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# UNRAVELLING THE COMPLEXITY: A REVIEW OF GEOMETRICAL MODELLING TECHNIQUES IN PLAIN WEFT KNITTED TEXTILE STRUCTURES

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***ABSTRACT:*** The geometrical modelling of weft knitted structures is useful to predict fabric properties and for creating physical models. This technology allows fabric simulation to reduce the intensity of the designer and improve work efficiency. This article explores the use of parametric and mathematical techniques to capture the complexities of knitted structures. Finite element analysis (FEA) and mathematical explanations of loop formations are among the topics discussed. This study attempts to offer a thorough resource for scholars, designers, and practitioners navigating the challenging field of weft knitted textile geometrical modelling by combining ideas from various techniques. Mathematical models are based on mathematical equations, these models are easier to understand, but they are unable to forecast how cloth will behave in real time. Since parametric models provide a 3D geometrical model based on the actual values of the substrate, they provide a more realistic representation of the fabric simulation than mathematical models. By breaking down difficulties into smaller components, the Finite Element Analysis (FEA) is used to address physics and engineering problems. Things with asymmetrical structures can easily simulated by using FEA. This study provides a platform for future research and innovation in textile engineering and design by synthesizing the present level of geometrical modelling in the context of plain weft knitted structures through a thorough analysis of the existing literature.

***Keywords:*** geometrical modelling, weft-knitted structures, simulation, textiles, finite element analysis

# KARMAŞIKLIĞI ÇÖZÜMLEMEK: DÜZ ÖRME TEKSTİL YAPILARINDA GEOMETRİK MODELLEME ÜZERİNE BİR DERLEME

***ÖZ:*** Atkılı örme yapıların geometrik modellemesi, kumaş özelliklerini tahmin etmek ve fiziksel modeller oluşturmak için yararlıdır. Bu teknoloji, kumaş simülasyonunun tasarımcının yoğunluğunu azaltmasına ve iş verimliliğini artırmasına olanak tanır. Bu makale, örme yapıların karmaşıklığını yakalamak için parametrik ve matematiksel tekniklerin kullanımını araştırmaktadır. Sonlu elemanlar analizi (FEA) ve ilmek oluşumlarının matematiksel açıklamaları tartışılan konular arasındadır. Bu çalışma, çeşitli tekniklerden fikirleri birleştirerek atkı örme tekstil geometrik modellemesinin zorlu alanında gezinen akademisyenler, tasarımcılar ve uygulayıcılar için kapsamlı bir kaynak sunmaya çalışmaktadır. Matematiksel modeller matematiksel denklemlere dayanır, bu modellerin anlaşılması daha kolaydır, ancak kumaşın gerçek zamanlı olarak nasıl davranacağını tahmin edemezler. Parametrik modeller, alt tabakanın gerçek değerlerine dayanan 3 boyutlu bir geometrik model sağladığından, kumaş simülasyonunun matematiksel modellerden daha gerçekçi bir temsilini sağlarlar. Sonlu elemanlar analizi, zorlukları daha küçük bileşenlere ayırarak fizik ve mühendislik problemlerini ele almak için kullanılır. Asimetrik yapılara sahip nesneler FEA kullanılarak kolayca simüle edilebilir. Bu çalışma, düz atkılı örme yapılar bağlamında mevcut geometrik modelleme seviyesini sentezleyerek tekstil mühendisliği ve tasarımında gelecekteki araştırma ve yenilikler için bir platform sağlamaktadır.

***Anahtar Kelimeler:*** Geometrik modelleme, Atkılı örme yapılar, Simülasyon, Tekstil, Sonlu elemanlar analizi

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## 1. INTRODUCTION

Textile is a vast field that captures the various industries of the world's market. The use of textile is not only limited to apparel or clothing purposes but it is also used in the automobiles, construction, medical and sports sectors etc. There are four ways to produce a textile product i.e. weaving, knitting, braiding, and nonwoven. To incorporate breathability and elastic properties in the fabric, knitting technique is most widely used all over the world. Because the knitted fabric is considered as the best because its structure is based on a loop that gives enough porosity to the fabric this improves the air permeability of the fabric. On the other hand, interlooping of the yarns contributes in the flexibility of the fabric. So various researches are conducted by textile scientists to evaluate and improve the properties of knits. Three-dimensional (3D) models are created to comprehend the knitted fabric's geometry. In these models, the mechanical behaviour of knitted fabrics was observed by their unit cells. Due to the complex structure of knit fabric, many researchers have done the computational modelling of knitted structure for the ease of learning and saving time. The scientist which worked on geometrical modelling are Chamberlain (1926), Peirce (1947), Leaf and Glaskin (1955), Munden (1959), and Kawabata (1989)[1-4]. They developed the two-dimensional (2D) and three-dimensional (3D) models of plain weft-knitted loop. Some researchers applied Finite Element Analysis (FEA) to determine the mechanical properties of knitted fabric [5].

## 2. GEOMETRICAL MODELLING

When textiles were designed and manufactured in the past, they had to undergo subjective testing to identify whether the properties achieved were in accordance with the desirable ones or not. If the properties are not in accordance with the required ones than the textiles again have to undergo the design phase and the manufacturing phase. This process should repeat until the desirable properties are achieved [5]. Modelling and simulation of textiles attract the interest of researchers. As it allows the assessment of textiles before the actual product is made. Hence, it reduces the cost of the textile product and also reduces the time consumption [6]. The modelling and simulation can be done for both woven and knitted [7, 8]. These models are broadly classified into two categories, as described in (Figure 1).

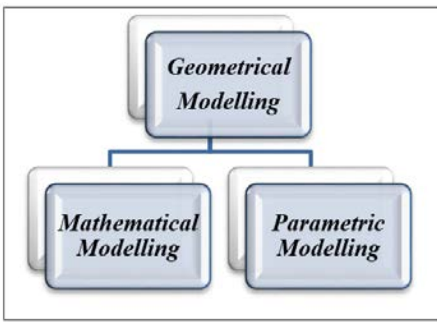



**Figure 1.** Classification of geometrical modelling

### 2.1 Mathematical Modelling

The mathematical model simulates the fabric with the aid of geometrical functions. These are simple and fast. Because it is based on mathematical equation in which only a few parameters are required to produce the geometrical structure. These parameters are derived from known geometries. However, these models cannot predict the real time behaviour of fabric.

There are several models that have been put forward in different eras to improve the accuracy of a basic unit of weft knitted structure, i.e. loop. Chamberlain [1] introduced the first basic loop model in 1926, and it is based on 2D structure. This model illustrates how a loop projects onto plain fabric. Circular arcs and straight lines are used to create the loop, as shown in (Figure 2) This model's limitation is the loop's 2D structure because the thickness and contact phenomenon between the yarns cannot be predicted. As such, this model cannot be applied for mechanical analysis.

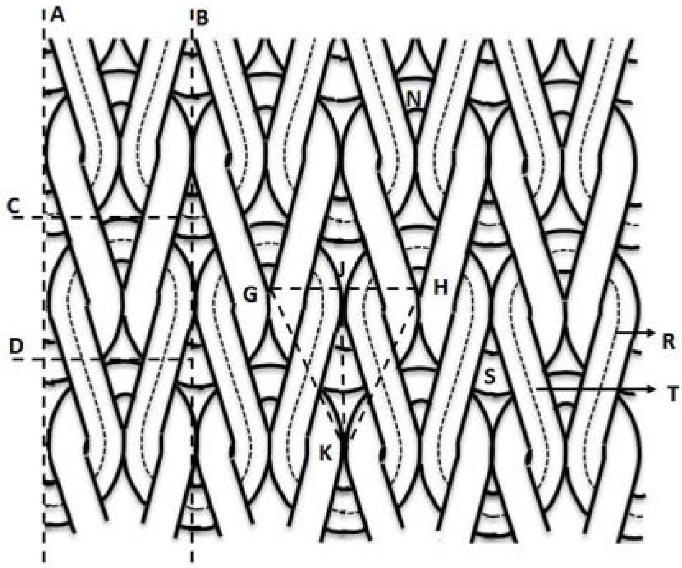



**Figure 2.** Chamberlain's jammed plain knitted loop [9]

Peirce [2] created 2D planar structure in 1947, as illustrated in Figure 3, the model's premise was that a circular, cylindrical surface would serve as the yarn's central axis when it forms a course. According to that model when the fabric is in relaxed form, the needle arcs and sinker arcs represent the semi-circle structure and the relation between yarn length and number of courses/wales per inch. The model was also based on circular arcs and straight line like Chamberlain.  The major drawback of the model was the bending of the loop, which was not taken into consideration. Because when a loop is joined with another loop the yarn bending will occur due to the stresses generated on the loop. It also has a limitation of being too idealistic in structure and hence making impossible to model different plain weft knitted structures.

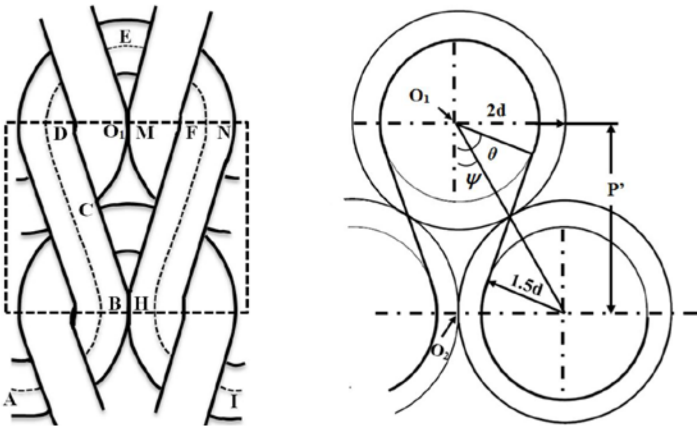



**Figure 3.** Planed structure of Pierce's loop[10]

Later, he made the assumption that these loops were placed on the cylinder in order to incorporate the bending of yarn, which gives the knitted loop three-dimensional effects. As seen in Figure 4, he discovered that the radius of curvature R must equal 4.172 times the yarn's diameter in order to create space for interlocking. He noticed that the course spacing affects the three-dimensional loop structure rather than the wales spacing in the fabric's plane. Additionally, he established a connection between the length of the stitch, course spacing, and wales spacing for open structure plain weft knitted fabric. Peirce proposed that by inserting a straight yarn with a length of ξd in the top of the loop and a length of ξd in its sides, more open structures may be investigated than the one he initially contemplated. Accordingly, he reported opening up the structure by adding a straight line parallel to the course line and a space of εd along the wale line O1O2. In a similar manner, the center of each loop was filled with a straight length ξd. The additional length of yarn was nearly equal to the increase in course spacing.length ξd. The additional length of yarn was nearly equal to the increase in course spacing.

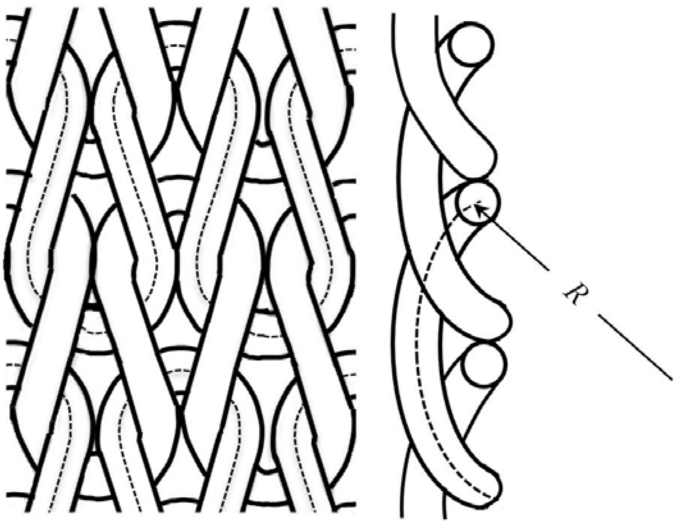



**Figure 4.** 3D model of Pierce's loop structure of plain weft knitted fabric [9]

Shin [11] in 1955, determined that the loop length is dependent on the yarn's diameter after analyzing Peirce's 2D model, as illustrated in Figure 5. The loop length was reported to be 16 times longer than the yarn's diameter based on that model. In this sense, the yarn diameter limited the variations in loop length. By comparing the two, the relationship between the experimental and theoretical values was discovered with the aid of the Peirce model's expressions.

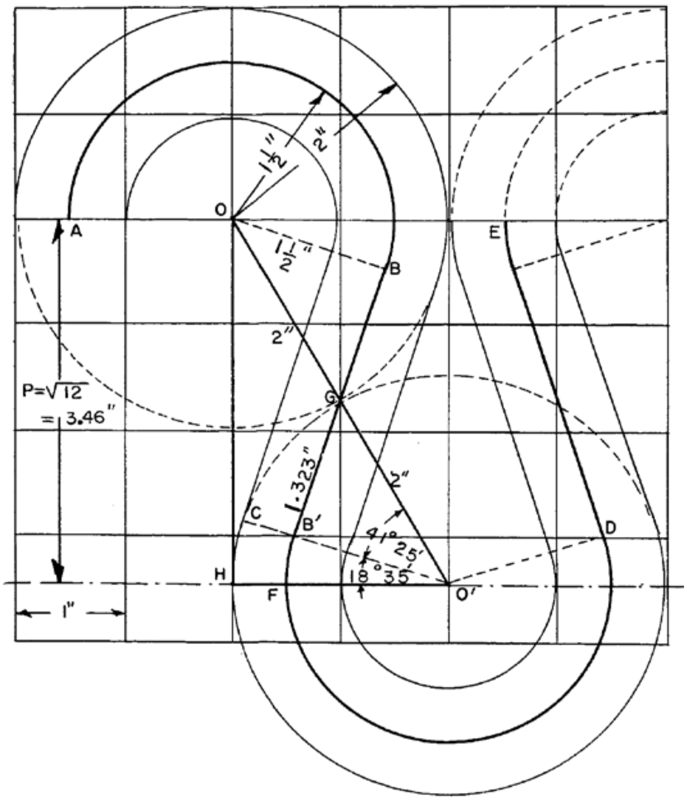



**Figure 5.** Stitch diagram geometric view of plain weft knitted loop [11]

In 1955, Leaf and Glaskin [3] also worked on the Peirce model, as shown in Figure 6. They assumed that the loop of the weft knitted fabric was based on circular arcs. The model found out the relationship between the density and the length of the loop. It provides the realistic density of weft knitted fabric. Similar to Shin their model was also based on 2D structure of the loop.

Furthermore; Munden [4] in 1959, presented the model which states that the forces and pressure will be developed on the loop due to its neighboring loops that relate to them. The direction of the force generated by the neighboring loop is parallel to the course of the knitted fabric. The finding of that model was the relationship between the length of the loop and size of the loop. The length of the loop is not affected by the stitch type or the characteristics of the yarn. The main drawback of that model is that there is no consideration of bending and internal stresses of the yarn incorporated in the weft knitted fabric, as illustrated in Figure 7.

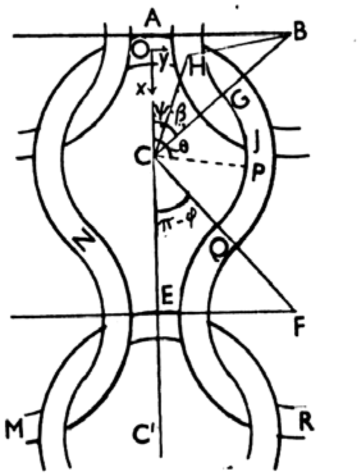
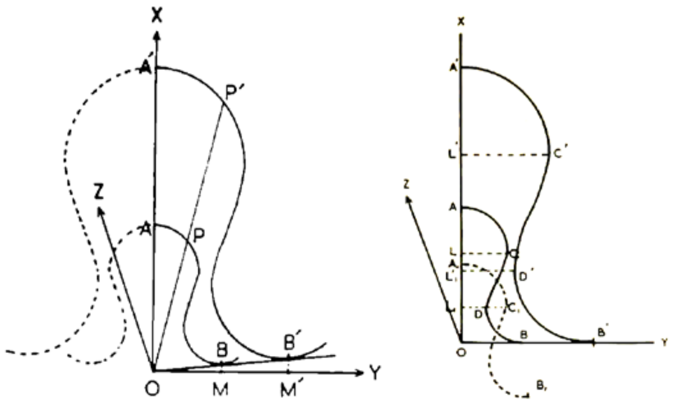


**Figure 6.** Projection of new loop on the plane of the fabric[3]

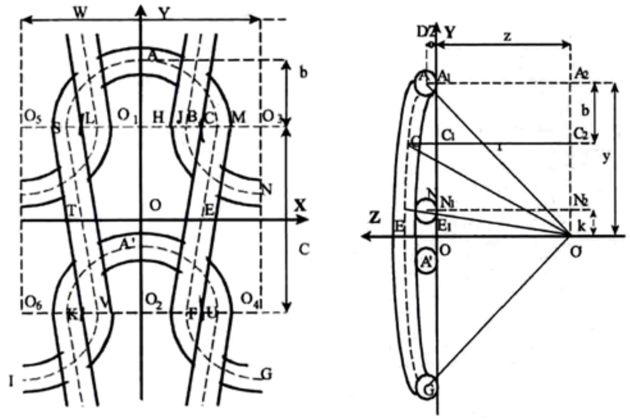


(a) (b)

**Figure 7.** (a) & (b) Geometrical construction of knitted loops of similar construction [4]

In 1977, Dejong and Postle [12] did energy analysis on the plain weft knitted structure, investigating the interlocking of loop in the structure of plain weft knitted fabric. They performed energy analysis on weft knitted fabric and utilized that to examine the biaxial deformation of weft knitted structure. They assumed that the yarns in the fabric structure are of straight configuration atfirst and illustrates certain equilibrium solutions for plain weft knitted structure under very minimal tension depicting yarn curvature etc.They also explained the way the yarns interact with each other in the fabric such that, when the yarns are easily compressible, their contact region is notably flat and the forces between the yarn within the fabric structure are evenly spread as described by Shanahan and Postle [13].

Whereas, for yarns that are incompressible, the contacts region lies towards [14] two-point contact model. The profile of the yarn contact area when knitted fabric is stretched would result in the extension of yarn contact region in walewise direction particularly but not during coursewise extension. They thoroughly examined the intricacies of loop-interlocking in the plain-knitted structure, making it feasible to determine the dimensions of relaxed fabric and tensile properties of weft knitted structures. Moreover; Kawabata [15] in 1989, proposed the model that is based on fabric structure and mechanical properties of yarn. The model predicted the textile properties of single jersey weft knitted fabric. The loop structure is based on circular arcs and straight line. Demiroz and Dias [16] presented geometrical Modelling of weft knitted model in 2000. The method presented a mathematical model for the representation of 3D plain knitted structures on the computer screen utilizing basic fabric parameters. They analysed the projections of the 3D view of the plain knitted stitch on the fabric plane (XY) and the normal plane (YZ), as shown in Figıre 8.



(a) (b)

**Figure 8.** A mathematical model of a stitch:
(a) a projection on XY-plane; (b) a projection on YZ-plane [16]

The model which was able to demonstrate the dimensions of plain knit used energy as an approach was an energy model by Choi and Lo [17]. The model has an advantage that the yarn in the fabric can be curved as anticipated clearly with non-linear mechanical properties. In that mechanical model, there was an adequate degree of freedom for loop deformation i.e., variation can be made in loop's height and as well as the loop's width and the yarn which is used to form the loop resulted negligible friction or zero friction making the loop completely elastic. Hence, the model can be used to solve dimensional as well as biaxial tensile properties of knitted fabric. The accuracy of the anticipated results was governed by a number of factors. The most significant one is the natural curvature and torsion of the yarn, which was considered as a challenging task to measure because it fluctuates with time and with surrounding environmental conditions.

Later on, Kyosev [18] created two models of plain weft knitted structures, as illustrated in Figure 9. Their first model is purely based on the working of Choi and Lo [17]. In that model of plain weft knit loop the yarn cross-section was considered as elliptical in shape. This is done to incorporate the bending effect at the intermeshing points of loops. Before their model everyone considers the cross-section of yarn circular in shape that is not the case in reality. But their deformation simulation is based on geometry methods and does not incorporate the properties of yarns. Because of that substantial limitations are arises in their deformation model. In their second model, the discretization of yarn into small element and mechanical interaction between the yarns was analysed, to achieve more realistic fabric deformation behaviour.

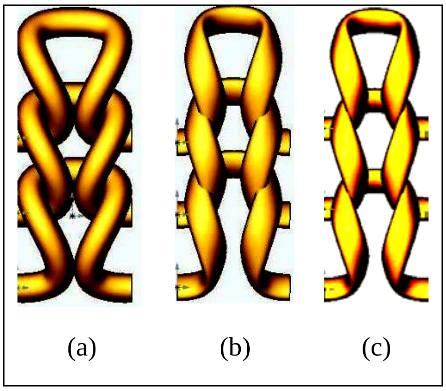



**Figure 9.** 3D model of weft-knitted fabric: (a) loops with circular yarn cross section; (b) loops with elliptical yarn cross-section; (c) with additional correction of the loop height [18]

Afterwards; another 3D geometrical structure was introduced by Liu and Long [19] that is based on multiple segments of space arc and curves. The space arc and curves were generated by parametric equations of sinusoidal function. By that simulation model the thickness and texture of the fabric are evaluated. Therefore; for improving the accuracy of 3D loops the piecewise function was developed by Kurbak & Soydan [20] to enhance the simulation of weft knitted fabric. They divided the loop into eight different points. Each point describes the orientation of the loop. Vassiliadis [5]analysed the length and structure of the loops by implementing the piecewise function to give the more realistic view of the loop in the fabric, but the complications were arising in calculations.

However, the mass spring model [21] is the simplest and the fastest approach for simulation of weft knitted fabric. That model not only simulates the shape of the loop when different tissues were mixed together but can also simulate the fabric in the state of deformation. In that model, fabric was represented as a mesh which consisted of a grid of mass points that connects together by springs. Springs are divided into three types: structural, shearing and bending springs. Structural springs connect a mass point to another in horizontal and vertical directions and responsible for Modelling of stretching/compression behaviour of fabric. Shearing spring connect mass points in diagonal directions. Bending springs connect mass points in horizontal and vertical directions and responsible for Modelling of bending behaviour of the fabric. The spring-mass model has an advantage over FEA because there is no need to solve equations simultaneously. Further, the mass spring model is more accurate for real time simulation of fabric than other mathematical models and it is much faster than FEA. One of the latest models which created a weft knitted loop shape was grid model [22]. By the use of four vertices of a quadrilateral grid in space, the contour of the loop trunk was identified. The coordinates of all the control points of a loop can be calculated through these four vertices as shown in Figure 10.

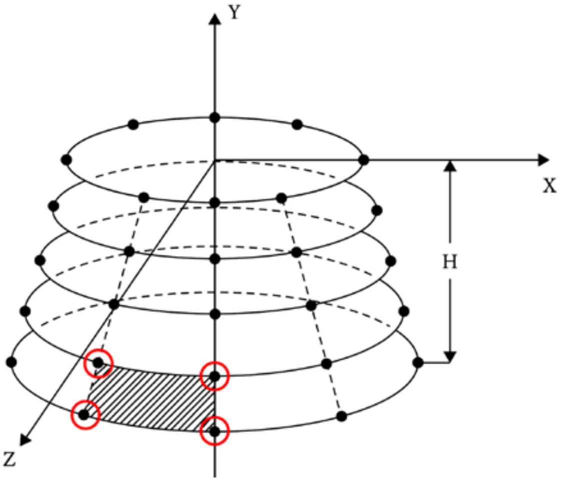



**Figure 10.** 3D grid model of space [15]

However, when using the spatial grid model, the four vertices can be considered as a plane but their co-ordinate values can be different and may vary at different planes and at vertices. Because of this, control points calculation of a loop was not simple. Hence, a vector is used to assist in this calculation. There are 11 control points in a loop, called as data points (center of the yarn cross-section). Each data point has 8 ring points (points on the circumference of yarn) e.g., D1, D2, D3. Through, these eight ring points, the space vector of any two of these eight points can be obtained, as shown in Figure 11.

Piecewise cubic hermite interpolation algorithm was employed for the calculation of coordinates of data points and ring points between the 3D space points. For realistic yarn simulation, triangular surfaces are created by connecting the points between the neighboring rings. The whole simulation of yarn loop is performed in the same way (Hu et al., 2023).

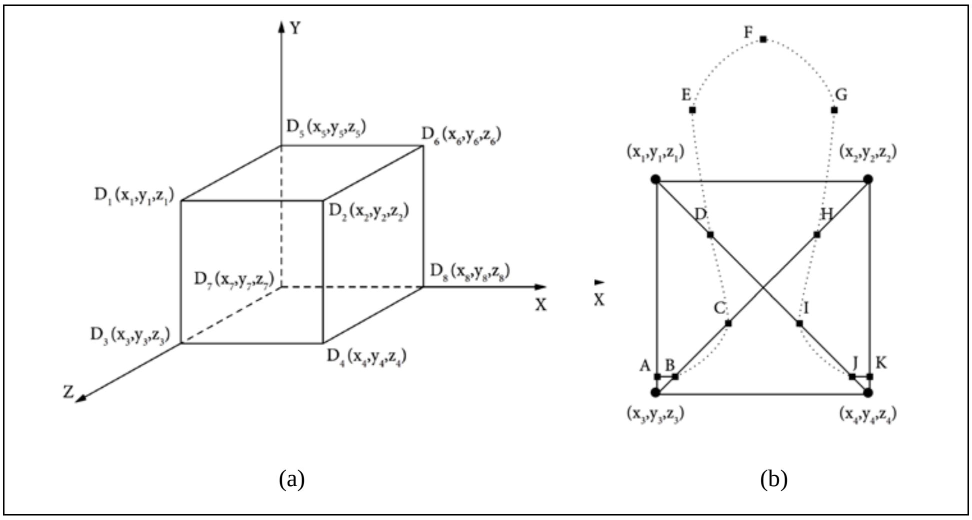



**Figure 11.** Schematic diagram of a single loop modelling in space. (a) Grid model in space. (b) Schematic diagram of loop data points [22]

## 2.2. Parametric Modelling

Parametric modelling techniques are used to obtain the parameters of a realistic model that describes a process. These methods determine the models by using known information about the system. These models give more realistic view of the fabric simulation than mathematical models. Because it requires the actual values of the substrate to generate a 3D geometrical model [21]. First, the theory of spline curves was put forward for loop's simulation which improves simulation's flexibility. The development significantly aided the simulation of weft knitted fabric. Since, the model introduced by Bezier [23] in 1972 has many benefits such as convex hull and intuition. But on the other hand, that model also had some drawbacks like the whole curve will shift when its data point changes. The Bezier cubic curve was unable to express the "n" points when there are many curve segments. Afterwards Piegl [24] in 1989; proposed the 3D loop model by using NURBs curve. B-spline curve can control "n" number of curve segments as it is a perfect piecewise polynomial. Thus, it can effectively resolve the above-mentioned drawbacks of the model that was previously introduced by Bezier. Shape of curve segment will not affect by changing other control points. NURBs is a common B-spline curve which is used to identify the curve by using homogeneous coordinates.It merged rational Bezier, Bezier, non-uniform rational B spline and uniform rational B spline and together. In order to obtain all benefits of B-spline curve, weight factors provided by NURBs for shape adjustment of the loop.Which makes loop flexible and has stable characteristics suited for weft knitted fabric simulations. The Figure 12 shows the structure of the loops that are generated by using NURBs curve.

Another parametric model was presented which was known as Surface Model [26]. In that model, with the help of CAD technology makes it simple to design textiles virtually, by improving the quality of fabric design and efficiency. In that way repeated knitting experimentations can be avoided. Hence, using surface model of OpenGL (API for drawing graphics) mesh chips and NURBs curve, 3D surface loop model was developed that model has realistic effect and strong adaptability to change loop shape. It was employed to simulate various knitted fabric structure on the computer. By modifying the cross-sectional shape, it is possible to generate complicated cross-sectional shape of yarn, using the mesh chips surface model.The deficiency in that model arrived due to the difficulty of mathematical tools. Afterwards, Lin (Li, 2012) in 2012 presented 3D parametric models of weft knitted fancy structures (tuck, jacquard, transfer and fleecy stitch) were developed on the basis of an improved plain knitted loop model. This model consists of nine control points and it is made by using NURBs curves. Previously, Kurbak [20] presented geometrical models of tuck stitch but that model had some problems. The changes in the loop shape cannot be analysed flexibly. Further, loop elasticity was not considered therefore analysis of fabric mechanics and drape was still not possible. Lin worked on an improved weft plain knitted model, as shown in Figure 13. It was assumed that yarn is circular, uniform in cross section and continuous when undergoes bending effect. After allotment of data points at the intermeshing points of loops, second continuous cubic NURBs curves was passed through these points to create plain weft knitted structure. Based on the knitted stich, tuck and other stitches were modeled.

According to the image processing method [28] of yarn simulation, the images of real weft knitted fabric will be taken in order evaluate it further. To achieve the 3D geometrical Modelling of the loop structure, the images of the real fabric are analysed in order to derive the real parametric values of yarn from the different images. For the bending of the loop in real state, Özdemir and Başer [29] proposed the idea to change the shape of the yarn into elliptical for the better simulation of yarn bending and the direction of the yarn in simulated structure of weft knitted fabric, as shown in Figure 14.

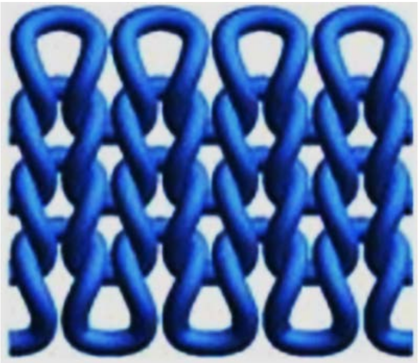


**Figure 12.** 3D simulation of weft knitted fabric based on NURBs curve [25]

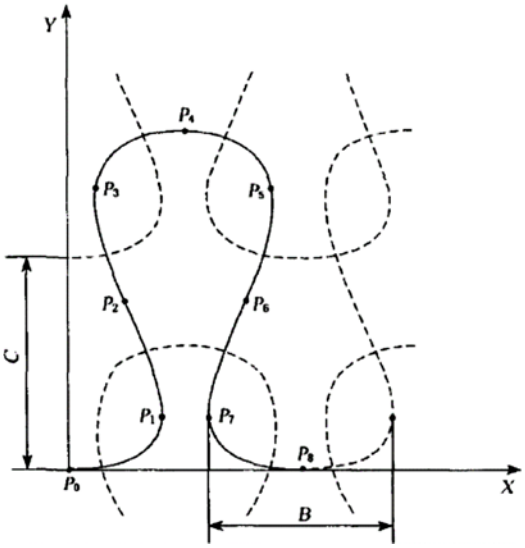
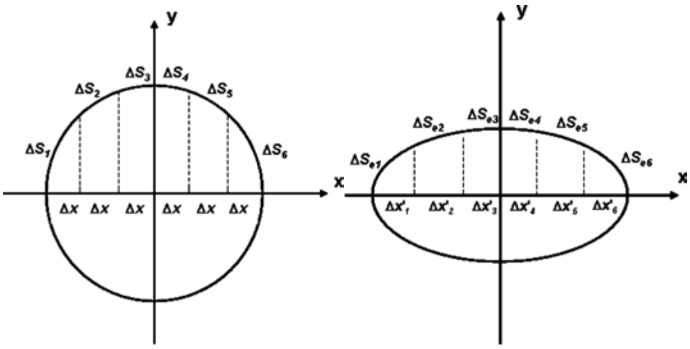



**Figure 13.** Plain weft knitted loop structure [27]

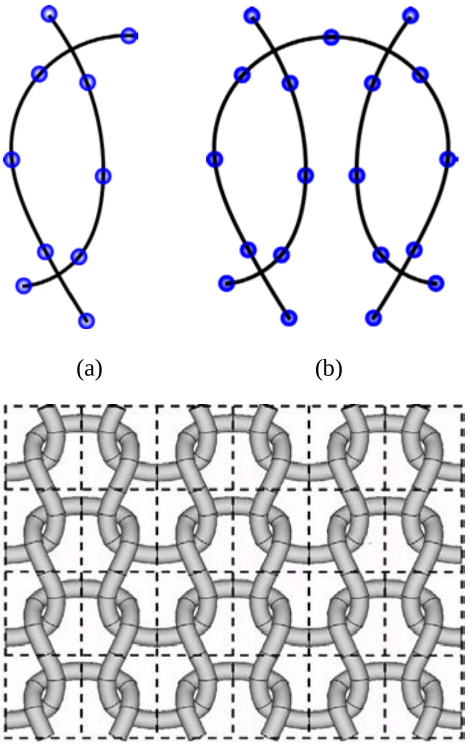



(a) (b)

**Figure14.** (a) Surface development of yarn cylinder from the yarn photographic image; (b) resizing of the yarn image based on elliptical yarn cross-section [29]

The eight values of weft knitted fabric dig out by Kaldor [8] to evaluate the type of the loop and analysed the images by extracting them the parametric values of yarn. This extraction was based on sequence of steps like denoizing, graying, image enhancement and edge extraction to realize the realistic simulation of weft knitted fabrics. These methods are designed for the comparative analysis for large number yarn characteristics and for the substantial collection of information about the yarn. This makes the evaluation more difficult, and it will no longer apply for a wider range of application. Furthermore, the next model that is represented by Durupinar and Güdükbay [30] that removes the faults like distortion and misalignment in simulation of the loops. This model is known as voxel model.

Wadekar [31] presented a yarn-level model for various knitted fabrics including plain weft knit fabric structure (all knit stitch pattern). He used Catmull-Rom splines with a series of control points which depicts the central axis of yarn. The cross section of the yarn is assumed to be circular and number of units is used to represent the complete loop of plain weft knit fabric. The single unit consists of two Catmull-Rom splines in which one spline represent the left half of the loop's head while another spline represents the left leg of the loop. This single unit is then reflected to produce a complete plain weft knitted loop. In that stitch, one spline represents the head of a stitch while two splines represent the legs of the loop, as shown in Figure 15.



(a) (b)

(c)

**Figure 15.** (a) Control points and splines of a unit cell; (b) Control points and splines of a single stitch; (c) Unit cells are tiled to create a complete fabric[31]

Ru [32] presented a geometrical model for the plain weft knitted fabric to simulate the deformation of the fabric at yarn-level. Cubic Catmull-Rom splines along with a series of control points are employed to define the central axis of the yarn. Based on the loop model given by Groller and Rau [33], Ru developed mesh-loop model in order to calculate the coordinates of the control points of the cast-on, plain, and cast-off loop of plain weft knitted fabric. Nine control points for plain, seven for cast-on and six for cast-off loop are used to represent the central axis of yarn path in a plain weft knitted loop. In order to simulate the deformation of fabric at yarn-level, he developed a physical model using dynamic spline which incorporates the stretching and bending of yarn. This model showed great accuracy in predicting the deformed behaviour of fabric but also had some limitations such that it could only be applicable for plain weft knitted fabric and could not be used for other fabric structures. In order to overcome this limitation, Ru [34] proposed another model to predict the deformation behaviour of the fancy weft knitted fabrics with four basic loop units i.e. plain, tuck, float, and loop transfer. The same methodology is adopted to develop the models of fancy weft knitted fabrics as that of plain weft knitted fabric. However, movement vector is employed in this work to depict the structural loop variations. This research also had some limitations as it was for planar fabrics and did not reached the level of real clothing that adheres to the intricate contours of the human body. Further, this model also lacks efficiency.

## 3. SIMULATION TECHNIQUE FOR WEFT-KNITTED FABRIC

The technique which is most widely used to simulate weft knitted fabric is FEA. The FEA is used to solve the problems either of physics or engineering by dividing them into simpler elements. Objects that have irregular structures those structures can be easily simulated by using FEA[35]. The theoretical values were acquired by using FEA and then can be compared with the experimental ones. The primary benefit was that it allowed engineers to determine the performance of structures in various environments without requiring time and physical testing, and it also allowed them to easily evaluate features which can't be reached through experimental studies[36]. For FEA simulations to be properly computed, appropriate geometric models must be used as an input and must fulfill certain requirements. More significantly, the models should only touch at contact points and must not overlap, despite having a realistically accurate shape. A significant portion of the earlier models that illustrate the yarn shape in a knitted fabric were strictly geometric in nature. Because of how yarn models intertwine or bend or lack properly defined contact points of yarn, it makes them unsuitable for FEA Modelling. A yarn level model can be employed to establish initial geometric conditions. These models were capable to represent weft knitted fabrics with the help of parameterized yarn level geometries. This ensures the primary conditions required for various FEA simulations.

Generally, FEA is applied to textiles by applying the material property to the model which depicts behaviour of the yarn's material of the textiles, interaction between the yarns and suitable boundary conditions [37]. Wadekar [38] employed FEA technique to estimate unique mechanical properties of weft knitted fabric. He developed an optimized yarn level geometric model for weft knitted fabric. Physical parameters such as yarn interpenetration, bending energy and length of the yarn are the optimized parameters of this research in order to prevent the inter-penetrations while reducing the curvature and maintaining the length of the yarns. Yarn level geometric model is then imported in FE software and FEA is performed. Hexahedral reduced integrated elements was were used to mesh the FEA model geometry. Different loading conditions were applied and the mechanical behaviour of the fabric is determined. Cherradi [39] used FEA technique to simulate nonlinear orthotropic mechanical behaviour of monofilament knitted textile. Anisotropic polyamide is taken as yarn's material. Interaction between the yarns due to the contact and friction caused relative normal and tangential movement of the yarns. Also these movements of yarns results in a nonlinear material behaviour. In order to consider these movements during simulation, hard contact i.e. (contact pressure can only be transmitted between the surfaces when clearance between them is zero) is used in contact property model and Coulomb friction model is used for the tangential movement. Boundary conditions are applied in which loading is done in wale direction. The simulation is performed at four different deformation stages for three different structures (i.e. single jersey with no constraint, with tie constraint and a structure with adjusted form on edge) to determine the change in contact zone region and geometry at each at each stage. Comparison of the experimental and simulation results showed that both models (model with no constraint and adjusted model) have considerable accordance however, model with tie constraint showed higher difference between the experimental and simulation results.

## 4. CONCLUSION

The textile industry's development and production processes are accelerated by the merging of textiles withcomputer technologies. Research and development efforts are still ongoing to increase the knitted loop structure's accuracy, which aids in a more accurate 3D representation of the weft knit fabric. One of the newest areas of geometric Modelling is parametric Modelling. Compared to mathematical models, it produces more accurate and realistic results. Because of parametric models, single jersey mechanical analysis is now easier. While there are many different simulation techniques available, the majority of applications for FEA are in the textile industry. The researchers can assess more intricate weft-knitted structures with greater efficiency because of the use of FEA.The researchers can assess more intricate weft-knitted structures more quickly through the use of FEA.

Future research on weft-knitted structure simulation may focus on combining material science and multi-scale Modelling approaches to create more lifelike simulations. Additionally, the use of machine learning tools could improve accuracy and yield sustainable analysis, both of which could contribute to the production of textile products that are environmentally friendly. The efficiency of simulating these kinds of structures is further enhanced by cooperation with other platforms, such as CAD.

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