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Data Article

An online yarn spinning dataset

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ABSTRACT

This data article presents an online yarn spinning dataset for evaluation and benchmarking of a variety of image processing algorithms and computer vision models for imaging based testing of textile yarn quality. The dataset comprises of continuous yarn spinning videos of 59.05 tex, 29.5 tex and 14.76 tex cotton yarns. These videos were recorded during yarn production on a ring spinning frame using a customised image acquisition system. Three videos of 250 meters yarn length each were recorded for all three yarn varieties. Each yarn spinning video was 29.26 gigabytes in size and contained 20200 image frames. After image acquisition, each yarn sample was physically tested on an industrial yarn quality tester to generate ground truth labels for various yarn quality parameters. The online yarn spinning dataset was recently used to validate computer vision models for online detection of nep like defects in yarn spinning process through a comparison of defect count with ground truth labels [1]. Similarly, in the future, this dataset can be used to evaluate performance of a variety of other imaging based online and offline yarn quality testing and defect detection systems.

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Specifications Table

Subject	Textile Engineering
Specific subject area	Quality control in textile yarn spinning process
Type of data	Image Video
How the data were acquired	All yarn spinning videos were recorded on a ring spinning frame (Marzoli MST Spin Tester, Marzoli, Italy) during yarn production using a Basler 1440-220um digital camera (Basler, Germany). The image acquisition was controlled using a graphical user interface application, which was developed in Python programming language and interfaced with the camera using Basler Pypylon library. After imaging, all recorded yarn samples were subjected to physical testing on Uster Tester 3 (Uster, Switzerland) and resultant yarn quality parameters are provided as ground truth labels for respective yarn samples.
Data format	Raw
Description of data collection	Three different varieties of 100% cotton yarns i.e. 59.05 tex, 29.5 tex and 14.76 tex linear density were produced and three yarn spinning videos were recorded for each yarn variety.
Data source location	• Institution: Italian Institute of Technology • City/Town/Region: Genova • Country: Italy • Latitude and longitude (and GPS coordinates, if possible) for collected samples/data: n/a
Data accessibility	Repository name: Figshare Plus Data identification number: N/A Direct URL to data: https://doi.org/10.25452/figshare.plus.19752871.v2 Instructions for accessing these data: N/A
Related research article	N. Haleem, M. Bustreo, A.D. Bue, 2021. A computer vision based online quality control system for textile yarns. Comput. Ind. 133, 103550. https://doi.org/10.1016/j.compind.2021.103550

Value of the Data

- Online yarn imaging on a spinning frame is a technically challenging task due to which various computational algorithms for imaging based yarn quality inspection are limited to offline testing application. The presented dataset overcomes this constraint by providing systematically acquired online yarn spinning videos for three different yarn varieties and their ground truth labels for various yarn quality parameters.
- This dataset can be used by broader textile and computer vision research communities to develop, validate and test imaging based yarn quality testing algorithms and defect detection models. The performance of these algorithms can be benchmarked through comparison with yarn quality testing data acquired using an industrial yarn testing system.
- This dataset can also be used for educational purpose to demonstrate (i) yarn spinning process in general, (ii) variations in fibre mass and yarn diameter, (iii) various types of yarn defects e.g. neps, thick places and thin places and (iv) yarn hairiness i.e. hair fibres protruding out of yarn body.
- A variety of computational algorithms and models aiming to evaluate (i) yarn evenness, (ii) variety of yarn defects and (iii) yarn hairiness can be applied directly on yarn spinning videos provided in this dataset and their outcomes can be compared with the ground truth labels to assess their performance in real world industrial application.

1. Data Description

A number of imaging based yarn quality testing systems were proposed in the recent past with an eventual objective to evaluate yarn quality in an online manner i.e. during yarn production [2–5]. However, these systems were instead mostly applied on yarn specimens, which

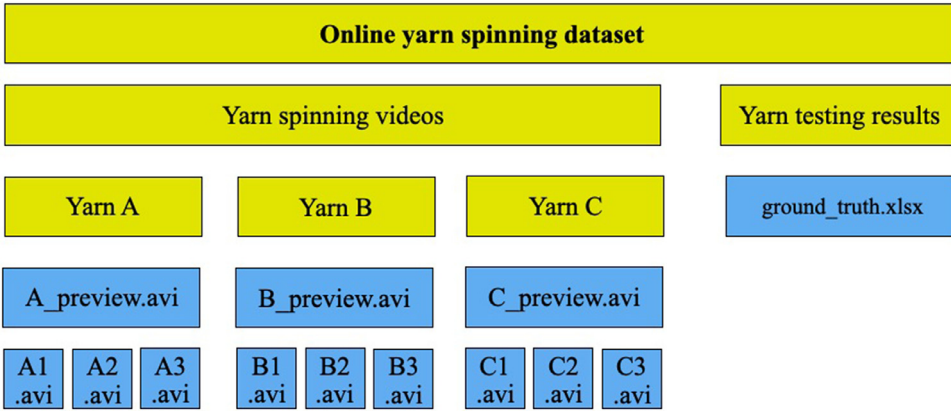

Fig. 1. A schematic overview of yarn spinning dataset. The blue blocks refer to the files in the dataset and yellow blocks refer to data categories and subcategories.

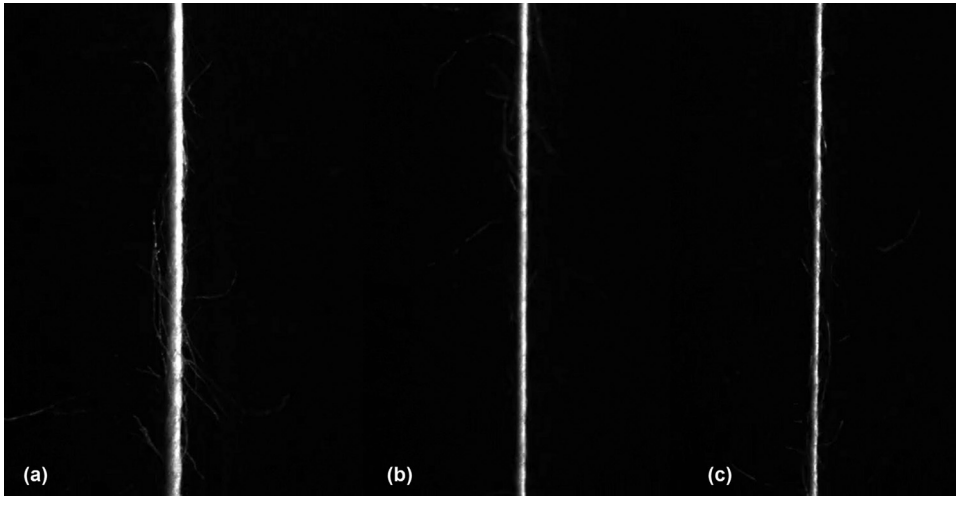

Fig. 2. Example images of (a) yarn A, (b) yarn B and (c) yarn C taken from yarn spinning dataset.

were either static or moved on laboratory scale transport devices, as online yarn imaging is a technically complex task. In order to facilitate on-going research on online yarn quality control systems, we are presenting an online yarn spinning dataset. The online yarn spinning dataset [6] contains two types of data i.e. yarn spinning videos and yarn testing results, as schematically shown in Fig. 1.

The yarn spinning videos comprise of three different varieties of yarns i.e. 59.05 tex, 29.5 tex and 14.76 tex, which are represented for convenience as yarn A, yarn B and yarn C, respectively. Tex is SI unit of yarn linear density and defined as the weight in grams of 1000 meters of yarn length. Fig. 2 shows example images of all three yarn varieties, which are taken from corresponding yarn spinning videos. For each yarn variety, one preview video and three actual yarn spinning videos are provided in the dataset. For example, A_preview.avi is a preview video and A1.avi, A2.avi and A3.avi are three yarn spinning videos for yarn A category. The preview videos are sampled from the first video in each yarn category (i.e. A1.avi, B1.avi and C1.avi) and their playback length is 1 minute. The purpose of the preview videos is to provide a quick overview

Table 1
Various metrics of yarn quality provided in yarn testing results.

Category	Parameter	Description
Evenness	CV%	Coefficient of variation of fibre mass in yarn segments of 8 mm length
Thin places	-30%	A thin place defect where the fibre mass is 30% less relative to normal yarn
	-40%	A thin place defect where the fibre mass is 40% less relative to normal yarn
	-50%	A thin place defect where the fibre mass is 50% less relative to normal yarn
Thick places	+35%	A thick place defect where the fibre mass is 35% high relative to normal yarn
	+50%	A thick place defect where the fibre mass is 50% high relative to normal yarn
Neps	+140%	A nep type defect where the fibre mass is 140% high relative to normal yarn
	+200%	A nep type defect where the fibre mass is 200% high relative to normal yarn
	+400%	A nep type defect where the fibre mass is 400% high relative to normal yarn
Hairiness	H-index	Ratio of total length of hairs protruding out of yarn body to the total yarn length tested

Table 2
Yarn spinning parameters for three different yarn varieties.

Yarn category	Linear density (tex)	Spindle speed (rpm)	Total Draft	Yarn twist (m^{-1})
A	59.5	10000	16.7	546.27
B	29.5	14642	33.4	773.03
C	14.76	15000	63.5	1092.54

of corresponding yarn spinning videos to the user to evaluate usefulness of the dataset before downloading it. The size of each yarn spinning video is 29.26 gigabytes and it contains 20200 uncompressed yarn images, which represent 250 meters of continuous yarn length. These videos can be viewed using open source VLC player [7] or another suitable multimedia viewer software.

The second part of the dataset i.e. yarn testing results are provided in a Microsoft Excel file and named as ground_truth.xlsx. These results show yarn quality testing data for each yarn sample in the dataset, measured using an industrial yarn quality tester [8]. All metrics of yarn quality reported in ground_truth.xlsx are briefly described in Table 1. The ground truth data contains meaurements of various yarn quality parameters including evenness, defect count (i.e. number of thick and thin places and neps) and hairiness and can be used to benchmark the performance of any imaging based yarn quality testing system. Such a system will be first applied on all image frames of a corresponding yarn video file and then its testing outcomes can be compared with the provided ground truth labels to evaluate its performance.

2. Experimental Design, Materials and Methods

To record yarn spinning videos, three different yarn varieties i.e. 59.5 tex, 29.5 tex and 14.76 tex were produced using a 937 tex 100% carded cotton roving (32.8 mm fibre length, 0.188 tex). All yarns were produced on a Marzoli MST Spin Tester (Marzoli, Italy) with a spinning ring of 40 mm diameter. The temperature and relative humidity in the spinning shed were maintained at 21.9°C and 53% respectively. The processing parameters for each yarn variety are given in Table 2.

A custom image acquisition assembly was used to record yarn spinning videos and a graphical user interface (GUI) software application was developed in Python programming language to control image acquisition. The imaging system comprised of a Basler 1440-220um digital camera (Basler, Germany), which was fitted with a 50 mm lens (Tamron, Japan) and two extension rings of 5 mm thickness each. A GES-6K-20-T (Genesi Lux, Italy) LED light of 3600 lumens intensity was used to provide illumination. The camera and illuminator were mounted on two tripods to focus on a yarn spinning position on the ring frame machine, as shown in Fig. 3. The physical

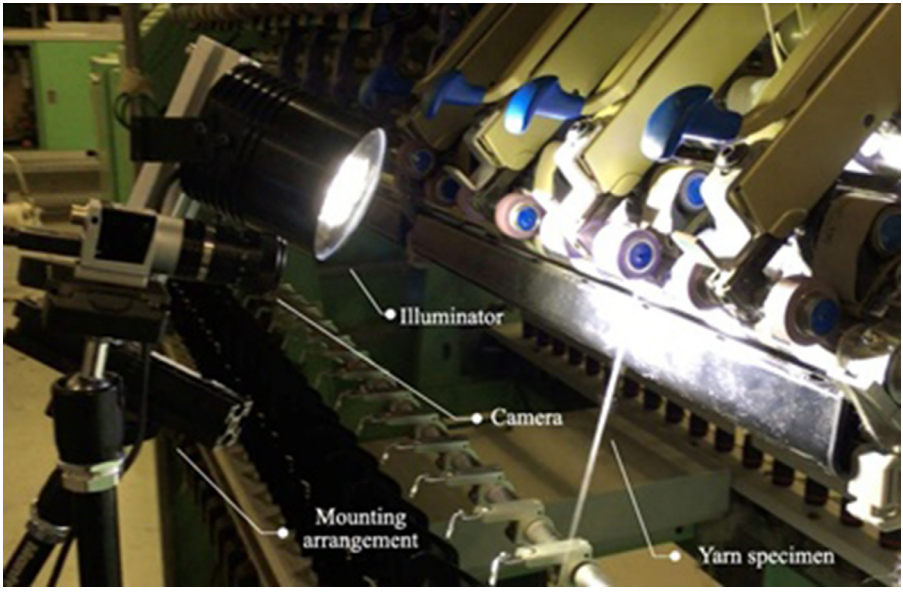

Fig. 3. Image acquisition system for online yarn imaging deployed on a ring spinning frame.

Table 3
Imaging speed and delivery speeds for all three yarn varieties.

Yarn type	Imaging speed (frames per second)	Yarn delivery speed (m/min)
A	24.58	18.25
B	25.46	18.88
C	18.46	13.71

distance between the camera and yarn sample was 21 cm and the vertical field of view was 1.23 cm.

The camera was connected to a Dell Precision 7510 laptop (Dell, USA) through USB 3 connection. The GUI application was interfaced with the camera using Basler Pypylon library to capture continuous yarn image stream. The exposure time setting of the camera was setup at 3 µs to account for rapid motion of yarn specimen during spinning process. The digital resolution of the camera was 1440 $\times$ 1080 pixels. The imaging speed for each yarn variety was selected such that all yarn segments were captured in continuous images with no overlapping of yarn segments between two consecutive images. This was achieved by synchronising imaging speed with yarn delivery speed, which depended on spinning process parameters. Both imaging and yarn delivery speeds are given in Table 3. Each yarn video was recorded for 250 meters yarn length and saved in AVI video format without applying any image compression.

After image acquisition, each yarn bobbin was taken off the spinning frame and subjected to yarn quality testing on Uster Tester 3 (Uster, Switzerland). The yarn testing speed was setup at 100 m/min and total test time was 2.5 minutes. The resultant yarn quality parameters included yarn evenness in terms of CV%, defect count for three different types of yarns defects (i.e. thin places, thick places and neps) and yarn hairiness. The yarn testing data is provided as ground truth labels for yarn quality within the dataset.

Ethics Statement

This work complies with the ethics in publishing standards provided by the journal / publisher.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Yarn Spinning Dataset (Original data) (Figshare plus).

CRediT Author Statement

Noman Haleem: Conceptualization, Methodology, Investigation, Writing – original draft; **Matteo Bustreo:** Conceptualization, Methodology, Project administration; **Alessio Del Bue:** Supervision.

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