STUDY ON THE RUSTLING SOUND OF VARIOUS FABRICS AND THEIR PROPERTIES

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ABSTRACT

In the textile industry, there is a thriving attentiveness to the use of certain types of fabric among people. The sound produced due to the rustling of these fabrics varies according to diverse parameters. Fabric sound is contemplated as a disturbance in certain circumstances to the user. The disturbance due to sound brings about irritability, loss of concentration, and anxiety, and affects the sensorial clothing comfort of humans. The sound created due to abrasion of the fabric itself or with other surfaces during its usage, is dependent on various physical and chemical parameters of the fabric. The main purpose of this study is to evaluate the rustling sounds established by different woven fabrics made of nylon, silk, polyester, and polyester/cotton blended fabrics. This research assesses the rustling nature of different types of fabrics based on GSM, structure, Type of fiber, flexural rigidity, and drape.

Keywords: Sensorial Comfort, Rustling Sounds, Flexural Rigidity

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INTRODUCTION

In the textile research field, researchers are keen on sensory evaluations related to vision, olfaction, and audition [1]. Fabric's objective measurements such as drape, tactility, lustre, and odour have been in consideration for over the decades in the manufacturing industry, but in the case of fabric rustling sound, there is no deep concern, which is also the key factor that affects the sensorial comfort of clothing. Fabrics coated for water repellency and wind-proof make considerable noise that bothers consumers and others in some situations. On the other hand, the sound of some fabric can provide a person with aesthetic satisfaction. The rustling of silk for women's clothes can be a desirable attribute that pleases consumers. There are commonly three types of noise: internal, external, and semantic, in some cases some fabric absorbs noise, and the rest emits noise. Mostly acoustic material absorbs sound.

In the case of various differential parameters, researchers are attempting to find relationships between sound and the structural parameters of fabrics such as fiber content, cross-sectional shape, fabric construction, smoothness, sensorial comfort, auditory sensibility, and finishing such as anti-microbial finish, etc. However, the characteristics and properties differ for woven fabric and knitted fabric with respect to their structure, shape, elongation, strength, etc. In this context, we have taken both knitted and woven fabrics. In most studies related to sound parameters, researchers used the basic principle which focuses on Zwicker's psychoacoustic parameters- loudness, sharpness, roughness, and fluctuation- to rustling sounds. And the research of rustling sounds of various fabrics was seldom

Material

Nylon, Polyester, Silk, Polyester/Cotton, DC motor, PLC (programmable logic controllers), Drive, Nylon Shaft, Nylon Cylinder, Decibel meter.

All the described fibres have constituent length, fibre strength, uniformity, fineness, and elongation.

a) Nylon- Weave – plain, Thickness – 10mm, gsm – 75
b) Silk – weave – plain weave, thickness – 0.140 mm, gsm – 70.80
c) Cotton is a constituent fibre that blends and corresponds with polyester well.
d) Polycotton – weave – plain, thickness – 4.5-inch, gsm – 95

e) Polyester – weave – plain, thickness – 0.2mm, gsm – 170.

Table 1. Characteristics of specimen

Type of Fabric	Fiber content	Yarn Type	Fabric construction/Name	End Usage
Nylon (F1)	Nylon	Filament	Plain	Swimwear
Silk (F2)	silk	Filament	Plain	Blouse
Polyester (F3)	polyester	Filament	Plain	T-shirt
Polyester/Cotton (F4)	Polyester- 30 % Cotton – 70%	Blended yarn	Plain	Bed cover

Properties:

Properties of Nylon:

Flexibility: Nylon is known for its flexibility and elasticity. When nylon fibers in fabric move or bend, they can generate rustling sounds, especially when the fabric is disturbed or when it rubs against itself or other materials.

Smooth Surface: Nylon fabrics often have a smooth surface texture. The smoothness of the material can contribute to rustling sounds, as it allows for easier movement and friction between the fabric's fibers.

Tensile Strength: Nylon's strong and durable nature means that the fabric can resist deformation, but when subjected to stress or tension, it can generate rustling sounds as the fibers shift and interact.

Surface Coating or Treatments: Some nylon fabrics may have surface coatings or treatments that can affect the rustling sound. These coatings can add a layer of texture or stiffness that influences the sound produced.

Moisture Absorption: Nylon has the capacity to absorb moisture from the environment. The presence of moisture can affect the rustling sound, as it may change the way the fibers interact when moving.

Fabric Weave or Structure: The specific weave or structure of the nylon fabric can impact the rustling sound. A looser weave or a more textured fabric may produce a different rustling sound compared to a tightly woven, smoother fabric.

Thickness and Weight: The thickness and weight of the nylon material can influence the rustling sound. Thicker and heavier nylon materials may produce a more pronounced rustling sound due to the increased mass and surface area.

Properties of silk:

Smooth Surface: Silk has a smooth surface with a naturally lustrous sheen. This smoothness allows the fibers to glide against each other and other surfaces with minimal friction, resulting in a soft rustling sound when the fabric moves.

Thickness and Weight: Silk is incredibly lightweight, which means it is highly responsive to even the slightest movements. This lightweight nature contributes to the delicate rustling sound as the fabric shifts.

Flexibility: Silk is a flexible and pliable material. When silk fabric is bent or draped, the fibers within it can move freely, producing a gentle rustling or whispering sound.

Tensile Strength: Silk is strong and durable for its weight, but it's also relatively delicate when compared to some other fabrics. The fibers can create rustling sounds when subjected to slight tension or friction.

Moisture Absorption: Unlike some other fabrics, silk does not readily absorb moisture from the environment. This can affect the rustling sound, as silk tends to maintain its smoothness and properties even in dry conditions.

Fabric Weave or Structure: The specific weave or structure of the silk fabric can impact the rustling sound. A looser weave or a more textured fabric may produce a different rustling sound compared to a tightly woven, smoother fabric.

Surface Coating or Treatments: Some silk fabrics may have surface coatings or treatments that can affect the rustling sound. These coatings can add a layer of texture or stiffness that influences the sound produced.

Properties of Polyester:

Smooth Surface: Polyester fibers have a relatively smooth surface, which allows them to slide against each other and other surfaces with minimal friction. This smoothness contributes to a relatively soft and quiet rustling sound.

Flexibility: Polyester is a flexible material, and when the fabric is bent, folded, or draped, the fibers can move and interact, producing rustling sounds.

Lightweight: Polyester is a lightweight fabric, and its low mass contributes to a gentle rustling sound when the fabric is disturbed or moves.

Weave Structure: The weave structure of polyester fabric can impact the rustling sound. A tight and smooth weave, such as a plain weave, can produce a soft and subtle rustling sound, while more textured or open weaves may result in a slightly louder or crinkling rustling sound.
Surface Coatings and Treatments: Polyester fabrics can be treated with coatings or finishes for various purposes, such as moisture resistance or texture. These coatings can affect the rustling sound by adding a layer of stiffness or texture to the fabric.
Moisture Absorption: Polyester has low moisture absorption, which means it retains its smooth surface and properties even in dry conditions. This can affect the rustling sound by minimizing changes due to humidity.
Fabric Weave or Structure: The specific weave or structure of the polyester fabric can impact the rustling sound. A looser weave or a more textured fabric may produce a different rustling sound compared to a tightly woven, smoother fabric.

Properties of Polyester/cotton blend:

Polyester Properties:

Smooth Surface: The polyester component of the blend has a relatively smooth surface, which contributes to a soft rustling sound as the fibers glide against each other and other surfaces with minimal friction.
Strength and Durability: The strength of polyester can result in a rustling sound when the fabric is stressed or manipulated, especially during movements that put tension on the fabric.
Flexibility: Polyester's flexibility means that the fabric can produce rustling sounds when it is bent, folded, or draped.

Cotton Properties:

Softness: Cotton is known for its soft and natural feel. While it may not have the same smoothness as polyester, the cotton component can add a soft and subtle quality to the rustling sound.
Breathability: Cotton is a breathable material, and this can influence the rustling sound by allowing air to pass through the fabric more easily.
Moisture Absorption: Cotton is highly moisture-absorbent, and the blend may retain some of this property. The presence of moisture can slightly affect the rustling sound as the fabric's fibers interact differently when damp.
Blend Ratio: The proportion of polyester to cotton in the blend can affect the rustling sound. Higher percentages of polyester may result in a smoother and softer rustling sound, while higher percentages of cotton may introduce a more natural and airy quality to the sound.

Weave Structure: The weave structure of the blend fabric plays a crucial role. A tight and smooth weave, such as a plain weave, can result in a soft and subtle rustling sound, while more textured or open weaves may introduce variation and create a slightly different rustling sound.
Surface Coatings and Finishes: Any surface coatings or treatments applied to the blend fabric can influence the rustling sound by altering the texture and stiffness of the fabric

Methodology

The rustling sound of fabrics is measured using a simple mechanical concept. Here two same or different types of fabric come in contact to produce the sound. This sound is determined with a compact instrument of 50 cm * 30 cm. This instrument consists of 2 parts, one consists of DC motor, PLC, and Drive whereas the other part consists of a Nylon cylinder, a Decibel meter, and 2 fabrics. The sound produced by the motor does not transmit to other parts of the instrument. A glass shield of width 5mm is situated in between the two parts in addition to an acrylic sheet. A hollow Nylon cylinder is wound with fabric ‘F1’ in the anti-clockwise direction. One end of the fabric ‘F2’ is stretched straight above the cylinder and the other end of the cloth has been drawn over the cylinder and stretched to the bottom of the base. This would form a bent curve where both the fabrics would come in contact and produce sound when the cylinder is rotated continuously at a constant speed.

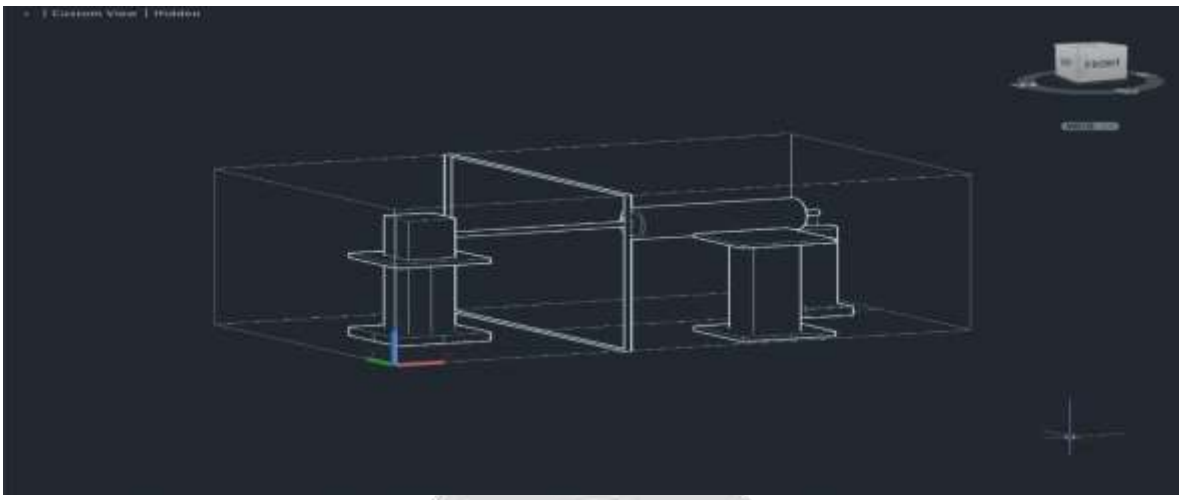

Fig. 1. Top view of the Instrument.

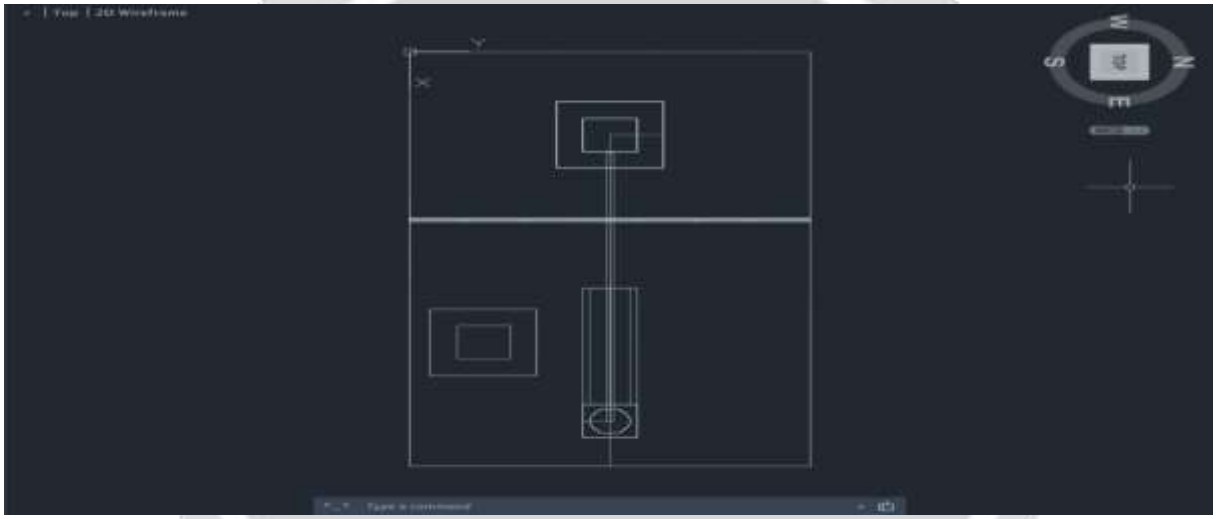

Fig. 2. 3D Model of the Instrument.

The velocity of the cylinder at which it is rotated plays a major role. The power from the DC motor is transmitted to the cylinder through a nylon shaft. The other end of the shaft is in a 'D' shape connected to the cylinder, which prevents slippage. The speed of the DC motor is controlled with a Programmable Logical Controller (PLC) with the help of a Drive. The input speed can be varied according to the fabric. The speed of the cylinder and the mechanical property of fabric determines the amount of sound produced. The sound is measured by a decibel meter and tabulated.

Result and Discussion

The preliminary study results of the different fabric types are tabulated below. Based on the preliminary study it has been noted that the rustling sound of nylon is higher when compared to others. This is likely due to more roughness of the fabric and friction force between contact surfaces. The lower decibel value observed for the Polyester/Cotton blend may suggest that this fabric produces less sound due to its lower physical properties compared to other fabrics. However, it is important to note that the specific results of the study may depend on the methodology used and the fabrics that were tested. Overall, the study provides insight into the sound properties of different fabrics and how they are affected by their physical properties.

Table 2. Preliminary Sample test for various Fabrics.

					Stiffness (Bending	

Type of Fabric	Thickness (mm)	GSM (grams/sq. meter)	Abrasion	Crease (degree)	Length) in cm		Sound in Decibel
					Warp way	Weft Way	
Nylon	0.113	67.44	0.001	111	3	3.5	26.48
Silk	0.140	70.80	0.0019	105	2.3	3.3	13.76
Polyester	0.123	64.64	0.0004	121	1.9	1.8	17.68
Polyester/Cotton	0.212	82.47	0.0015	130	2.0	2.1	10.32

Conclusion

This study was carried out to examine the psychoacoustic characteristics of four different fibres, and their composition and to identify their relationship with physical sound parameters. The sound levels of the fabric have been affected by various factors such as roughness, shear, and bending. In the consideration of polyester and nylon, both have more similar properties with slight variations due to physical characteristics. Sound from each fabric was recorded. Most of the water-repellent and windproof materials such as parachutes, sports materials, sleeping bags, trekking tents, and military apparel which are made specially to withstand high climatic changes and weather can also be studied for their sound parameters in the further proceedings.

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