Journal of Critical Social Sciences and Review (JCSSR)

RESEARCH ARTICLE
VOLUME NO. 1, ISSUE NO. 1, 2026 (MARCH)

Sew Guider: A Smart Sewing Guide Machine for Assisting Garment Creation

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Received: 04/11/2026 Revised: 04/23/2026 Accepted: 04/27/2026 Published: 04/29/2026

ABSTRACT

This study addresses the need for an interactive, technology-driven learning tool to enhance sewing education among young individuals and students. Utilizing a Developmental Research methodology and a Modified Prototype Model, the system integrates machine vision, a webcam, and a touchscreen interface to provide near real-time sewing guidance and error detection. The system delivers step-by-step instructions in a game-like environment across five progressive learning levels, monitoring stitch accuracy and alerting users to errors. The system was implemented on a Raspberry Pi 4 Model B 8GB and developed using Python, OpenCV for HSV color detection, Pygame for graphical user interface and pattern overlay rendering, and YOLOv8n-seg and YOLOv8n for near real-time needle detection. A fixed green pattern overlay is displayed on the Raspberry Pi Monitor for users to follow, and stitches are classified as cyan for correct and red for incorrect, with accuracy computed using the formula Score = detected stitch coverage divided by the overlay pattern multiplied 100%. A portable sewing machine and a Juki embroidery machine serve as the primary and secondary hardware components for the learning sessions. In the testing and evaluation phase, ISO 25010:2011 standard surveys were used to assess the system's functionality, reliability, usability, and maintainability. The study concludes that Sew Guider demonstrated its effectiveness as a guided learning tool for practicing basic sewing skills.

Keywords: Sewing Education, Machine Vision, Real-Time Error Detection, Raspberry Pi System, Interactive Learning Tool

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INTRODUCTION

Sewing is one of the oldest skills people have ever learned. It started thousands of years ago when early humans used bone needles and threads made from plants or animal parts to stitch clothes together for survival (Batchelor, 2024). Over time, sewing became more than just fixing or joining fabric; it turned into a craft, a source of income, and also a way to express culture. In the Philippines, sewing has always been part of everyday life. It is not only about making clothes and accessories, but also about showing creativity and identity. Fabrics like piña, abaca, and hablon are examples of this. They carry stories about our history and heritage. These fabrics reflect the talent and pride of the communities that make them (Tatler Asia, n.d.). Sewing has also been useful in schools, homes, and small businesses because it teaches practical skills and helps people earn money.

Currently, fewer young people are interested in sewing. Mostly thought it takes too much time and effort compared to modern hobbies or gadgets. Most of the sewing artisans and weavers left in the Philippines are already older, and the younger generation does not show much interest in continuing the craft (Philstar, 2015). If these skills are not passed down, they could slowly disappear (Mandap, 2015). This is a big concern because it means we might lose an important part of our culture and tradition.

That is why the researchers came up with Sew Guider: Smart Sewing Guide, 2: A Machine for Assisting Garment Creation. The goal is to make sewing easier and more enjoyable with the help of technology through a game-like approach. Sew Guider has a webcam and a touchscreen that can guide the user step by step while sewing. It can also show mistakes in near real-time, which makes learning less frustrating. What makes the device unique is that it features five pre-programmed basic sewing practice patterns designed to progressively develop the user's stitching skills, from simple straight lines to intermediate designs. Technology has already proven to make sewing more accurate and simpler through automation (Ajith et al., 2025; Kong, 2025). By combining these modern tools with structured guided practice, Sew Guider hopes to encourage more people, especially the youth, to learn and appreciate sewing as both a practical skill and an important part of Filipino livelihood and tradition.

Research Gap(s)

Current sewing learning tools remain limited in interactivity, particularly in delivering real-time guidance and error detection, which constricts their effectiveness in providing and improving practical skill development of people who want to learn and experience sewing.

Theoretical Framework

This study is based on established learning and technology theories that support interactive and feedback-driven skill development. It is primarily founded in Experiential Learning Theory, which emphasizes the knowledge developed through direct experience and reflection (Kolb, 1984). In this context, learners actively engage in sewing activities while receiving immediate feedback, improving skill acquisition. The framework also comes from Constructivist Learning Theory, which tells us that learners build knowledge through active interaction with their environment (Piaget, 1972). The system facilitates this by allowing users to learn through guided practice and real-time correction.

Furthermore, the study incorporates principles of Immediate Feedback Theory, where timely responses to user actions enhance learning efficiency and reduce errors (Shute, 2008). Through machine vision techniques such as image processing and object detection, the system provides near real-time evaluation of stitching performance. The integration of YOLO-based detection and OpenCV supports accurate monitoring of user actions, enabling automated error detection and classification. Additionally, elements of Gamification Theory are applied by structuring the learning process into progressive levels, increasing user engagement and motivation (Deterding et al., 2011).

By combining experiential learning, constructivism, immediate feedback, and gamification, the framework supports an interactive and adaptive learning environment. This approach enhances users' ability to develop sewing skills effectively through continuous guidance, real-time evaluation, and performance-based feedback.

Objectives

This study aims to design and develop a smart sewing guide machine that assists users in creating basic accessories by integrating a webcam, image processing, game-like elements, and an interactive interface. The device aims to provide near real-time error detection, step-by-step guidance, and structured practice through five pre-programmed patterns of progressively increasing difficulty.

METHODOLOGY

Research Design

This study employs a quantitative developmental research design. The method is appropriate for the study as the primary objective is to design, develop, and evaluate an interactive sewing guidance system that enhances skill acquisition among students. The study utilized a modified prototype model to support iterative development, allowing continuous refinement of both hardware and software components based on testing and feedback. Furthermore, a quantitative descriptive approach was applied during the evaluation phase to assess the system's performance and user acceptability. Primary data were gathered directly from participants using structured survey questionnaires based on the ISO 25010:2011 software quality model, focusing on functionality, reliability, usability, and maintainability. The collected data were then analyzed to provide an accurate and objective description of the system's effectiveness as a guided learning tool for sewing skill development.

Participants and Sampling Technique

The target population of this study was currently enrolled students of Bulacan State University for the academic year 2025-2026, sewing practitioners, and CpE/IT professionals. A sample size of 13 students, 2 sewing practitioners, and 2 CpE/IT professionals was utilized. The researchers used purposive sampling, allowing participants to be selected based on availability and relevance to the study.

Instrument

The instrument utilized is a structured survey questionnaire composed of 6 sections: Informed Consent and Introduction, Personal Information, Functionality, Reliability, Usability, and Maintainability of the device, which is based on the ISO 25010:2011.

Data Gathering Procedure

The researchers digitally distributed the survey questionnaire to the students of Bulacan State University using Google Forms. The researchers visited local sewing shops to provide the survey questionnaire with their permission, to give their professional opinion and view on the study, and lastly, the researchers visited the CpE/IT offices to provide the survey questionnaire and ask for their professional opinion on the study. The questionnaire utilized closed and 5-point Likert- Scale questions.

Data Analysis Procedure

The data were analyzed using frequency and percentage to describe the demographic profile of the respondents. The weighted mean and verbal interpretation were utilized as the primary tools for assessing the system's functionality, reliability, usability, and maintainability based on the ISO 25010:2011 criteria. The results were then interpreted to determine the overall effectiveness and acceptability of the system as a guided learning tool for sewing skill development.

Ethical Consideration

Throughout the whole research process, strict ethical guidelines were followed, especially when it came to the use of human subjects. Before accessing the survey, participants had to complete an informed consent form that made sure they understood the goal of the study and their right to withdraw at any time. All gathered primary data was anonymized in accordance with the Data Privacy Act of 2012 and safely kept in secure digital lockers that were only accessible by the primary researchers. This ensured confidentiality and prevented unwanted data access.

RESULTS

Demographic Profile

The respondents of the study consisted of 13 students, 2 sewing practitioners, and 2 CpE/IT professionals. Among the student participants, the distribution reflects individuals with basic knowledge and experience in sewing-related activities. The inclusion of sewing practitioners provided practical insights based on hands-on experience, while CpE/IT professionals contributed to technical evaluation of the system. This combination of respondents ensures a balanced perspective in assessing both the functionality and usability of the developed system.

Table 1

Summary of Respondent's Assessment on the Sew Guider: A Smart Sewing Guide Machine for Assisting Garment Creation

Evaluation Criteria	Average Weighted Mean	Descriptive Interpretation
Functionality	4.44	Strongly Agree
Reliability	4.35	Strongly Agree
Usability	4.57	Strongly Agree
Maintainability	4.49	Strongly Agree
Overall Weighted Mean	**4.46**	**Strongly Agree**

Table 1 represents the summary of the weighted mean and descriptive interpretation of the overall acceptability of the system. The respondents have given their following opinion about the device regarding the evaluation criteria, which are functionality for 4.44, reliability for 4.35, usability for 4.57, and lastly maintainability for 4.49, with all having a descriptive interpretation of "Strongly Agree". This indicates that the developed system is highly acceptable and meets the beneficiaries' expectations.

Table 2

Accuracy Test Results of the Sew Guider from the Intermediate Sewer.

Levels	Trial 1	Trial 2	Trial 3	Average	Threshold	Pass/Fail
1	69%	57.6%	74.8%	67.1%	60%	Pass
2	37%	44%	52.4%	44.5%	35%	Pass
3	43.9%	47.3%	51.3%	47.5%	40%	Pass
4	39.6%	26.2%	11.4%	25.7%	30%	Fail
5	43.9%	23.5%	39.4%	35.6%	25%	Pass
Overall				**Total Avg: 44.1 %**		**4/5 = 80%**

Table 3

Accuracy Test Results of the Sew Guider from the Professional Sewer.

Levels	Trial 1	Trial 2	Trial 3	Average	Threshold	Pass/Fail
1	94.1%	80.7%	84.7%	86.5%	60%	Pass
2	55.8%	85.1%	86.1%	76.5%	35%	Pass
3	77.0%	91.6%	84.6%	84.4%	40%	Pass
4	54.6%	59.3%	67.0%	60.3%	30%	Pass
5	58.7%	72.7%	89.3%	73.5%	25%	Pass
Overall				**Total Avg: 79.42 %**		**5/5=100%**

The accuracy of the Sew Guider was evaluated by conducting three trials from per level, totaling 15 Trials. Each trial was done by both intermediate sewer and a professional sewer, after

which the system's final score was recorded as the accuracy measurement. A pre-defined per-level threshold was established before testing to account for each level's complexity.

For the intermediate sewer, the average score across all trials was 44.1%, with 4 out of 5 levels meeting their respective thresholds, yielding an overall accuracy rate of 80%. In comparison, the professional sewer achieved a significantly higher average score of 79.42%, with all levels passing the threshold, resulting in a perfect 100% accuracy rate.

The data suggests that while the Sew Guider demonstrates an acceptable accuracy rate for intermediate sewers, it performs a lot better when used by professionals due to their advanced skill and familiarity with sewing.

Table 4

Overlay Alignment Stability Test Results of the Sew Guider.

Trials	Level 1	Level 2	Level 3	Level 4	Level 5
1	Stable	Stable	Stable	Stable	Stable
2	Stable	Stable	Stable	Stable	Stable
3	Stable	Stable	Stable	Stable	Stable
4	Stable	Stable	Stable	Stable	Stable
5	Stable	Stable	Stable	Stable	Stable
Stability Rate	**5/5 = 100%**	**5/5 = 100%**	**5/5 = 100%**	**5/5 = 100%**	**5/5 = 100%**

The overlay alignment stability of the Sew Guider was evaluated by testing whether the pattern overlay renders in the same fixed position each time the program is launched. The goal of this test is to confirm that the system consistently displays the correct pattern alignment of each level across repeated program launches. This ensures that the user will receive a dependable visual guide regardless of how many times the system is restarted.

As presented in the table, all 5 trials across 5 levels were marked stable by a human observer, as the pattern overlay appeared in the same fixed position in every program launch without any deviation. This yields a stability rate of 100% for all levels and an overall stability rate of 100% across all 25 Trials.

Table 5

Scoring Consistency Test Results of the Sew Guider from the Intermediate Sewer.

Levels	Average	±15 Range	Trial 1	Trial 2	Trial 3	Consistent?
1	67.1%	52.1% - 82.1 %	69%	57.6%	74.8%	Yes
2	44.5%	29.5% - 59.2%	37%	44%	52.4%	Yes
3	47.5%	32.5 % - 62.5%	43.9%	47.3%	51.3%	Yes
4	25.7%	10.7% - 40.7%	39.6%	26.2%	11.4%	Yes
5	35.6%	20.6% - 50.6%	43.9%	23.5%	39.4%	Yes
Overall						**5/5 = 100%**

Table 6

Scoring Consistency Test Results of the Sew Guider from the Professional Sewer.

Levels	Average	±15 Range	Trial 1	Trial 2	Trial 3	Consistent?
1	86.5	71.5% - 100%	94.1%	80.7%	84.7 %	Yes
2	76.5	61.5% - 91.5%	58.8%	85.1%	86.1%	No
3	84.4	69.4% - 94.4%	77.0%	91.6%	84.4%	Yes
4	60.3	45.3% - 75.3%	59.6%	59.3%	67.0%	Yes
5	73.4	58.5% - 88.5%	58.7%	72.7%	73.5%	Yes
Overall						**4/5 = 80%**

The scoring consistency was evaluated by conducting three trials per level, totaling 15 trials. The same intermediate and professional sewer performed each trial under the same conditions, with the system fully reset after each run, and then the final score was recorded and used for the consistency evaluation.

To determine whether the system produces repeatable scores, a consistency boundary of ±15% points for each level's average was created before testing to account for the natural variability of each sewing performance.

For the intermediate sewer, all five levels passed the consistency check, achieving a rate of 100%, this indicates that the device produces repeatable and stable scores for intermediate users across all levels.

On the hand, the professional sewer only 4 out of 5 passed the consistency check, yielding an overall rate of 80%, level 2 fell outside of the ±15% consistency boundary, primarily due to Trial 1 (58.8%) score, however Trial 2 (85.1%) and Trial 3 (86.1%) was significantly higher than Trial 1, suggesting that this could be a warm-up effect for the professional sewer at this specific level.

Despite this anomaly, the high consistency across the remaining levels demonstrates that the Sew Guider generally produces reliable and repeatable scores for professional users as well.

DISCUSSIONS

Integration Performance of the Sew Guider

The integration of hardware and software components plays a critical role in determining the overall functionality of the Sew Guider system. The results indicate that the system was able to successfully operate as a unified platform, with the Raspberry Pi, webcam, and LCD touchscreen working cohesively alongside the Python-based program, OpenCV detection pipeline, Pygame interface, and YOLOv8 models. The system demonstrated the ability to process visual input in near real time, which is essential for providing immediate feedback during sewing activities. This suggests that the system meets its intended objective of guiding users through stitching tasks with minimal delay.

Challenges in Detection Accuracy and Other Factors

Despite the overall functionality of the system, certain limitations were observed during the integration phase. Variations in lighting conditions significantly affected the accuracy of HSV-based color detection, leading to inconsistencies in stitch classification. Additionally, the YOLOv8 model required parameter tuning to improve needle detection reliability, indicating sensitivity to real-world conditions. These findings highlight that the system's performance is influenced by environmental factors and configuration settings. Like other vision-based systems, maintaining controlled conditions is necessary to achieve optimal detection accuracy.

Implications of Calibration and Iterative Development

The need for calibration and repeated adjustments emphasizes the importance of iterative development in refining system performance. Through multiple integration cycles, improvements were made in both detection accuracy and system responsiveness. This aligns with the principles of the Modified Prototype Model, were continuous testing and refinement lead to enhanced system reliability. The results suggest that calibration is not merely a setup step but a critical process in ensuring consistent operation, particularly in applications involving real-time image processing.

System Usability and Real-Time Feedback Effectiveness

The successful display of pattern overlays and stitch classification through the LCD touchscreen indicates that the graphical user interface effectively supports user interaction. The integration of visual feedback with real-time detection enhances the usability of the system, allowing users to immediately interpret and respond to guidance. This is particularly important for beginners, as it supports skill development through continuous feedback. The findings imply that the system is not only functional but also user-oriented in its design.

Overall System Readiness and Performance Implications

In summary, the integrations results show that the Sew Guider system can perform its intended functions under actual operating conditions. While minor limitations were identified, these were addressed through calibration and parameter adjustments. The system demonstrated stable and consistent performance after iterative refinement, indicating that it is sufficiently reliable for further testing and evaluation. Overall, the findings support the effectiveness of combining embedded systems and machine learning techniques in developing assistive sewing technologies and confirm that the system is ready for formal performance assessment.

CONCLUSIONS

Summary and Recommendations

The findings of the study demonstrate that the Sew Guider system is capable of functioning as an integrated platform that combines hardware and software components to provide real-time sewing guidance. The system successfully utilized the Raspberry Pi, webcam, and LCD touchscreen alongside the Python-based program, OpenCV detection pipeline, Pygame interface,

and YOLOv8 models to deliver immediate visual feedback. The results indicate that the system can process and analyze stitching activities with minimal delay, supporting its objective of assisting users, particularly beginners, in improving their sewing accuracy.

However, the system's performance was influenced by environmental and operational factors. Variations in lighting conditions affected the accuracy of HSV-based stitch detection, while the YOLOv8 model required parameter adjustments to achieve reliable needle recognition. These findings suggest that proper calibration and setup are essential to ensure consistent system performance. Despite these limitations, iterative refinements during the integration phase improved the system's stability and accuracy, confirming the effectiveness of the Modified Prototype Model in guiding the development process.

To further enhance the system, future improvements may focus on increasing robustness under varying lighting conditions, possibly through adaptive image processing techniques or improved dataset training for the detection model. Additionally, expanding the range of detectable stitch patterns and optimizing system performance for faster processing could improve usability. Further testing with a larger and more diverse group of users is also recommended to validate the system's effectiveness and generalizability in real-world applications.

Declaration of the use of AI

This study incorporates artificial intelligence (AI) as a core component of the Sew Guider system to enable real-time detection and classification of stitching patterns. Specifically, the system utilizes YOLOv8n and YOLOv8n-seg models for object detection and segmentation, allowing accurate identification of needle position and stitch formation during sewing operations.

The AI models were integrated with a Python-based processing pipeline using OpenCV and were deployed on a Raspberry Pi 4 Model B to support real-time image analysis. These models were trained and fine-tuned to recognize relevant sewing features, contributing to the system's ability to provide immediate visual feedback and guidance to users.

The use of AI in this study is limited to pattern recognition and detection tasks within the system. All system design decisions, data processing, and result interpretations were conducted by the researchers. The authors assume full responsibility for the implementation, performance, and outcomes of the AI components used in this research.

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Declaration of Generative AI

During the preparation of this manuscript, the authors used ChatGpt AI. The tool was used solely to improve clarity, grammar, and overall readability. The authors reviewed and revised the output as necessary and take full responsibility for the content of the manuscript.

Funding
This study was funded by the research themselves.

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