A study of generative artificial intelligence' applications and industrial design of robots in innovate a prototype used in textile designing and printing

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Abstract:
This Analytical study concerns with analysis some new technologies trends and the latest of Generative AI and Robotics worldwide which can be used in textile designing and printing industry, and make major difference to increase the efficiency of the production, studying the effect in Design, Data color, color ways, Bespoke printing designs (tailored to one's needs) and Development of Innovative Technologies and Products because. In theory, if you combine generative AI and a robot, you get an artificially intelligent robot with a high level of automation; it will act like smart robots, able to optimize tasks it is assigned to do. Generative AI models are based on deep learning techniques and use neural networks and architectures to create new data based on the data in the training set; it includes building these models Basic steps, the most prominent of which are: preparing data, building the model, testing the model, publishing the model, and improving the model. Generative AI is a subfield of deep learning uses networking technologies, deep neural simulation ability Humans create new data, or original and innovative content in designing ……etc.
Textile designers can use algorithms to explore new alternative designs and characteristics of fabrics. The study conducted innovative idea for arm prototype depend on automated system worked by generative AI (trained model to make machine learning) in creating new one piece and repeated designs with many color themes and implemented on fabrics by using silk screen printing. The research problem: How to benefit from generative AI and robotics' industrial design to automate textile designing & silk screen printing to achieving textile printing automation, achieving sustainability, improve and increase efficiency and productivity, also to reduce Textile printing industry footprint and all kinds of waste. The research importance: The utilization and combining generative AI and arm robot with a high level of automation; potential to generate new prospects in textile industry, to facilitate the process of Textile designing & printing by getting an artificially intelligent arm robot, will act like smart robots, able to optimize tasks it is assigned to do. The research Objectives: Proposed and innovate idea of industrial prototype arm robot that could be used in textile designing and silk screen printing and Automate the design process and printing silk screen process by using generative AI to reduce Textile printing industry footprint.

Keywords:
Generative AI-Textile printing industry-Industrial Design- Robotics- Sustainability- Efficiency in textile printing- Machine deep learning

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1. Introduction:
Textile production is estimated to be responsible for about 20% of global clean water pollution from dyeing and finishing products [1] The fashion industry is responsible for up to 8 percent of global carbon emissions every year [2] and textile printing take big part of that because of chemicals, dyeing, different printing methods through designs' color samples and production. The scope for smart robotic with deep learning by Generative AI in manufacturing, also known as Industry 4.0, is potentially more transformational in textile printing for the same previous reasons [3]. The study also focuses in the importance of Robotics' industrial design in implementation and achieving high performance. Printing designs onto fabric is one of the core tasks in fashion industry. In many cases, the printed design is the only difference between related product lines. Robots are perfect for printing and drawing as the complex paths can be programmed to achieve productivity, efficiency and innovation in textile printing industry[4][5].Generative AI has many major features like data generation because Generative artificial intelligent models are used to generate Data such as images, designs, texts. Sounds……etc. Second feature is Innovation and Originality because Generative AI can creates new similar data and also for the data it was trained on. The third important feature is Versatility or multitasks, because Generative AI can be applied to a wide range of creative tasks [6][7]. Using Generative AI models are based on deep learning techniques and use neural networks and architectures to create new data based on the data in the training set, to transform the manual process and automate the printing textile design process and

application on fabrics by using industrial arm Robotics. Generative AI algorithms can be used to explore and analyze complex data of (textile printing repeats, colors according fashion trends, one piece designs……) in new ways, allowing businesses and designers to uncover hidden patterns and trends that may not be apparent from the raw data alone. Also can help automate and accelerate a variety of tasks and processes in textile printing designs and silk screen printing, saving time and resources for businesses and organizations [8][9]. Deep learning is a machine learning method that empowers machines to tackle complex tasks [10] like this one in silk screen textile printing steps and process. Also integration between generative AI and smart industrial arm robotics can help in executing the steps of printing with high efficiency, speed and without waste.

The Problem Research:

Can be summarized in an attempt to answer the following question: How to benefit from generative AI and robotics' industrial design to automate textile designing & silk screen printing to achieving textile printing automation, achieving sustainability, improve and increase efficiency and productivity, also to reduce Textile printing industry footprint and all kinds of waste that is taking big part of pollution, consumption (water, energy, money and effort), that happened through manufacturing, also faults and defects in printing steps beginning from process of textile design to silk screen printing.

The Research importance (Significance)

The utilization and combining generative AI and a robot with a high level of automation; potential to generate new prospects, new textile designing ideas, to facilitate the process of Textile designing & printing by getting an artificially intelligent robot, will act like smart robots, able to optimize tasks it is assigned to do.

The Research Objectives:

- Studying the Methodology of using generative artificial intelligence potential and industrial design robotics to facilitate the process of Textile printing industry by using deep machine learning.
- Generate ideas of textile designs, generated by application based AI, and proposed industrial prototype arm robot that could be used in textile designing and silk screen printing.
- Automate the design process and printing silk screen by using generative AI to reduce Textile printing industry footprint.

The Research Hypotheses:

- The study assumed that the building models steps of generative AI by using machine & deep learning which based in training models foundation, can help in automate textile printing industry.
- The study assumed that Proposed and innovate idea of industrial arm robot prototype, that could be used in textile designing and silk screen printing can help in reducing waste, increase efficiency and productivity, saving time and effort…..etc.
- The study assumed that automate the design process and printing silk screen steps by using smart arm robot can achieve reducing Textile printing industry footprint.

The Research Methodology:

- The descriptive analytical approach / through studying applications of Generative AI and industrial robotics in the field of textile printing industry, On the extent of its accelerating impact on this field through the previous years.
- The applied research approach through trials of some generative AI applications to generate textile printing designs by using four ways to generate designs.
- The explanatory approach includes the researcher's own suggested idea for arm robotics which can be used in textile printing samples and one piece printing in textile printing factories and also could be used in fashion industry startups companies.

2. Literature Review:

2.1: Generative artificial Intelligent

Generative AI is a type of artificial intelligence technology refers to deep-learning models that can generate high-quality text, images, audio and synthetic data…etc. and other content based on the data they were trained on. The recent buzz around generative AI has been driven by the simplicity of new user interfaces for creating high-quality text, graphics and videos in a matter of seconds[11][12]. In the fashion industry, generative AI is used to create unique clothing designs, patterns, and textures. It helps designers explore innovative combinations, optimize fabric usage, and personalize fashion recommendations for customers. Generative AI brings efficiency, creativity, and customization to the world of fashion [13]. Using Generative AI models are based on deep learning techniques and use neural networks and architectures to create new data based on the huge database in the training set and create something entirely new based on that information. Generative AI likely to be useful in virtually every

industry. [14][15], to transform the manual process and automate the printing textile design process and implement application by using industrial Robotics driven by generative AI. It includes building these models Basic steps, the most prominent of which are:

2.1.1- Preparing and collecting data:

Collecting Data in textile printing design	Some Data examples in textile printing design
In this step, we should determine the type of data to be generated and standardize a large set of the same type into the training model, if the goal is to generate textile printing designs ideas, inspiration, (repeated or one piece), a wide range of designs with many color ways according the fashion season color trends must be collected to help The model for learning various deigns styles, patterns repeats (Full Drop/Block Pattern repeat – Half drop Pattern repeat- Brick Pattern repeat- Random Pattern Repeat…..). Also colors trends themes. Then prepare this data and format it in an appropriate way to be processed by the model, such as: dividing designs into small elements, such as design compositions or units and converting them into Digital representation such as vectors. So in this step you should choose your data and prepare it carefully with wide and perfect range of huge dataset of pattern, designs….. enough high-quality data that is relevant to the task. So, it means Collecting relevant data from various sources is the first step in a data-driven approach.	 Fig (1) Clarify some examples of Huge Data should be collected from various sources in textile printing

	design in this step [17]-[18]-[19]

2.1.2- Building the AI Architecture model:

In this step: Choose the model architecture suited to your needs. The model architecture will depend on factors like the type of data, complexity of the task and hardware available. Start with a simple, proven architecture before trying more advanced options. Which includes the use of one of the approved structures on deep learning algorithms to build the model [20][21], such as: adversarial generative networks (GANs) or variational autoencoders VAEs (or Transformers)? Then use the training data to teach the model, and initialize the model via Hyperparameters, and improving them until the desired performance is reached [22][23][24]. we can benefit with the training foundation models in big data of textile printing designs ideas (repeated or one piece), a wide range of designs with many color ways according the fashion season color trends must be collected to help The model for learning various deigns styles, patterns repeats (Full Drop/Block Pattern repeat – Half drop Pattern repeat- Brick Pattern repeat- Random Pattern Repeat…..). Also colors trends themes (Fig 1). All this previous data in textile printing should to be a starting point and basis for creating new models through repetition Training

model on a specialized dataset in textile printing designs and this called (Fine Tuning) Than It saves training time and improves the quality of results, for example: if there is a foundational model that has been previously trained on repeated textile printing or textile designs colors themes in general, it can be used as a basis for building for building new generative model dedicated to generating textile designs repeats or textile designs colors themes by retraining the models on a data set specialized in textile designs repeats or textile designs colors themes.

2.1.3- Testing the model:

In this step: we Use test data to evaluate the model's performance and determine its efficiency in generating content similar to the target content The accuracy and soundness of its results, and identifying its weak points, such as bias or the presence of security vulnerabilities, can also be used Some evaluation strategies, such as: Reinforcement Learning from Human Responses Feedback[25][26]. (by collecting reviewers from designers or exports in textile printing industry' to feedback about the model's performance and analyzing it to correct errors and improve Output quality.

2.1.4- Evaluating and optimizing the model:

In this step: it's time to see how well it performs. Adapting the model for use in the operational environment, including converting the model [27] in textile printing designs with all previous mentioned features (repeated, color themes……..) to an operable format the production environment, ensuring its integration with other systems of the facility, and monitoring the model's performance and adjusting it periodically To ensure that it continues to achieve the desired results, and to ensure that it is compatible with protection and security standards[28].

2.1.5- Improving the model performance:

In this step: Evaluate the performance after deployment and continually improve it by collecting feedback from (users, viewers and Experts). Comparing the model with the expected goals and identifying the weakness points in the model and the areas that can be improved, it can be improved the model by retraining it or modifying its technical architecture and applying new algorithms to achieve the target. Also we can use (prompt Engineering) to access valid inputs and achieve the best results from generative models, this includes a set of best practices Methods and techniques that help clarify the required outputs [29][30]. So we can evaluate the model in textile printing designs with all the previous mentioned features (repeated, color themes…….etc.) from viewers, users and experts.

By the end, you'll learn how AI models can generate new examples similar to what it's been trained on from textile printing designs, colors themes, different kinds of repeat……..and all what is required to be achieved in textile printing design successfully process.

2.2: Some applications of Generative AI used in textile printing designs:

There are some applications based on generative AI can help in generate textile printing designs and fashion industries like patterned AI, One of the most important is:

2.2.1: FabricGenie application as applied case study:

The application is an innovative tool depends on generative AI, depends on describing the design ideas in as much details as possible to receive the most accurate results. Tailored design options based on personal input or room images. So, FabricGenie stands out by offering a personalized design experience that caters to your individual style and preferences, to make unique print designs for curtain, blind& Upholstery fabrics free with powerful AI tool. There are four ways to use FabricGenie depends on:

- Theme - Create a design by completing a simple form, including some data you should enter (Theme, style, elements, foreground, and Background colors).
- Text - Describe your design in minute detail for complete control.
- Text & Image - Provide a text description and upload an image to be used for colour reference only.
- Image - Upload a design to generate new designs based on that design [31][32][33].

2.2.1.1: Generate designs with FabricGenie- (trail 1):

Some Trials by using fours ways in fabricGenie	Results of the four ways (one by one as mentioned)

- Using the first way in FabricGenie application which depends on generates designs from (Theme) which were (Abstracted African faces).

The request is:
Theme: Abstracted African faces
Elements: geometric poetry
Style: painting colors
Foreground Colors: mustered, orange, Green, white outline
Background Colors: "Cream"

Fig (2) Clarify some Results of generated textile printing design generated by using FabricGenie application AI tool - first way (Theme) – 4 designs - (researcher designs)

- Using the first way in FabricGenie application which depends on generates designs from (Text)

The request is:
"Abstracted African faces with African abstracted poetry outline design with mustard, orange, green and brown colors"

Fig (3) Clarify some Results of generated textile printing design generated by using FabricGenie application AI tool - Second way (Text)- 4 designs - (researcher designs)

- Using the first way in FabricGenie application which depends on generates designs from (Text &Image)

The Text is:
"Repeated faces outlines vertical and horizontal many sizes"

The image is:

Fig (4) Clarify some Results of generated textile printing design generated by using FabricGenie application AI tool third way (Text & Image) -4 designs- (researcher designs)

- Using the first way in FabricGenie application which depends on generates designs from (Image)

The image is:

Fig (5) Clarify some Results of generated textile printing design generated by using FabricGenie application AI tool - forth way (Image) -4 designs- (researcher designs)

2.2.1.2: Generate designs with FabricGenie- (trail 2):

Some Trials by using fours ways in fabricGenie	Results of the four ways (one by one as mentioned)
- Using the first way in FabricGenie application which depends on generates designs from (Theme) which was Lilluim Flowers **The request is:** **Theme:** Lilium flowers **Elements:** Zebra skin, strips **Style:** Scandinavian **Foreground Colors:** Future Dusk, Transcendent Pink **Background Colors:** Aquatic Awe"	 Fig (6) Clarify some Results of generated textile printing design generated by using FabricGenie application AI tool - first way (Theme) – 4 designs - (researcher designs)
- Using the first way in FabricGenie application which depends on generates designs from (Text) **The request is:** Different kinds of Lilium flowers inspiration source suitable for curtain one-piece printing design with pastel fashionable colors."	 Fig (7) Clarify some Results of generated textile printing design generated by using FabricGenie application AI tool - Second way (Text)- 4 designs - (researcher designs)

- Using the first way in FabricGenie application which depends on generates designs from (Text &Image)

The Text is:

"same flowers in the image with another trendy color theme 2025"

The image is:

Fig (8) Clarify some Results of generated textile printing design generated by using FabricGenie application AI tool - third way (Text & Image) - 4 designs - (researcher designs)

- Using the first way in FabricGenie application which depends on generates designs from (Image)

The original image is (designed by the researcher):

Fig (9) Clarify some Results of generated textile printing design generated by using FabricGenie application AI tool- forth way (Image) - 4 designs - (researcher image & designs)

After that, the fabricGenie application sent 4 generated designs ideas (four variations of the design request) to the registered email in the application, with maximum 20 designs per day. After that the client can order any of these designs as cut length fabric or made to measure curtains, blinds or cushions. Also you can request design sample of the fabric by ordering before the final order.

2.2.1.2: Generated Designs Analysis (Finding):

After 2 Trails (African theme & Liliam flowers) by using the four ways to generate designs (Theme-Text- Image & Text- Image), there are some important points should be considered:

- There are many generated designs could be generated by changing themes, words in the text, entering image as reference with text and also if it is only image. So, using Generative AI in textile printing design will make huge variety of the generated designs results that can achieve the clients' desires, demand and requirements. Also can save time, money, effort, reducing waste and achieving sustainability in one of the most polluted industry.
- There are no generated designs, when the designer use complicated image or composition with many elements to generate design from. Also not always the generated design meets the designer or client imagination, so Generative AI need more developing & studies to generate more creative designs in the field of textile printing.

3. Industrial design robotics and automation in textile printing industry

Generative AI is instrumental in advancing robotics and automation. It enables robots to learn and adapt to new environments, perform complex tasks, and interact with humans more naturally. Generative AI-powered robots can enhance manufacturing processes [13]. Robotics is an innovative technology used to perform various tasks in the industry [34]. Machine learning robots have transformed the way machines interact with their environment adapting to the situations. Machine learning guides the robots to use the data for task completion [35]. When design a robot functionally, the first step is to define the functional requirements for the robot, because industrial robotics consist of multiple systems that work together to produce the optimal functionality and performance on the production line, and this is why should be determined which tasks will be performed and how, under what conditions, in which level of accuracy and speed, interaction with system, humans, errors, failures…. [36][37].There is seven patterns of AI [38][39] and we use two patterns of them in the proposed prototype, Autonomous systems Pattern and The pattern-matching pattern. Textile printing design process using silk screen has many detailed steps and machine learning algorithms that help robots to learn autonomously rather than programming them for each task, so by using generative AI and machine learning we can execute the printing steps successfully and automate the steps to reduce effort, optimize the printing process by adjusting variables such as ink flow, pressure, and speed in real-time to achieve the best results. Color calibration, reducing the burden on human operators and increasing overall productivity. Also can achieve Pattern Recognition: Machine learning can analyze and identify patterns in the printing process, leading to improved efficiency and consistency. When innovates the industrial design of the proposed integrated compact system, consideration was given to fulfilling the design requirements for use, functionality, and others to ensure ease and safety of use and efficient performance of the required function.

3.1 Suggested automation compact system with arm robotic prototype for silk screen printing unit based in generative AI:

3.1.1 The printing process and steps using robotics:

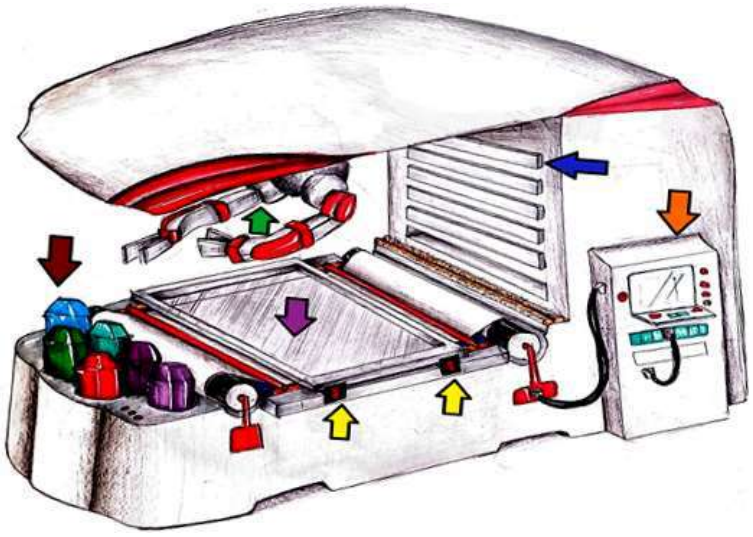

Fig (10) clarify automation compact system for textile printing based in Generative AI (Suggested Prototype)

- After choosing the design which has been generated by FabricGenie or any similar application based in AI in the previous step (Generating designs), choose and prepare the mesh or silk screen, Expose the Emulsion Paint to Light Source, Prepare the stencil and set up the mesh/Screen with the generated design according the design colors numbers. These steps will be executed outside the compact system.
- The compact printing automation system as clarified in Fig (10) based in generative AI and machine deep-learning models that can generate high-quality silk screen process performance, where most steps of printing are executed by robot arm according to the system's pre-programming, training models and all the steps and methodology of generative AI, which is done through the control unit, and as indicated by the orange arrow in fig (10).
- The Blue arrow in Fig (10) refers to and indicates the place designated for the silk screens according to the orders in which they are used, from bottom to top or vice versa according the system and automation process.
- The printing paste is also prepared by using AI algorithms which can analyze large amounts of data colors and use machine learning to match and analysis colors combinations for the chosen design from fabricGenie or any similar application in real-time, to make the color matching process more efficient, accurate, automated and reducing waste in printing paste, fabrics, Time, energy and all kinds of waste which can be caused by preparing wrong colors pastes. Also by using data colors based in AI you can make printing paste many times and produce many meters required from the same design with the exact same colors. After preparing each color in the required printing design should be placed in its designated container according to the order in which it will be used. The brown arrow in Fig (10) indicates the containers for the printing paste.

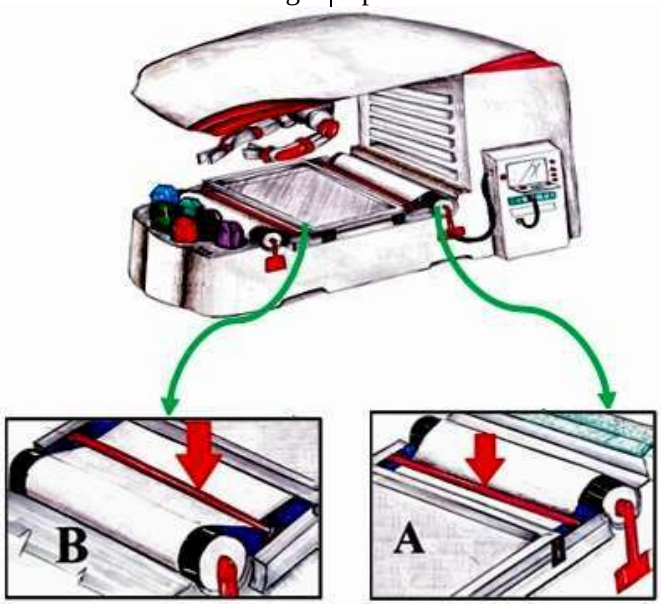

Fig (11) clarify fabric fixation in the compact system

There are 2 ways to fix the fabrics before printing & this step is doing manually like that:

- When we are printing continuous repeated design, we should fix the fabrics manually into the Cylinder as clarified in fig (11A), then The fabric is stretched on the printing table using two rulers designated for this purpose, which are indicated by the red arrows in Figure (11) A and B. The two clamping rulers automatically move down to tighten the fabric and install it on the printing table. Then the printing steps begin and continue until they are completely finished. The two rulers move up and the cylinder B begins to roll automatically to pull and wrap the printed fabric. After that, the printing process is repeated until the whole fabric is printed. The number of times the printing process, each color is applied individually. Repeated and determined according to the size of the fabric' meters, numbers of colors design and the size of the silk screen printing.
- When we print sample or one piece design only (Unrepeated design), or DTG printing (direct on clothing), a finished clothing product like T-shirt, polo shirts, sweatshirts, bags…the piece is fixed on the printing table using only the two rulers.

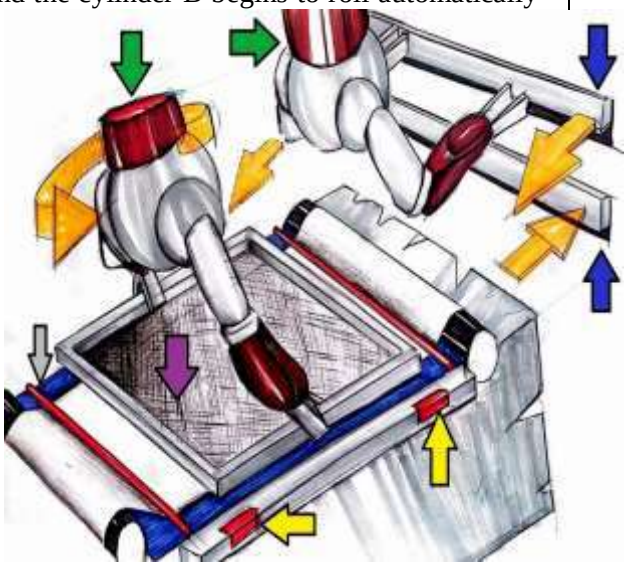

Fig (12) clarify picking up the silk screen by arm robotics' & using in printing process

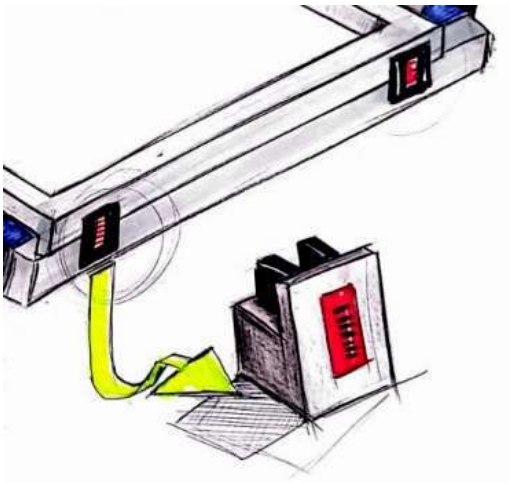

Fig (13) clarify silk screen printing unit fixation way by clips

In this step, the arms' robot, which indicated by the green arrows in Fig (10) and (12), pick up the silk screen with specified order, according to the programming has done. The specific silk screen, which indicated by the purple arrows as drawn in Fig (10) and (12), is picked up from its storage place (indicated by the blue arrows) in Fig (10) and (12) to put it on the printing table which indicated by the gray arrow in Fig (12), then fixed into the printing table as clarified in Fig (13) to ensure the successful completion of the printing process, as silk screen is positioned in the right place after the fabrics or the piece of clothing by the fixing units, (with clips as indicated by the yellow arrows in Figures (10) -(11) and (13).

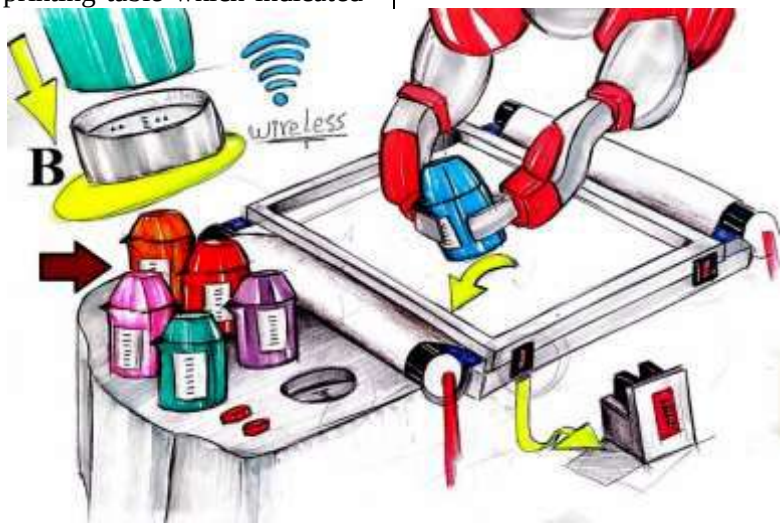

Fig (14) clarify the step of putting printing paste by arm robotics

In this step, the arms take the specific colored printing paste container according to the design pre-programming in the compact system, as shown in Fig (14), and then pour the required amount of paste in the specified place, also according to the pre-programming of the integrated compact system. The amount of colored paste required is calculated according to some elements like, the size of the required design to be applied, the percentage of this color in the design, Is this color will be solid plain or textured…etc. we can control these elements through two factors. First : Generative AI & machine learning to indicate the amount of printing paste according to each design nature, the speed of implementing the paste, numbers of printing, pressure, process time. Second: the suitable industrial design of arms' robot according to the right movement angle of arm and pressure movement controlling, positioning the paste in the right place in the screen before implementing the color through silk screen …etc.

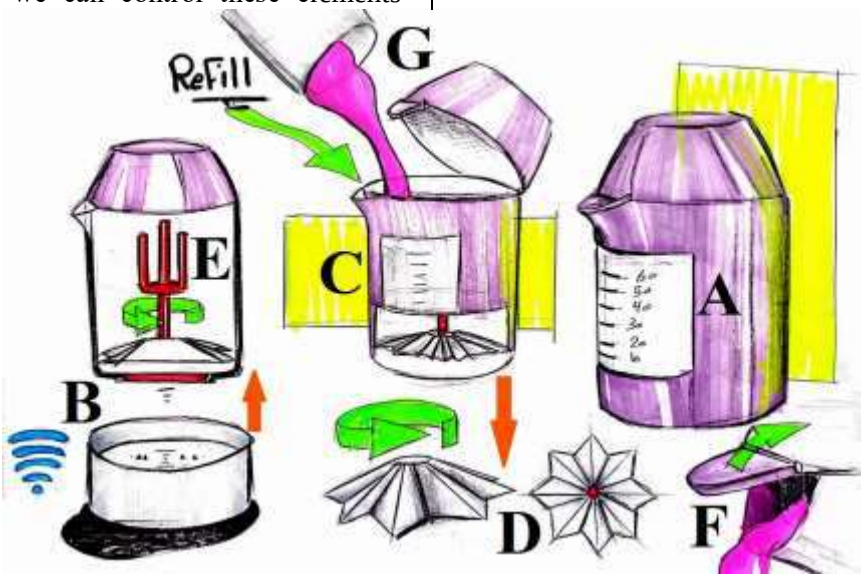

Fig (15) clarify containers or bowl of colored printing paste

- Figure (15) shows containers for printing colored paste, where the symbol (A) indicates the shape of the container and that it has a transparent indicator. Shows the amount of printing paste inside it, in order to follow up and refill the container when the paste is close to finish or running out, the process of refilling the container is done manually as the symbol (G) indicates. The symbol (A) also indicates that the bowl is completely covered, in order to isolate it from the air that affects the paste and makes it dry.
- There is a sensor in the arms' robot, which determines the weight of the printing paste container when it is carried. If the weight drops below what is predetermined in the preprograming, it emits an alert sound (alarm) and the problem appear visually in the screen of the control unit, to let the engineer or the worker know that the container needs to be refilled. It also stops the compact integrated system from completing the printing process until it is turned on again after refilling the bowl or the container.
- When the arms pick up the bowl, it separates from its base, as shown by the symbol (B), which causes a fan to operate inside the bowl. Its location is shown by the transparent sketch indicated by the symbol (C), and its shape is shown by the symbol (D). This fan has a stirring fork inside it, shown by the symbol (E), as it works to stir the printing paste before printing, Inside the bowl for only 30 seconds, this stirring process immediately precedes the process of pouring the paste, as is required to ensure that the uniformity of color printing paste and density valid for the successful completion of the printing process.
- The base of the bowl contains a sensor that connects it to the bowl. Once the bowl separates from its base, it gives the command to the fan motor to start. The base also contains a device to charge the battery located at the bottom of the bowl, which supplies the fan motor with the electricity necessary for its operation, and the charging process takes place wireless, as symbol (B) shows in Fig (14) and (15).
- When the "bowl' is closed, the cover consists of two parts, a fixed part and a movable part. The symbol (F) indicates that during the pouring process, the cover moves to open automatically, when the angle of the bowl is changed to an inclined position for pouring the paste, and it returns again to its place when the

angle of the bowl returns to the vertical position. It closes completely.

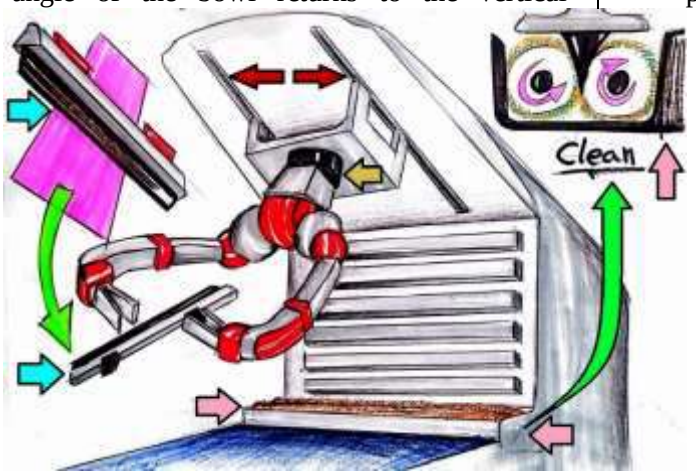

Fig (16) clarify movement direction of the controller and picking up Squeegee from its storage location in the compact system

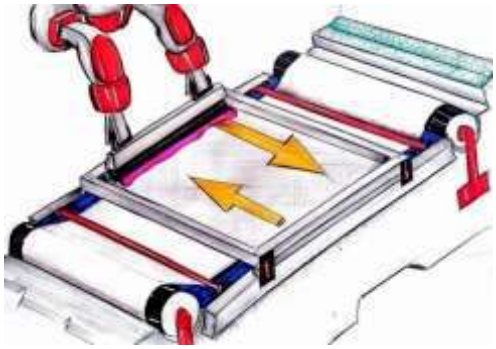

Fig (17) clarify spreading out the printing paste in the printing screen to fit the squeegee

- Figure (16) shows the movement' direction and path of the arms back and forth, which is indicated by the beige arrows, and also the center of their circular movement, which the arms is moving 360 degrees according the required task, which is indicated, to enable the arms to perform all their functions which are picking up the silk screen, Squeegee, and printing paste containers then returning them all into their right places again, in addition to fixing the silk screen on the printing table with the units designated for that and releasing it again, Also putting the colored printing paste onto the silk screen and spreading it with the Squeegee.
- After putting and distributing the printing paste on the silkscreen, the arms take the Squeegee, which indicated by the turquoise arrows in Fig (16), from its storage place, which indicated by the pink arrows in Fig (16).Then the arms spread the printing paste into the silk screen as shown in the Fig (17).

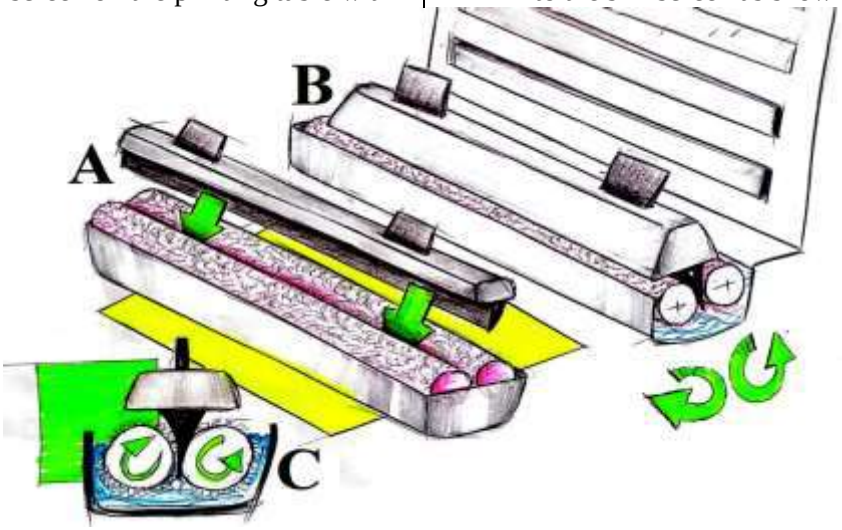

Fig (18) clarify the squeegee' storage place & cleaning steps in the cleaning place using thinner

- After putting the printing paste on the silk screen, the arms return the squeegee again to its storage place, which is shown in Figure (18). It contains two brushes in the form of two cylinders, as symbol (A) shows, and it also contains a thinner, once the squeegee is placed inside its storage unit, as symbol (B) shows. The two brushes begin rotating automatically in opposite directions, carrying the thinner to clean the squeegee, as symbol (C) shows. This process continues about (2) minutes to ensure complete cleaning. It is worth noting that the two brushes can be removed manually to enable them to be cleaned outside the compact system, and also to clean the squeegee storage unit and change the thinner.

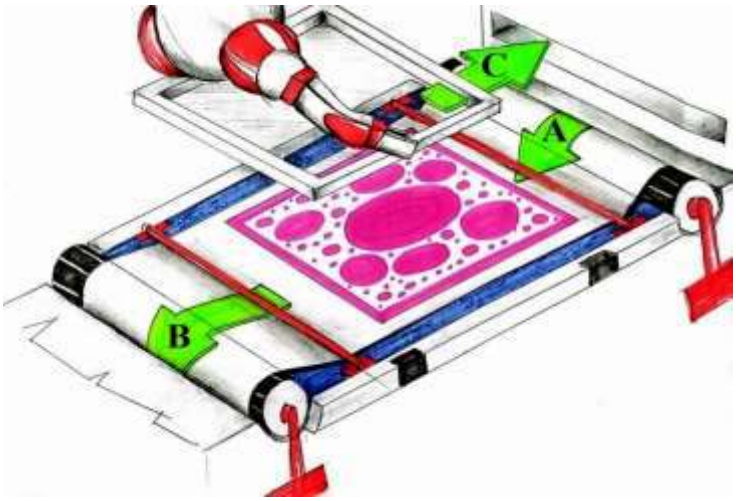

Fig (19) clarify step of printing the first color of the design by using the arm robotics- one piece print or sample before mass production

- After printing the first color, the arm robotic release the silk screen from the printing table, and store it in specific right place as symbol (C) shows in Figure (19)
- The temperature of the printing table is adjusted according to the type of fabric, type of printing paste, and size of the design, so the heat helps speed up the process of drying the printing color paste into the fabric and fixing the color on it.
- The printing steps are repeated again with the next printing color paste and according to the numbers of colors in the required design. After printing with all colors is complete, the two fixing rulers move upward, freeing the fabric from the printing table.
- If depends in this step in the kind of printing, if it is printing with pigment or reactive dyes…. because component of printing paste indicate if we need extra steps of curing or thermo fixation in another machine or after treatment.
- This way and steps are suitable in one-piece design and for design sampling in textile printing factories before the mass order.

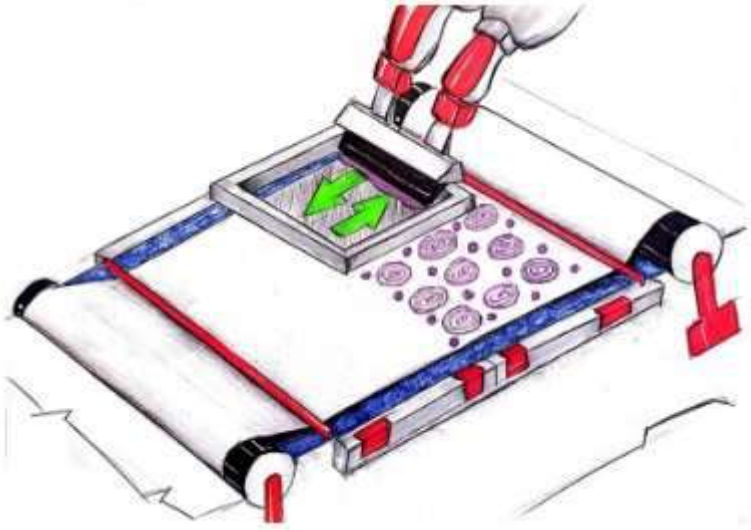

Fig (20) clarify step of printing the first color of the design by using the arm robotics- a part from repeated design

- In Fig (20) clarify a part of textile printing process by robotic, (repeated design- first color), then second color, and then the third color until completing the whole colors in the area between the two rulers. It is possible to change the space between the two rulers to obtain the number of required printed according to the target design. The textile rolled in the cylinder before and after printing.
- The green arrow in fig (20) indicates the process and direction of printed colored paste through the silk screen by using suitable squeegee, according the size & dimension of silk screen which indicated according the design repeat.

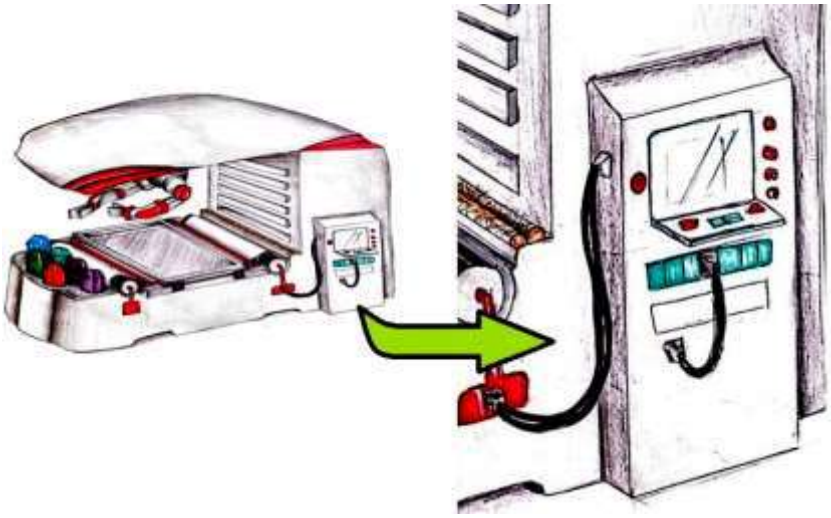

Fig (21) clarify control and programming unit included computer screen for showing the selected generate design & the direction of the arm robotic movement through printing process

- All the special various data are provided by the control and programming unit in the system, which is shown with light green arrow in Figure (21), where the whole entire data is determined according the generated design from step one like per example fig (8) or (9), the times are confirmed for each step of the printing, Data colors and all the required conditions as mentioned in details before, to execute effectively and achieve efficiency, so the robotic used these training models and data, as inputs and standards to control the printing process successfully. The control unit works according to the autonomous electronics pattern of the autonomous systems pattern, which does not only mean working according to the pre-programming, but also will soon learn from the work steps and their results, as the changes will continue in the process completely. To achieve best results, and adjusts work accordingly.
- The required functions were achieved, including storing and handling the silk screen, and printing containers, installing the squeegee on the printing table and picking them, spreading the printing paste, cleaning the squeegee after each step, alerting the containers to be refilled when necessary, and also monitoring and verifying the quality of the results. And all other required tasks in printing process.
- Using requirement through Easy and safe use has also been achieved in entering data through the control and programming unit, installing and handling the fabric to be printed, filling the printing containers, and cleaning the squeegee and its storage place, beside some manual steps as mentioned before in details.

3.1.2 Quality control in the automated compact system:

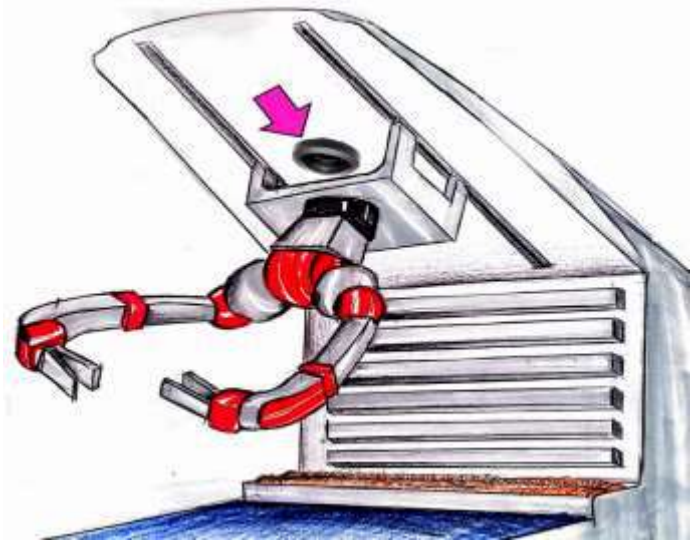

Fig (22) clarify quality control using lens to check the result after every step & at the end of process

- During the printing process and after each partial step in printing color by color as mentioned, the quality control lens, which indicated by the fuchsia arrow in Fig (22),

monitors a partial result and compares it with the standard training model, instead of the result matching the standard training model accompanying the next steps, and if the result does not match the standard training model The control unit making alarm and display the problem which detected visually in the screen, then the system shuts down, doesn't back to work until taking correcting step from the supervisor human being. This step of quality control is repeating step by step until the completing final printing step.

- The results of the printing process steps are monitored and compared with the standard models entered according to the artificial intelligence pattern-matching pattern, which is based on template matching by matching the sample with the reference template, some of its real-world examples include robot navigation. In its work, the arms robotic rely on a combination of the pattern-matching pattern and the Autonomous systems pattern to combine the two characteristics, to achieve the required function.

Conclusions and discussion:

From the theoretical framework of the study and experimental methodology; it can be concluded that:

- Using Generative AI models are based on deep learning techniques and use neural networks and architectures to create new data based on the data in the training set, to transform the manual process and automate the printing textile design process and application by using industrial smart arm Robotic. It includes building these models Basic step, can benefit with the training foundation models in big data of textile printing designs ideas (repeated or one piece), a wide range of designs with many color ways according the fashion season color trends must be collected to help The model for learning various deigns styles, patterns repeats (Full Drop/Block Pattern repeat – Half drop Pattern repeat- Brick Pattern repeat- Random Pattern Repeat…..). Also colors trends themes. All this previous data in textile printing should to be a starting point and basis for creating new models through repetition Training model on a specialized dataset in textile printing designs and this called (Fine Tuning).
- FabricGenie application as case study achieve variety of generated designs by using four ways,(Theme- Text- Text & Image – Image) but until now can't generate design, when using complicated composition with many elements.

From the explanatory framework of the study; it can be concluded that

- Proposed and innovate idea for industrial design smart robotic (sketches of prototypes) depends on Generative AI' pattern, as explained can be used to develop new control algorithms for industrial design of the smart arm robotic, enabling them to learn new behaviors and adapt to changing conditions more effectively in executing the textile printing process using silk screen. Generative AI can be used to develop robotics, that can learn to perform new tasks of textile printing designs steps ……, and silk screen printing by picking and choosing the colors according to the colors generate designs from FabricGenie application, to generate samples that can be used in textile printing industry and for the fashion industry startups. By the end, we can use the generative AI to make trained model to make alternative printing designs and implemented it into the fabrics by using silk screen.

Recommendation:

Using artificial intelligence, digital transformation and automation techniques more in designing and printing textiles industry, to reduce the carbon footprint of the industry, reduce all kinds of waste, increase productivity and efficiency, and also create new business models for entrepreneurs & startups.

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