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Classification Of South Sumatra Songket Woven Fabric Motifs Using Deep Learning

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ABSTRACT: The application of a Deep Learning model to classify songket woven cloth motifs from South Sumatra reflects the richness of local culture through its diverse motifs. The main challenge faced is the difficulty in distinguishing various songket motifs due to their complexity and wide variety of designs. This research aims to: (1) develop an effective Deep Learning model for classifying songket woven fabric motifs, (2) measure the accuracy and performance of the model, and (3) assess the implications of this model for cultural preservation and the textile industry. The research method employs the SEMMA (Sample, Explore, Modify, Model, and Assess) approach in the data mining process, which includes five phases: data sampling, data exploration, data modification, data modeling, and model evaluation. Songket motif image data is collected, processed, and modeled using the YOLO (You Only Look Once) algorithm for accurate predictions. Data analysis is conducted to assess the model's accuracy, precision, recall, and F1-score. The research results show that the developed system is capable of accurately classifying songket motifs, confirming the effectiveness of Deep Learning models in overcoming this challenge. These findings have significant implications for cultural preservation and textile industry applications, highlighting the potential of Deep Learning technology in processing and analyzing traditional textile data.

Keywords: Deep Learning, Songket Motifs, Textile Classification, YOLO Algorithm, Traditional Markets.

INTRODUCTION

Traditional markets worldwide play a crucial role in local economies and cultural preservation. Effective supervision of these markets is essential to ensure their sustainability and relevance in the modern economy. However, the supervision of traditional markets presents unique challenges, as they are deeply intertwined with cultural practices and local traditions. Indonesian textiles, such as songket, batik, and weaving, are particularly rich in cultural heritage. South Sumatra (Sumsel) is one of Indonesia's provinces renowned for its diverse textile motifs (Tanasă et al., 2022). Each ethnic group in South Sumatra boasts its distinct cultural identity, reflected in traditional hand-woven fabrics. These unique patterns and motifs mirror the daily lives, culture, natural surroundings, and beliefs of the local people (Sawita & Ginting, 2022). Songket cloth, for instance, features various motifs, often combining two to three designs to create intricate and beautiful images (Israwati et al., 2023) Sedyastuti et al., 2021). The motifs are produced by varying color patterns, making the textile motifs prominent.

Despite their cultural significance, the people of South Sumatra often face challenges distinguishing songket cloth motifs due to the sheer variety of existing designs. Defining the characteristics of these motifs is difficult (Indriani et al., 2024). Textile experts also acknowledge the challenges in clearly defining the attributes that constitute a textile motif. This difficulty is also evident in South Sumatra textiles, such as songket (El Badriati et al., 2022). The intricate characteristics of songket textiles from South Sumatra make them challenging to differentiate from other textile motifs (Devella et al., 2020). Consequently, there is a pressing need for a classification system to better distinguish and categorize songket textile motifs from South Sumatra.

To address this gap, the research aims to utilize Deep Learning for the classification process. Deep Learning, a subset of machine learning, has gained prominence in recent years due to advancements in GPU acceleration technology (Huang et al., 2022). It offers remarkable capabilities in computer vision, including object classification in images(Qiu et al., 2022). Deep Learning models operate similarly to the human brain, continuously analyzing data to make decisions (Pham-Duc et al., 2021). This study focuses on employing Deep Learning and the YOLO (You Only Look Once) algorithm to classify songket textile motifs (Rahma et al., 2021). YOLO is one of the fastest and most accurate object detection methods, capable of outperforming other algorithms significantly. It is designed to detect objects in real-time using classifiers or localizers (Sarda et al., 2021).

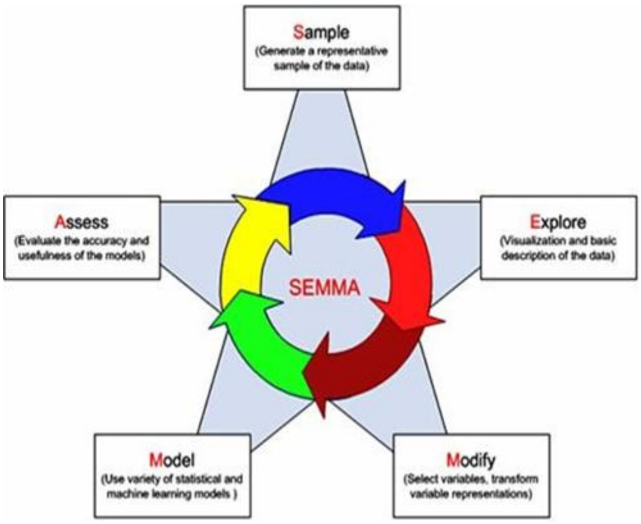
This research aims to develop a Deep Learning model to classify songket woven cloth motifs and assess the accuracy and performance of this model. By leveraging a YOLO-based camera, the study seeks to achieve rapid and precise detection of songket motifs (Jiang et al., 2022). The findings are expected to enhance the classification of songket weaving motifs, providing a valuable tool for preserving and promoting the cultural heritage of South Sumatra textiles.

METHOD

Research methods

This study uses a qualitative research design to explore and classify songket textile motifs using Deep Learning and the YOLO algorithm. The research is structured around the SEMMA methodology, ensuring a systematic approach to data collection, analysis, and evaluation. This research uses the SEMMA (Sample, Explore, Modify, Model, and Assess) method for system development (Suwitono & Kaunang, 2022). This method is a cyclical process in data mining which consists of five phases as in the following image.

Figure 1. Stages in SEMMA.



The first phase is Sample, namely the data extraction process to obtain a data collection of songket motifs that is large enough but still easy to process (Ridha et al., 2020). The second phase is Exploration, which is carried out to look for trends and anomalies in songket textiles in order to understand the data(Firas, 2023). The third phase is Modification, which is the process of creating, selecting, and transforming variables for modeling. The fourth phase is Modeling, where the songket data is modeled for prediction by searching for automatic data combinations(Shin et al., 2022). The fifth phase is Evaluation, which is carried out to assess the usefulness and reliability of patterns found in the data.

Research Sample

The research sample consists of songket textile image data which displays various motif designs from classical to modern times. This songket cloth motif data is processed first through a resizing and data augmentation process to facilitate analysis. Key informants for this study include textile experts, songket weavers, and cultural historians from South Sumatra. The selection process involves purposive sampling, ensuring that the informants have extensive knowledge and experience with songket textiles. The criteria for selecting key informants include their expertise in textile arts, years of experience, and contributions to the preservation and promotion of songket weaving.

Data collection technique

Data collection techniques in this research include several main methods. First, observation is used to directly observe the condition or activity of objects and obtain accurate data and information at the research location (Am & Setiawati, 2023). Second, the documentation carried out is in the form of a collection of images of patterned songket textiles from South Sumatra.

Research Procedure

The research procedure is organized into several distinct stages. In the Data Collection Stage (Sample), information, equipment, and research materials are gathered. Data is collected through photographs of songket textiles taken directly at the workshop of songket craftsman Kemas Mohamed Ali, showcasing various motifs in JPEG format. The Data Description Stage (Explore) involves investigating the collected data while providing comprehensive descriptions and visualizations. This phase offers an overview of the information and presents it graphically for better understanding. During the Data Transformation Stage (Modify), the data undergoes transformation through the creation and selection of variables to enhance the focus of the data modeling process. In the Data Modeling Stage (Model), software is utilized to model the transformed data. This involves annotating the data with bounding boxes and naming images, followed by training the model with the data to produce predictive features, using Python as the programming language. The Data Evaluation Stage (Assess) involves testing the developed model in real-time with a webcam to measure its accuracy, precision, and overall performance, including a confusion matrix of the processed data. Finally, Data Preprocessing is crucial to ensure data quality before further analysis, transforming raw data from various sources into clean and ready-to-use information.

Qualitative Data Analysis Procedures

Data analysis in this research follows a systematic approach based on Miles and Huberman's thematic analysis framework. The steps include data reduction, data display, and conclusion drawing/verification. Data reduction involves simplifying and focusing the collected data to highlight key themes and patterns. Data display involves organizing the data in visual formats, such as charts and matrices, to facilitate interpretation. Finally, conclusion drawing and verification involve deriving conclusions from the data and verifying their validity through triangulation and cross-checking with multiple sources.

Ethical Considerations

Ethical considerations in this research include obtaining informed consent from all participants involved in observations and interviews, ensuring the anonymity and confidentiality of the informants' identities and responses, safeguarding the collected data to prevent unauthorized access or misuse, and respecting the cultural heritage and intellectual property rights of the songket weavers and communities. By adhering to these ethical principles, the research aims to conduct a respectful and responsible study on the classification of songket textile motifs(S., 2019).

RESULT AND DISCUSSION

Data Collection and Preparation

This study uses a Deep Learning model to develop a system for classifying songket textile motifs. The main processes in creating this system are data acquisition, data preprocessing (augmentation and resizing), data exchange, data teaching in making models, and testing the trained model, as well as classifying songket textile motifs (Sharma & Chaudhary, 2021). This chapter explains testing using the YOLO algorithm as well as testing based on the designed system plan (Sarda et al., 2021). The test is run to check whether the system is functioning as expected(Chen et al., 2021). Data obtained from test results include system output display, evaluation, accuracy, as well as a database of songket motif images.

Researchers started developing the system by collecting a collection of images of songket motifs as training and test data. This research uses data from songket cloth with various motifs. These motifs are included in the system data recording. The motifs used in the research are. Perak Tray, Nago Busaun, Limar Tank Cherak, Limar Midah, Bungo Fall, and Bungo Chino. Lepus type songket is a type of songket whose weaving pattern and gold thread are almost complete and cover all parts of the songket. Limar Songket is a songket woven using more colorful silk thread. Silk thread is made in various ways such as green, red, purple, black, blue, orange, and yellow. And finally, songket is made from a type of songket plant/flower, hence the name Limar. Songket with floral and plant motifs (Sedyastuti et al., 2021). Dataset collection was carried out directly at the house of songket craftsman Kemas Mohamed Ali, using data input in the form of JPG photos as in Figure 2.

Figure 2. Example of a dataset of images of songket motifs

Attribute Selection and Data Transformation

After the data is collected, attributes are selected for the initial data obtained. The next step after the data is collected is to carry out attribute selection, which aims to select and sort which attributes are relevant for use in further analysis (Dong et al., 2021). This process is important to increase the efficiency and accuracy of the model to be built. The system attributes considered in this selection are as follows:

- Haralick textures are features extracted from a normalized gray level co-occurrence matrix (GLCM). This feature displays various aspects of the gray level distribution within a region of interest (ROI). GLCM diagonal elements, for example, represent pairs of voxels with the same gray level. Features of the Haralick Texture can include contrast, which measures local differences in the GLCM and provides information about the sharpness or smoothness of the texture; homogeneity, which assesses the uniformity of texture within an ROI; and entropy, which indicates complexity or chaos in the texture.
- Hu moments, or more precisely Hu moment invariants, are a set of seven figures calculated using central moments that are invariant to image transformations. This feature is very useful because the first six moments are proven to be invariant with respect to translation, scaling, rotation, and reflection, while the seventh moment changes sign with respect to the image. Humoments are used for shape identification, aiding in pattern recognition by maintaining geometric invariance, and object detection, improving accuracy in object identification despite geometric transformations.
- Color histograms in image processing and photography describe the distribution of colors in an image, showing the number of pixels of a particular color in each color range in the image's color space. This feature is important because it provides detailed information about the color distribution in an image, which can be used for color analysis, classification, and segmentation. Additionally, color histograms help in object and background detection by distinguishing objects from the background based on color distribution.

The goal of attribute selection is to reduce the dimensionality of the data by eliminating irrelevant or redundant attributes, thereby reducing model complexity. This process also aims to improve model performance by focusing on the most informative attributes, so that the model can be more accurate and efficient. In addition, attribute selection speeds up the computing process by reducing the amount of data that must be processed, so that analysis can be carried out more quickly (Valtonen et al., 2019). Thus, selecting the right attributes is very important in building a reliable and efficient model (Matsuo et al., 2022). Haralick Textures, Hu Moments, and Color Histograms are some of the features that can provide rich and useful information in image analysis, each providing a different but complementary perspective.

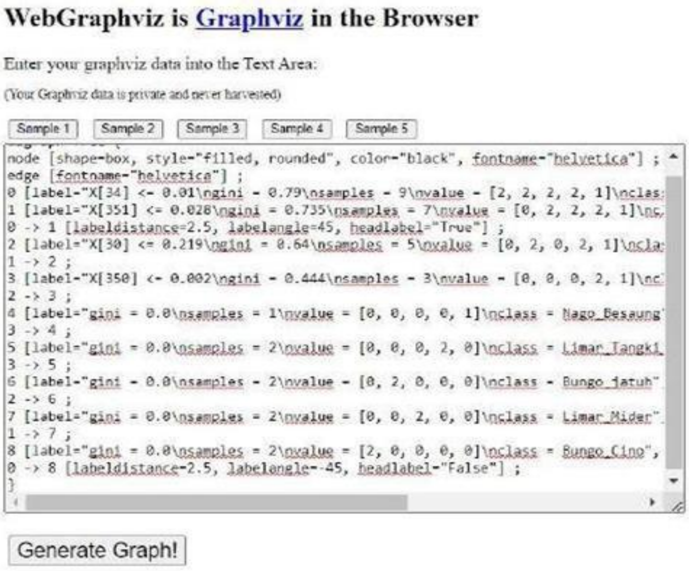
Data Transformation

At this stage, the data is changed through the process of creating, selecting, and changing the focus variable for model selection purposes. This process includes various steps, such as resizing the image to ensure that the resulting data is consistent with the previous image. Data transformation is critical in ensuring that each variable used in the model has the appropriate format and scale, thereby increasing the accuracy and efficiency of the model (Ullal et al., 2021). By carrying out data transformation, we can optimize the information obtained from the dataset and prepare it for the next stage of analysis.

Data Modeling and System Development

Pycharm software and the python programming language were used to develop this classification system. Building a system requires a very large data set(Bartlett et al., 2021). The following image shows the syntax of parts of the songket classification system :

Figure 3. Syntax section of the songket classification system



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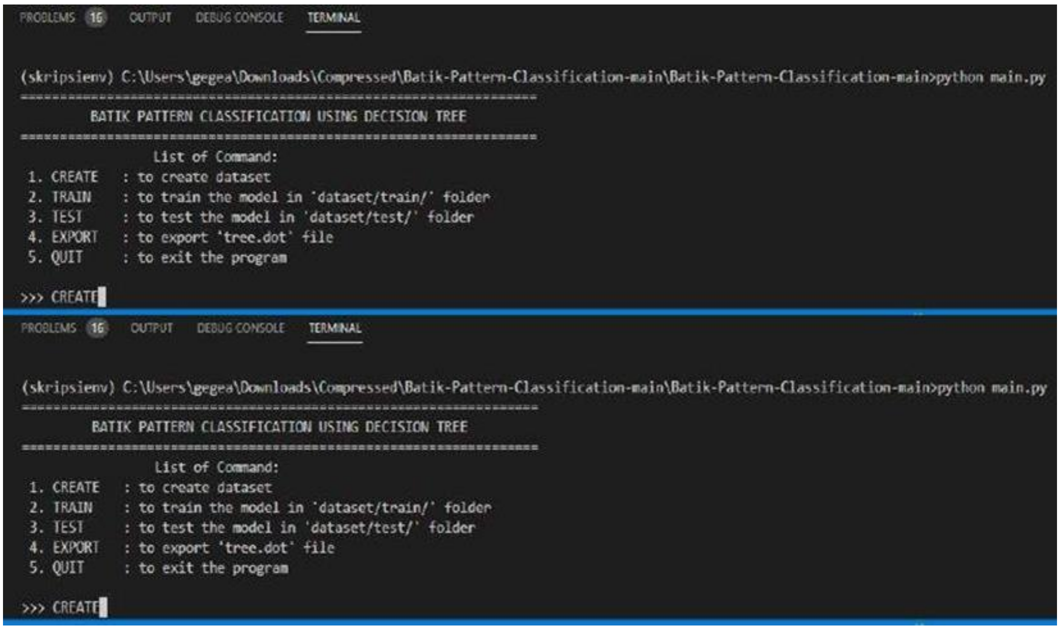
Data modeling in this research uses PyCharm software and the Python programming language to develop a songket cloth classification system. The choice of PyCharm as an Integrated Development Environment (IDE) and Python as the main programming language is based on its flexibility and ability to process data and support various libraries for machine learning and data science (Mortenson & Vidgen, 2016). The process of creating this system requires a very large and high-quality data set to ensure the resulting model has a high level of accuracy. To determine the classification results of songket motifs, there are four stages.

Figure 4. Modeling Stages

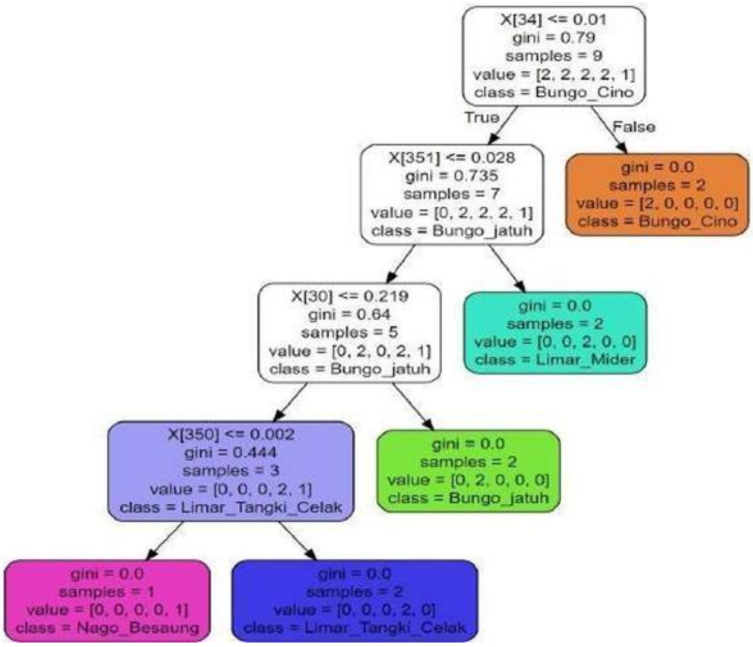


- CREATE The first stage in modeling is CREATE, where existing data records are entered into the system. At this stage, it is important to ensure that the data entered is relevant and has gone through a data cleaning process to remove anomalies or inconsistent data. High- quality data is critical to the success of subsequent stages.

- TRAIN The second stage is TRAIN, where the training data set is entered into the system. This training data is used to train the classification model so that it can recognize patterns in the data. During this stage, various machine learning algorithms can be applied to find the best model that is able to classify songket motifs accurately.
- TEST After the model is trained, the next stage is TEST, namely the testing phase where the dataset in the system is tested. Testing is carried out using test data (testing dataset) which is not included in the training data to evaluate model performance. The results of this test provide an overview of the level of accuracy and generalization of the model to new data that has never been seen before.
- EXPORT The final stage is EXPORT, where the system displays the classification results of the existing dataset. The results of this classification are then exported in a format that can be used for further analysis or for implementation in a larger system. At this stage, it is important to ensure that the classification results can be easily interpreted and accessed by end users.

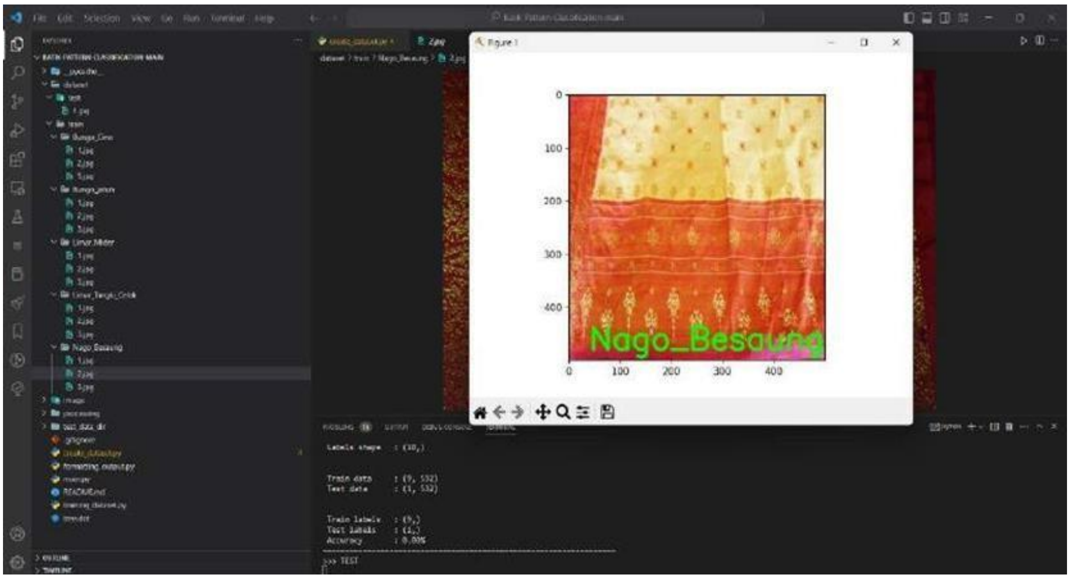
Decision trees are one of the methods used in this classification system. Decision trees map various decisions that can be taken based on the features in the data. Figure 5 shows the decision tree of the songket classification system, which illustrates how the system makes decisions based on relevant attributes (Sharifani & Amini, 2023). This decision tree helps in visualization of the decision making process and can be interpreted easily by humans.

Figure 5. Decision tree



When testing is carried out to produce the final results of songket classification, the system uses the available dataset to classify the desired songket thematic images (Taye, 2023). Figure 6 shows the final classification results, which illustrate how the system succeeded in classifying images based on existing songket motifs. The success of the system in classifying images shows that the model developed has a high level of accuracy and can be relied upon to be used in real applications.

Figure 6. Final classification results



The system successfully classifies the desired Songket thematic images. The development of a songket motif classification system using PyCharm and Python shows that with the right dataset and appropriate methods, the system can achieve satisfactory results (Sharma & Chaudhary, 2021). The data modeling process which includes the CREATE, TRAIN, TEST, and EXPORT stages, as well as the use of decision trees, allows the system to classify songket motifs accurately and efficiently(Wang et al., 2020). The final classification results show that this system can be used as an effective tool in identifying and grouping songket motifs, providing added value in the preservation and development of traditional Indonesian fabrics.

The findings of this research underscore the potential of Deep Learning in classifying traditional textile motifs. The integration of Haralick textures, Hu moments, and color histograms provides a comprehensive approach to image analysis, enhancing the model's effectiveness. This study contributes to the theory and practice of traditional market supervision by demonstrating how advanced technologies can improve the classification and preservation of cultural heritage. The implications for traditional market supervision are significant, suggesting that similar methodologies could be applied to other aspects of market analysis and heritage preservation. However, the study is limited by its reliance on high hardware specifications, which may restrict accessibility for researchers with limited resources. Future research should focus on optimizing methods to reduce hardware dependencies and expanding datasets to further enhance model accuracy and applicability. Additionally, exploring alternative data processing techniques and integrating broader datasets could provide deeper insights and improve the classification system's performance. By addressing these limitations and recommendations, future research can build upon these findings to advance the field of traditional market supervision and contribute to the preservation of cultural textiles.

CONCLUSION

This research successfully achieves its primary objective of classifying songket textile motifs from South Sumatra using various datasets. The analysis of songket cloth motifs indicates that achieving optimal results with the application program requires very high hardware specifications. The experiments conducted with different datasets confirm that the research effectively identifies songket textile motifs, aligning with the study's goals. However, the research has notable limitations, particularly the dependence on high hardware specifications, which may pose challenges for researchers with limited resources. This limitation underscores the need for future research to improve procedural methods and utilize higher hardware specifications to enhance accuracy. Recommendations for future studies include developing more efficient methodologies and testing with broader datasets to further increase the accuracy and effectiveness of the application programs used. Such advancements could lead to more precise classifications and a better understanding of songket textile motifs.

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