing methods. The results would likely show improvements in recognition accuracy and efficiency, supporting the hypothesis.

Overall, while the introduction likely wouldn't use the term "hypothesis," it would provide the background and motivation for developing a new finger vein recognition method, indirectly setting the stage for the hypothesis to be validated in the following sections.

4. If the authors did not provide hypothesis, try to “Creatively” generate what you think theyshould have been.

Ans:-

We can creatively generate a hypothesis even if the authors didn't provide one:

1. Analyze the Research Question or Problem:

- Start by clearly understanding the central question the authors are trying to answer or the problem they're investigating. This will be the foundation for your hypothesis.

2. Identify Patterns or Trends:

- Look for existing data, observations, or prior research mentioned in the paper. Are there any patterns or trends that emerge? These could be clues to a potential hypothesis.

3. Consider Opposites or Extremes:

- Flip the script! If the research seems focused on a specific phenomenon, hypothesize the opposite scenario. This can spark new questions and insights.

4. Introduce a Variable:

- Can you identify a variable that might influence the phenomenon under study? Hypothesize how changes in that variable might affect the outcome.

5. Bridge the Gap:

- Are there seemingly unconnected concepts or findings mentioned? Hypothesize a connection between them and explore the implications.

NOTE :-

- A good creative hypothesis should be falsifiable. We should be able to design an experiment or observation to test its validity.
- Don't be afraid to be bold! Sometimes the most groundbreaking discoveries come from unexpected hypotheses.

By following these steps, we can generate creative and testable hypotheses even when the authors haven't provided one themselves.

5. Attempt to state the null hypothesis for each alternative hypothesis.

Ans:

Alternative Hypothesis (H_1) vs. Null Hypothesis (H_0):

- **H_1 :** This is the hypothesis that proposes a difference, effect, or relationship between variables. It's what you expect to find based on your research question or the case study's focus.
- **H_0 :** This is the opposite of H_1 . It states that there's **no difference**, effect, or relationship between the variables. It's the default assumption you aim to reject (if data supports H_1) through statistical testing.

Null Hypothesis (H0): The proposed lightweight deep network finger vein recognition algorithm does not effectively extract and match the features of finger vein images, and its recognition accuracy and matching speed are not better than other previous recognition algorithms.

Alternative Hypothesis (H1): The proposed lightweight deep network finger vein recognition algorithm effectively extracts and matches the features of finger vein images, and its recognition accuracy and matching speed are better than other previous recognition algorithms.

Null Hypothesis (H0): The Mini-RoI finger vein region feature extraction algorithm does not effectively extract the core feature regions in the finger vein image.

Alternative Hypothesis (H1): The Mini-RoI finger vein region feature extraction algorithm effectively extracts the core feature regions in the finger vein image.

Null Hypothesis (H0): The lightweight deep network based on channel stacks does not effectively reduce the computational effort of the model while acquiring detailed information features in the finger vein image.

Alternative Hypothesis (H1): The lightweight deep network based on channel stacks effectively reduces the computational effort of the model while acquiring detailed information features in the finger vein image.

Null Hypothesis (H0): The model trained by the triplet loss function does not have strong robustness, and there is a need to retrain the model when a new category enters the trained model.

Alternative Hypothesis (H1): The model trained by the triplet loss function has strong robustness, and there is no need to retrain the model when a new category enters the trained model.

6. Did the authors specify a specific Alpha Risk level for rejecting the Null hypothesis? If so, what was it? If they did not specify the Alpha Risk level, what do you think it must have been?

Ans:-

The provided sections do not explicitly mention a specific alpha risk level for rejecting the null hypothesis. However, in scientific research, the standard alpha risk level commonly used is 0.05, indicating a 5% chance of rejecting the null hypothesis when it is actually true.

Since the sections do not specify an alpha risk level, it's reasonable to assume that the authors might have used the standard level of 0.05 unless otherwise stated. This level is widely accepted in scientific research and is often used unless the study requires a different level of significance for specific reasons.

D. Sample

1. Do you believe that the sample was large enough?

Ans:-

the information provided in the case study excerpt, it appears that the sample size used for the experiments was not explicitly stated. However, the dataset descriptions mention the number of images and subjects included in the study. For example, the SDUMLA-**HMT dataset contains 3816 finger vein images,** and the **PKU-FV Database includes high-resolution images of 50 subjects with five images per finger.**

Whether this sample size is **large enough** depends on various factors such as the complexity of the finger vein recognition task, the diversity within the dataset, and the statistical power required to detect meaningful effects. Without further details, it's challenging to determine definitively if the sample size was sufficient. Typically, larger sample sizes are desirable to improve the generalizability and reliability of research findings.

A. Given the sample size could you compute the standard error of the mean to accomplish this you would need the values for both N and the standard deviation. Did they provide you with this data. What do you believe the “Critical region” for rejection of the null hypothesis should have been.

Ans:-

The standard deviation or the specific values of N (sample size) required to compute the standard error of the mean. Without this data, it's not possible to calculate the standard error of the mean or determine the critical region for rejection of the null hypothesis.

However, in statistical hypothesis testing, the critical region for rejecting the null hypothesis is typically determined based on the chosen significance level (alpha level), which represents the maximum probability of making a Type I error (incorrectly rejecting a true null hypothesis). Commonly used alpha levels are 0.05 and 0.01, indicating a 5% and 1% probability of Type I error, respectively.

Since the authors did not explicitly specify an alpha level in the excerpt, it's challenging to determine the critical region for rejection of the null hypothesis. However, if a standard alpha level of 0.05 were assumed, then the critical region would typically be the upper or lower 5% of the sampling distribution, depending on whether it's a one-tailed or two-tailed test.

E. Results and Conclusions

1. Are appropriate statistical tools used?

Ans:-

Yes, appropriate statistical tools are used in the experiment. The statistical analysis includes comparisons of recognition accuracy, matching time, and other performance metrics across different datasets, algorithms, and experimental conditions. Tables are provided to present the results, and statistical measures such as averages and percentages are used to summarize the findings. Additionally, the use of a triplet loss function in training the deep model is a statistically grounded approach to enhancing the recognition accuracy of the algorithm. Overall, the statistical analysis provides a rigorous evaluation of the proposed finger vein recognition algorithm.

- **Limited Details on Statistical Methods:** The case study focuses on describing the algorithm and its performance. It mentions using triplet loss for training the deep learning model but doesn't elaborate on specific statistical tests used for evaluating the results.

A. Ex. Was the "Homogeneity of variance" assumption tested (An F-max Test) could you doone?

Ans :-

To perform an F-max test for assessing the homogeneity of variance assumption, we would need access to the raw data, particularly the variances of the different groups being compared. Unfortunately, the case study excerpt provided doesn't include this raw data. However, I can outline the general steps for conducting an F-max test:

Collect Data: Obtain the data for the groups or conditions being compared. In this case, it would involve collecting the relevant data related to finger vein recognition performance, such as accuracy rates or matching times, for each group or condition.

Calculate Variances: Compute the variances for each group. This involves calculating the sample variances for the data within each group.

Perform F-max Test: Once the variances for each group are calculated, you can perform the F-max test, also known as Levene's test. This test evaluates whether the variances across groups are significantly different from each other.

Interpret Results: Based on the results of the F-max test, you can determine whether the assumption of homogeneity of variance is violated. If the p-value from the test is below a predetermined significance level (e.g., 0.05), it suggests that the variances are significantly different, indicating a violation of the homogeneity of variance assumption.

B. Ex. The nature of measurement for the independent and dependent variables and how manyof them might indicate the type of statistical tool that should have been used?

Ans:-

The nature of measurement for both the independent and dependent variables can influence the choice of statistical tools or tests used in the analysis. Here's how:

Nature of Measurement:

Nominal: Variables that are categorical and do not have a natural order. Examples could include gender, ethnicity, or treatment group.
Ordinal: Variables that have a natural order but the intervals between the categories are not necessarily equal. Examples could include Likert scale ratings (e.g., strongly disagree, disagree, neutral, agree, strongly agree).
Interval: Variables where the intervals between the values are equal but there is no true zero point. Examples could include temperature measured in Celsius or Fahrenheit.
Ratio: Variables with a true zero point, where ratios are meaningful. Examples could include height, weight, or time.
Number of Variables:

Univariate Analysis: Involves the analysis of a single variable.
Bivariate Analysis: Involves the analysis of two variables to determine if there is a relationship between them.
Multivariate Analysis: Involves the analysis of more than two variables simultaneously to understand complex relationships.
Type of Statistical Tool:

Parametric Tests: These tests assume specific distributional characteristics of the data, such as normality and homogeneity of variance. Examples include t-tests, ANOVA, linear regression.
Non-parametric Tests: These tests do not assume specific distributional characteristics of the data or are more robust to violations of assumptions. Examples include Wilcoxon rank-sum test, Kruskal-Wallis test, Spearman correlation.
Descriptive Statistics: These are used to summarize and describe the characteristics of a dataset, such as mean, median, mode, standard deviation.
Inferential Statistics: These are used to make inferences or predictions about a population based on sample data, such as hypothesis testing, confidence intervals.
Based on the nature of measurement of the variables (nominal, ordinal, interval, ratio) and the number of variables being analyzed (univariate, bivariate, multivariate), researchers can select appropriate statistical tools that match the characteristics of their data and research questions. For example, if the independent variable is nominal and the dependent variable is interval/ratio, and there are two groups being compared, a t-test or Mann-Whitney U test might be appropriate. If there are multiple groups, ANOVA or Kruskal-Wallis test could be considered.

3. Were Graphic charts used?

Ans:-

Yes, graphic charts were used in the study. The text mentions the presentation of results using tables, such as Table I, Table II, Table III, and Table IV. Additionally, the study includes figures, such as Fig. 10, Fig. 11, and Fig. 12. These tables and figures likely contain graphical representations of data, such as bar charts, line plots, or scatter plots, to visually convey the results of the experiments and analyses conducted in the study. **Graphics are often useful for summarizing complex data, identifying trends, and comparing different experimental conditions or groups visually.**

A. If so, Were they helpful in showing the results.

Ans:-

Yes, the tables and figures were likely helpful in presenting the results of the study. Tables are effective for organizing and comparing numerical data, while figures, such as charts and graphs, are useful for visually representing trends, patterns, and relationships in the data. They can make complex information more accessible and easier to interpret for readers. By providing visual representations of the results, tables and figures help readers understand key findings, compare different experimental conditions or groups, and identify trends more quickly and intuitively than by examining raw numerical data alone.

Tables:

- **Table I (Preprocessing Time):** Shows how long different preprocessing steps take, emphasizing the method's efficiency for real-time applications.
- **Table II (Recognition Results):** Compares the proposed method's accuracy and speed with other algorithms, highlighting its advantages.
- **Table III (Backbone Networks):** Compares various network architectures used for finger vein recognition, showcasing the proposed lightweight network's superiority.
- **Table IV (Comparison with Other Algorithms):** Demonstrates the proposed algorithm's edge in terms of error rate, accuracy, and speed compared to existing methods.

These tables effectively condense key findings and serve as visual aids to enhance understanding.

B. If graphic charts were not used, try to construct them from the reported data: i.e. Sketch out aBar graph, Histogram or Frequently Polygon

Create a bar graph based on the reported data from Table II: "Recognition Results of Our Method on the Finger Vein Databases". This table likely contains information on the recognition accuracy and matching time of the proposed method compared to other algorithms on finger vein databases.

Let's assume the data is presented as follows:

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Method	Reg. Acc (%)	Matching T (ms)
Proposed	95	20
Algrithm A	90	25
Algorithm B	80	30
Algorithm C	92	24

Graph implementation ↓.

In this bar graph:

- The x-axis represents different methods (Proposed, A, B, C).
- The y-axis represents recognition accuracy in percentage.
- Each method is represented by a bar, with the height of the bar indicating the recognition accuracy.
- The asterisks (*) on the bars show the approximate height of each bar.

This bar graph visually compares the recognition accuracy of the proposed method with other algorithms, making it easier to interpret the differences in accuracy between them.

```
Recognition Accuracy (%)
100 |
    |
 95 |          *
    |          *
 90 |   *      *   *
    |   *   *  *   *
 85 |________________
      Proposed A   B   C
```

the data and graph I provided were hypothetical, based on the structure typically found in research papers. It have specific data from our case study that we like to use to construct a graph.

4. Does the investigator relate the results to the hypothesis?

Ans:-

In the case study provided, the investigator does indeed relate the results to the hypothesis. They discuss how the proposed lightweight deep network finger vein recognition algorithm effectively extracts and matches the features of finger vein images, surpassing the recognition accuracy and matching speed of previous algorithms. They also highlight the performance of their method in comparison to other state-of-the-art algorithms, demonstrating its advantages in terms of equal error rate, accuracy rate, and detection time. This connection between the obtained results and the initial hypothesis strengthens the validity and relevance of the research findings.

5. Does the investigator over-conclude, that is, are the conclusions supported by the data

Ans:-

The conclusions drawn in the case study are well-supported by the extensive analysis and empirical evidence presented throughout the investigation. The researchers meticulously evaluate the performance of their proposed finger vein recognition algorithm by conducting experiments on two public datasets: the SDUMLA-HMT database and the PKU-FV database. Through these experiments, they systematically demonstrate the effectiveness of their algorithm in accurately recognizing finger vein patterns.

Furthermore, the investigators provide comprehensive comparisons with other state-of-the-art finger vein recognition algorithms, highlighting the superior performance of their approach in terms of recognition accuracy and matching efficiency. They delve into the details of their method's enhancements, such as Mini-RoI region feature extraction and lightweight deep network architecture, showcasing how these innovations contribute to the algorithm's success.

Importantly, the researchers acknowledge the limitations of their study, such as the need for further validation on diverse datasets and potential challenges in generalizing the algorithm to broader biometric recognition tasks. By openly discussing these limitations, they demonstrate a cautious and responsible interpretation of their findings, avoiding unwarranted over-conclusions.

In sort, the investigator's conclusions are **firmly grounded in the data and analysis presented in the case study**. Their methodical approach to evaluation, coupled with transparent discussions of both strengths and limitations, lends credibility to the conclusions drawn, ensuring they are well-supported and reliable.

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RA2111003011002 [Karan Singh Rawat] A2 CSE (Core)