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Digital Apparel Pattern Generation System (DAPGS)

Lino B. Baldevarona, D.I.T
Associate Professor, Iloilo Science and Technology University, Philippines
libal_1980@yahoo.com

ABSTRACT

This developmental study was conducted to design and evaluate a Digital Apparel Pattern Generation System (DAPGS). Specifically, the study focuses on a system and a device that provides digital apparel pattern accurate and efficient for producing apparel patterns for custom-fit apparel. The method included establishing a customer profile for storing customer data, storing a plurality of customer body measurement taken photographically. The method also included producing digital apparel patterns automatically for a custom-fitting garment based upon the body dimensions

Keywords

digital generation, apparel, pattern, system, device, custom-fit, storing, plurality, automatic body-dimension, customer-profile

Introduction

Apparel pattern is one of the most critical steps in apparel production (McDowell, 1991). Taking body measurements and pattern making is manually done as practised by the majority of the couturiers today. The apparel industry is not exempted from this rapid development.

The Digital Apparel Pattern Generation System (DAPGS) development resulted from the ambiguousness and challenges of the previous designs relating to apparel pattern developments. The method of measuring body measurements for custom apparel manufacturing developed by Minsky (1997) with patent number 5956525 photographically recorded for unique form-fitting articles of clothing to which disposable strips of tape measures were temporarily adhesively affixed. In his study, the geometry of a garment divided into the fit zone and fashion zone. Another apparel pattern system developed by Goldman (1979) with a patent number 4,149,246, specifying custom garments for creating custom garments of clothing for a wearer by combining data on personal tailoring measurements of the wearer, physical characteristics of the wearer, a garment pattern, and garment options selected based on the resulting combination of personal and pattern data. Furthermore, the system embodied a central location unit, including a cutting table apparatus, a memory for a substantial number of patterns, and a pattern-processing system. The apparel pattern system created by the group of Collins (1990), with patent number 4,926,344, patented the data storage structure of garment patterns to enable subsequent computerised pre-alteration. The machine produces a computerised data storage structure for storing garment pattern data in machine-readable form for use in plotting the garment pattern data.

Synthesis

The identified state-of-the-art apparel pattern system has limitations such as wearing unique form-fitting articles of clothing to which disposable strips of tape measures are temporarily adhesively affixed. These require numbers of relevant articles of clothing it may result in skin allergic reaction, which is dangerous to the client's health. A pattern generation system based on internet interpolation and extrapolation in generating apparel patterns would be affected by intermittent connectivity. All technologies reviewed require more manipulative efforts, internet access, and devices; thus, using them would be time-consuming and need specialised skills in the operation. Because of the limitations of the above-mentioned prior arts, the study conceived.

Research Significance

The DAPGS is an apparel pattern system that can easily set can generate body measurement without touching the client, store and export client profile, generate fast and accurate apparel pattern system having special provisions on apparel designs internet access for exporting client apparel pattern and profile. It addresses the limitations of state-of-the-art body measurement and apparel pattern generation, such as health hazard, effort-intensive, and time-consuming, resulting in an efficient and hazardous to the client in generating body measurement and apparel pattern.

Purpose of the Research

Generally, this study aimed to design and develop a digital apparel pattern generation system.

Specifically, the study aimed to:

1. design and develop a digital apparel pattern generation system;

evaluate the system's performance regarding process, design, functionality,

accuracy, and efficiency.

Description of the Design

5.1 Design Criteria

5.1.1 The Hardware and Software

The study was made up of two components: designing the technology and its evaluation based on the parameters established and the acceptability of the process design, functionality, accuracy, and efficiency.

The design of the technology was made up of hardware and software. The hardware comprised a backdrop with a pre-determined width and height, a customer's name tag, a platform with markings of the customer's foot, a digital camera with a stand having a defined distance to capture digital images of the customer, and a computer. To fully understand the usefulness of the digital apparel pattern generation system, the researcher provided the system architecture of the study, system flow of the measurement generation as the first stem of the process. The system flow on pattern generation was also provided. The pictorial presentation of the study is shown in Figure 1.

Figure 1. Design of the Study

The evaluation was based on the parameters established, namely process design, functionality, accuracy, and efficiency. As to process design, the respondent tested whether generating a digital apparel pattern is simplified, manifests creativity, possesses the essential features needed in the actual operation, user friendly, considers the physical stability/attribute of the system, and considers the validity of user input. As to functionality, the respondents serve as a system user whether digital apparel pattern generation system could illustrate the general feature of apparel pattern generation, resize and alter the apparel pattern, and easy to use and understand works properly and satisfy their implied needs—three steps employed as to accuracy and efficiency. First, the clients were taken a body measurement, and the apparel pattern was made manually. Second, the client was taken its body measurement, and apparel pattern generated employing the present study. The third step was the measurements and time spent were compared, after which the respondents were asked to evaluate the system using the questionnaire checklist made by the researcher.

5.1.2 System Block Diagram

The system Block diagram was the interventions of the eTailor. The captured customers picture/image was the input. The system would process the input to determine the customers' profile of body measurements. The personal data needed would be encoded in the system. Re-sizing and design alteration was composed of apparel design and pattern generation formula for shorts, polo shirt, blouse, and skirt. The pattern output served as the printed apparel pattern generated by the system. The dynamic data for apparel served as ready data if a CNC fabric cutting machine is available for the cutting system. The system is illustrated in Figure 2.

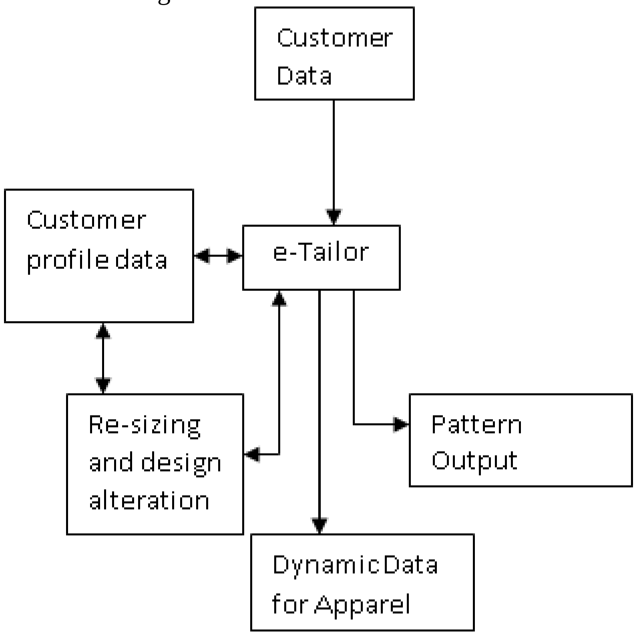

Figure 2. System Diagram

5.1.3 System Flow on Body Measurement Generation

The system flow in generating body measurements was from the start; the human intervention was the input of customer profile such as name, address and contact numbers, select apparel type, take image/picture and store or save the data to the database. An illustrated system is shown in Figure 3.

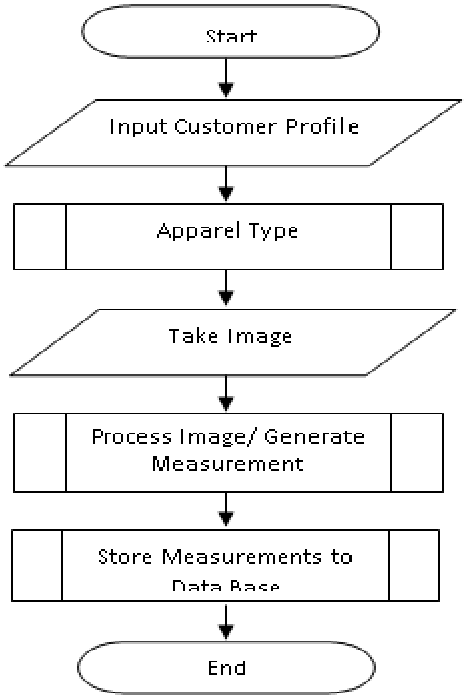

Figure 3. System Flow of Body Measurement Generation

5.1.4 System Flow on Apparel Pattern Generation

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The system would work with the human intervention on search/select costumer, and the system would display the body measurement and apparel type as ordered by the customer, then selection of apparel parts, a command generate after which the pattern would generate, a command on pattern print would do to generate the pattern. If the pattern maker wants to send a pattern, it could do through an icon for saving the image. Illustrated diagram is shown in Figure 4.

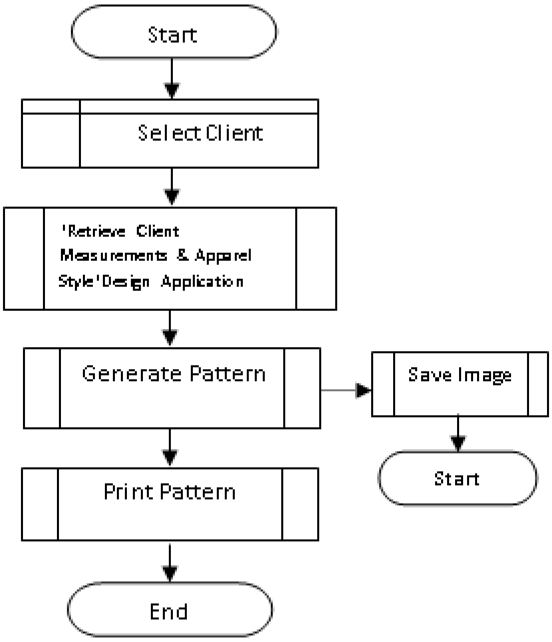

Figure 4. System Flow of Apparel Pattern Generation

5.1.5 System Development of the Study

A typical development process based on a scientific approach was adopted to develop the application needed for the digital apparel pattern generation system. These processes were described below:
The planning stage included identifying the research and resources, scheduling activities, persons contacted and consulted, and components used by the system. The deliverables of this activity were the draft of the research, tentative schedule and list of hardware components.
The second stage was the data gathering stage, wherein information about the subject of the research and hardware components of the system were gathered and reviewed. The results of this stage were basic information about the subject and hardware components. An intensive review was done on all essential information to ensure the correctness and relevance of the data.
The third stage was the conceptualisation and design, which included analysis, specification, validation, preparation and presentation of the proposal, the conceptualisation of software design, structure design, and initial hardware design.
The fourth stage was developing the system that involved initiation of the interface, database, system architecture, and programming language and coding. In this stage, the prototype system was designed using the data acquired in the analysis stage, basing designs upon those in similar existing projects at times.
The fifth stage was system integration, where the process of assembling, configuring, and connecting hardware components of the system to the software takes place.
The sixth stage was the testing/debugging in an iterative approach was done. A proper software testing method was applied to ensure that the software was adequately working according to its specification and design. All components were combined in the previous stage and were tested to guarantee that the integration process was done successfully.
The seventh stage was the presentation of output to the technical panel.
The last stage was integrating the technical panel's valuable suggestions to improve the study until the study was ready for the final presentation.

Parameters to be Analysed

The DAPGS should manifest the following:
Process Design. The process of generating digital apparel pattern is simplified, manifests creativity, possesses the essential features needed in the actual operation, user friendly, considers the physical stability/attribute of the system, and considers the validity of user input.
Functionality. Digital apparel pattern generation system should have the capability to illustrate the general feature of apparel pattern generation, resize and alter the apparel pattern, easy to use and understand works properly and satisfy the implied needs of a user.
Accuracy. The system should have the capability to generate apparel's exact measurement based on the customers' body size, ensure the apparel design's validity, capable of recording customers data, records data in real-time, and produces precise apparel pattern output.
Efficiency. The system should have the quality on the level of performance, which captures the desired data in near real-time, sustains repetitive operations, performs several tasks effectively, requires minimal memory storage space, provides required performance based on resources used, and can be efficiently executed.

Results and Discussions

7.1 Technology

A system and a device are disclosed to provide digital apparel pattern accurate and efficient for producing garment patterns for custom-fit apparel. The method includes establishing a customer profile for storing customer data, storing a plurality of customer body measurement taken photographically. The method also includes producing digital apparel patterns automatically for a custom-fitting garment based on the body dimensions.
Accordingly, it is a principal object of the invention to better fit at a lesser time than previously possible with minor inconvenience to the customer than previously possible in similar inventions. More specifically, it is the object of the invention to reduce the amount of human labour required to provide custom-tailored clothing while simultaneously increasing the consistency and number of measurements taken from each customer by obtaining sizing information from a customer's photograph. Thus, a related object of the invention is to obtain a large number of measurements from

a clothing customer's body in a short period and to input this information as data to an integrated computer system that process and generate apparel pattern to the customised specifications of that particular human body. It is a further object of the invention to provide a measuring tape at four sides in the photographic backdrop of the customer. The measuring tape is the basis for the calibration of measurement on the system obtained from the photograph. Still another object of the invention is to reduce the potential for measuring errors due to subjective differences from one individual to another or due to unpredictably variable levels of training by providing a low number of equally trained experts at a central manufacturing facility and by reducing the level of subjective professional judgment and training required of the master cutter who deal directly with the customer at a tailoring or apparel shop location.

7.2 How DAPGS works?

DAPGS is a program for tailored apparel wherein the body measurements are photographically recorded for computer data from an engineered, enhanced pictorial stand. DAPGS performs the following: (1) encoded customer's data into the computer system wearing his/her comfortable apparel with an elastic band around his/her waist; (2) captured the whole body standing on the pictorial stand equipped with measurements (which is validated by a measuring tape in the sides with a pre-determined digital camera attached to the system; (3) generated body measurements from the captured picture of the customer; (4) performed name search of the customers for easy retrieval; (5) manipulated and altered the picture to determine the exact body measurements for pattern generation preferred by the customer's style; (6) displayed or previewed all apparel parts of the pattern generated from the customer; and (7) generated the marks to guide the cutter in lay-outing and cutting the fabric.

7.3 Brief Description of the Technology

A detailed description of the study, which better understood, may be seen from the illustration.
Figure 5 is a complete setup of DAPGS devices; Figure 6 is the DAPGS or the eTailor; Figure 7A is the Part I of DAPGS for costumer's data; Figure 7B is the Part II of or DAPGS for customers data; Figure 8 is the DAPGS or eTailor Window for Taking of Body Measurements; Figure 9 is the DAPGS or eTailor for pattern generation, and printing of apparel pattern and Figure 10 is a block diagram of the whole system of the invention.
The DAPGS is composed of a backdrop (1) magnetically attach to the uppermost of a backdrop's platform with foot markings (2) having a left vertical measurement (3) and correct vertical measurement (4) in the English system of measurements, attached with a customer's name tag (5) with the defined distance from the customer' foot (6) from foot markings (6) of the customer shall stand to obtain his or her measurements, digital camera (7) and attached to a pre-determined height of stand (8) to capture digital images of the customer, computer (9) with a stand, and (10) to monitor, record, and process the data generated by the camera (not shown), and the flatter printer to print the apparel pattern generated by the system.

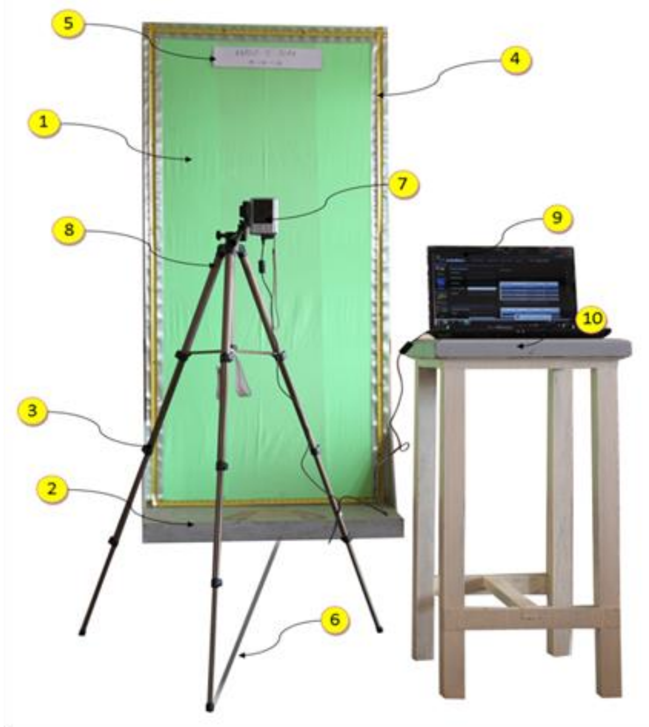

Figure 5. Complete Setup of DAPGS devices.

7.3.1 The DAPGS or the eTailor

As shown in Figure 6 are the various buttons for the specific function of the DAPGS window or the eTailor at the side is a customer's button (11), a pattern button (12), measurement button (13) and the exit button (14) of the system. At the upper portion of the dialogue box are the current customer status (15) customer's current job order pull-down menu (16) for validating the order of the customer and the reload button (17) of the previous transaction.

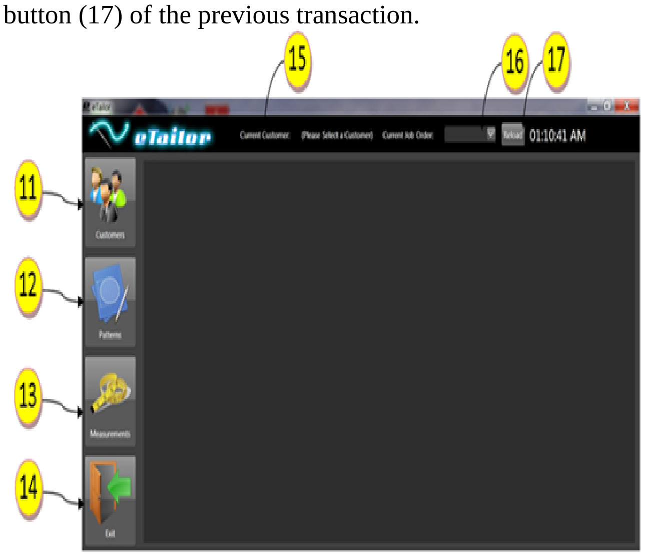

Figure 6. The digital apparel pattern generation system or the eTailor.

7.3.2 Part I of the DAPGS for Costumer Data or eTailor

Figure 7A shows the first part of DAPGS or eTailor window for required fields for costumer's data such as first name (18), followed by the middle name (19), and last name (20), then contact number (21), and address (22). For customers, pull-down menu (23) to search for all registered customers that transacted.

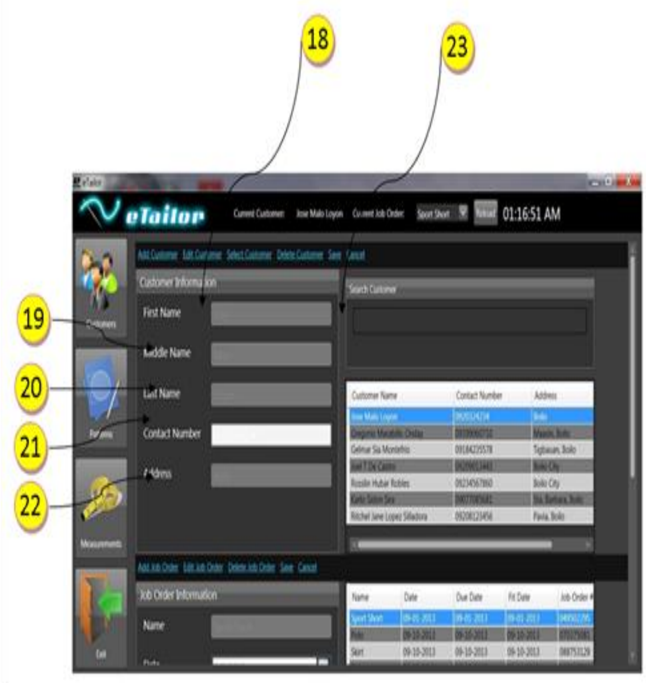

Figure 7A. Part I of the DAPGS for Costumer Data or eTailor

7.3.3 Part II of the DAPGS for Costumer Data or eTailor

As shown in Figure 7B is the Part II of the "e-tailor" window provided required fields for costumer's data for job orders like apparel name (24), date of transaction (25), due date (26), reasonable date (27), apparel style (28), textile (29), volume (30) of the transaction, status (31) of the transaction, side image (32) to browse the side image of the customer, and front image (33) to browse the front image of the customer. A dialogue box displays the job order transactions (34).

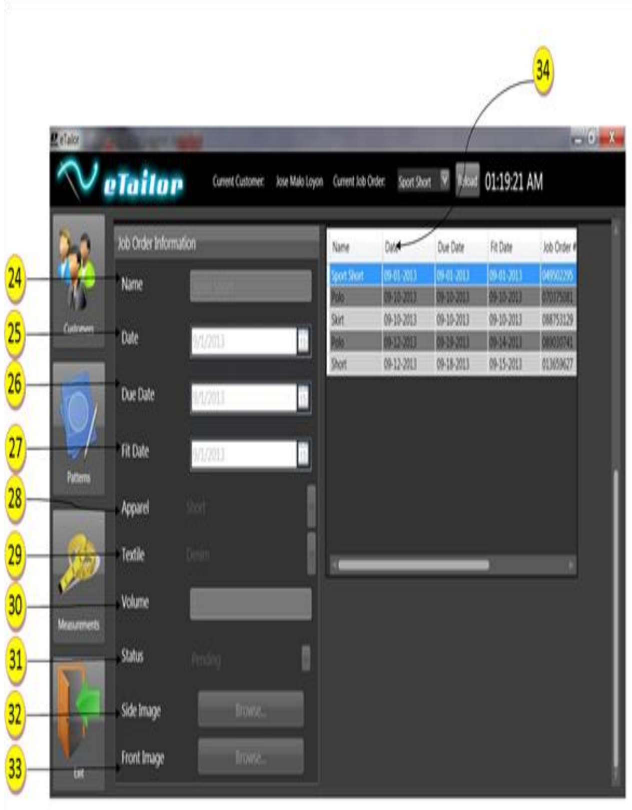

Figure 7B. Part II of the DAPGS for Costumer Data or eTailor

7.3.4 The DAPGS or eTailor Window for Taking of Body Measurements

The "eTailor" system window for taking body measurement have saved measurements (35) generated from the customer's picture based on its job order. The customer was given an elastic belt (38) to be attached at the waistline as a reference for accurate waist measurement. There is a measuring cursor to determine the vertical, horizontal, and circumferential measurements near the picture of the customer. The vertical measuring tape cursor (36) will move in vertical parts of the customer front picture of the body that needs vertical measurements, determining the starting point and endpoint in getting the length and the width. The horizontal measuring tape cursor (37) will move to the horizontal parts of the customer's front picture that needs horizontal measurements, determining the starting point and endpoint in getting the width to get the horizontal measurement. The horizontal measuring tape cursor (37) will move to horizontal parts of the customer front and side picture of the body that needs circumferential measurements to determine the starting point and endpoint in getting circumference. The data automatically reflect the customer's measurements data that will be the basis of the system in generating apparel pattern.

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Figure 8. The DAPGS or eTailor Window for Taking of Body Measurements

7.3.5 The DAPGS or eTailor System for Pattern Generation

Figure 9 shows that the DAPGS or eTailor system generates a pattern after clicking the pattern button (12) in Figure 6. It is equipped with additional features and toolbars for customising the desired apparel of the customer. Toolbar (39) indicates symbols such as grainline, centrefold, fabric name and colour, seam allowance and hatch are provided for the user to indicate in the pattern so that the cutter has a guide in cutting the fabric—the added label button (40) for labelling for additional instruction on the pattern. The generate button (41) generates pattern and refresh if corrections made from-time-to-time by the system. At the same time, the print button (42) prints the generated pattern. Print ratio field (43) displays the ratio of pattern output to print. View zoom (44) zooms ratio of the pattern generated on the computer screen for a clearer view.

Figure 9. The DAPGS or eTailor System for Pattern Generation

7.3.6 The DAPGS Block Diagram

The system Block diagram is the interventions of the system components of the eTailor database of the system, as shown in Figure 10. This invention allows the program to capture customer's images and processed them. This process can resize and redesign the generated apparel's pattern using formulas desired by the customer. The diagram also provides provisions for dynamic data for further developments, meaning the encoded data is editable. Also, the saved images are CNC ready for fabric's machine cutting.

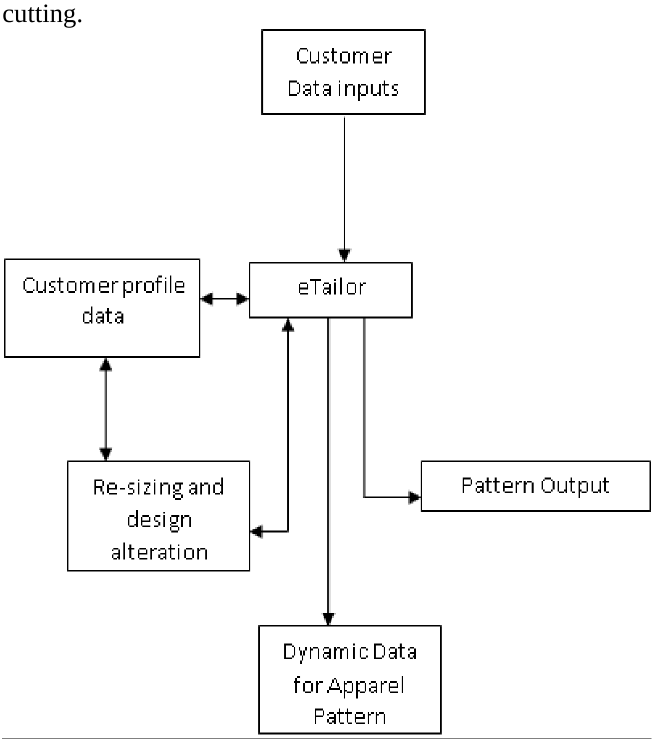

Figure 10. The block diagram of the whole system of the invention

Interpretation of the Data

The DAPGS is created in Iloilo Science and Technology University (ISAT U) based on Collins' group (1990). The nearest prior art presented has some disadvantages that the researcher's basis to conduct a further study specifically on the generation system of digital apparel patterns regarding process, design, functionality, accuracy, and efficiency.

The technical evaluation was done in ISAT U in the Fashion and Apparel Technology Department (FATD) by experts in the fashion and apparel industry and the academe.

Series of questions thrown by the panel for clarification. Valuable comments and suggestions were noted for further enhancement of the DAPGS. Moreover, experts' recommendations also given importance to the market valuation of the device.

After the evaluation, the questionnaires were gathered; the data were encoded, tabulated, computed, analysed, and interpreted using the average mean. **The evaluation of the DAPGS' system performance concerning process design, functionality, accuracy, and efficiency has a grand mean of 4.54, 4.53, 4.50, and 4.58, respectively and has an overall adjectival equivalent of "Excellent."** It is further described that the current study has superior or extraordinary attributes to the field.

Table 1. Overall evaluation of the DAPGS or eTailor

Parameters of the Study	Mean	Description
Design Process	4.54	Excellent
Functionality	4.53	Excellent
Accuracy	4.50	Excellent
Efficiency	4.58	Excellent

The evaluation result in Table 1 shows the study's parameters, wherein the process design is excellent regarding simplicity and creativity. It is considered user-friendly by the evaluators. Also, it has stable attributes and had produced valid and reliable user's input due to the capability to record customer's data in real-time, retrieve the data efficiently, and maintain its maximum level of performance for a long duration. Regarding functionality, the capability to generate apparel pattern with an exact measurement, capability to resize and alter the apparel pattern, inter-operability among application software's used, facility in usage, and satisfaction for the implied needs of a user. The system's accuracy is determined by comparing the measurement generated by the system with the measurement obtained manually from twenty participants with homogeneous results in the measurement taken. Also, the system's efficiency in generating apparel pattern determined by comparing the time spent by the system with the time obtained manually. This result is attested by the standard deviation shown by the system produced a homogeneous result compared to the manual pattern making. Furthermore, this is attributed to the margin of error in the capacity of a person doing body measurement and drafting apparel pattern manually because men by nature were unique individuals.

These findings conformed to the study of Veblen (2008) that "invention is the mother of necessity." It means, roughly, that the primary driving force for most new inventions is a need. Also, the study of Kim and Park (2007) espoused that generation of the individually fit basic garment is an essential step in the garment manufacturing process. Hence, the accuracy and reliability of the program is a must.

Gerber (2013), in his work on the Accumark system, supports this study by creating an intelligent pattern design software system for the apparel and fashion industry. The software can create new patterns or modify existing ones and uses powerful shortcuts to apply common pattern changes automatically. Thus, it delivers distinct value to each step from concept to consumer.

In their study, Kim and Kang (2003) developed a developed automatic garment pattern design system using three-dimensional body scan data to produce a far better model than the body model generated by the Fourier series expansion method. Their study utilised surface geometry of a standard garment model used in the apparel industry, reconstructed by stereovision technique, making surface warping algorithm a tool to equalise geometry and multi-resolution mesh generation on the optimum pattern mapping algorithm on functional patterns of garment making.

Cho (2010), in their study, stressed that the development of a method of constructing three-dimensional (3D) human body shapes. It leads to more straightforward computerised pattern making helpful in making accurate patterns and garments without adjustment.

Furthermore, Hong Kong Polytechnic University (2012), their study revealed that they developed a Block pattern generation while parameterising human bodies to fit feature-aligned and flattenable 3D garments. The same block pattern was used in the current study to generate 2D block patterns.

Furthermore, the process involved in the system had exhibited uniqueness in fashion and apparel production that offers a chance to solve the rigorous labour of manual work, making apparel pattern a necessity to ease people's work in the micro and macro apparel industry. The excellent rating described that the project developed by the researcher possesses the essential features that answer the computerisation of pattern making. It further implies that the present study is an efficient substitute to the conventional way of generating apparel pattern as practised by master cutters and tailoring operators.

Findings

The findings of the study are as follows:

1. A system and a device provided a digital apparel pattern accurate and efficient in producing garment patterns for custom-fit apparel. The method includes the steps of establishing a customer profile for storing customer data, storing a plurality of customer body measurement taken photographically. The method also included the steps of producing digital apparel patterns automatically for a custom-fitting garment based on the body dimensions.
2. The testing results revealed that the digital apparel pattern generation system could generate body measurement based on the picture captured by a digital camera and generate an apparel pattern and print the pattern. The process design, functionality, accuracy and efficiency were excellent.
3. In comparison, the system's accuracy and the manual measurement have no significant difference, and on efficiency, there is a significant difference between the

system generated and the manually generated apparel pattern in terms of time spent.

Conclusions

Based on the initial findings, the following conclusions were drawn:
1. The DAPGS was able to generate the apparel pattern as expected.

2. The DAPGS is a touchless technology in taking body measurement and an automatic system of generating apparel pattern.
3. A DAPGS excellently met the respondent's satisfaction as to design process, functionality, accuracy, and efficiency.
4. The DAPGS output generated and manually generated were accurately the same.
5. The DAPGS system was efficient than the manual method of apparel pattern generation as practised by master cutter and tailoring operators.
6. The DAPGS is far better than other apparel pattern generation, as stated in the literature of the present study.

Recommendations

Based on the conclusions, the following were the recommendations of the experts.
1. The accurate and efficient DAPGS can be an excellent substitute to the conventional way of apparel pattern generation by master cutters and tailoring operators, but the user should be provided with the manual of operation in the use of the program.
2. The technology should be available to the market for its usefulness to the fashion and apparel business. The commercialisation of the study is highly recommended if a beta model of the prototype can demonstrate the applicability of the system.
3. The enhancement of the automation of body measurement may consider the fastest data processing on measurement with the proper use of the technology available as shown in the study's findings.
4. More apparel pattern features should include accommodating the fast-changing trends on apparel design that other researchers may use and other researchers who may undergo the same development process.
A contentious development of the present study is encouraged to keep abreast of the present needs of the apparel industry, as shown by its usability and applicability in the field.

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