A Review on Recent developments of contaminants detection methodology systems

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1. Contaminants in Cotton:

Cotton fibre is the major raw material in the textile and apparel industries. Despite, advent and increase of synthetic fibre production, cotton continue to enjoy a unique position among the various fibres available due to its inherent properties and appeal. Cotton is a natural vegetable fibre produced across the globe. Due to the nature of growing and harvesting practices, cotton fibre is not available in its purest form. External matters such as trash and impurities of various kinds like vegetable matters, minerals, metals, etc are present in the cotton. While the ginning process remove certain unwanted materials, the spinning preparation machinery remove majority of them. In fact, the nature of spinning preparatory machines such as blow room, carding and combing are aimed at fulfilling this as one of their major objectives.

Cotton contaminants such as synthetics (plastics, films, strings fabrics), feathers, hair, jute, etc are difficult to remove in the existing spinning preparatory processes and hence came the purpose-built contamination detection system by various manufacturers. These systems are primarily placed in Blow Room lines. A review of the currently available detection systems is explained in this paper and the scope for future development and the need for the same is briefly discussed at the end.

2. Introduction:

Cotton (genus: *Gossypium*) is one of the most important fibre and provides much needed impetus to the agricultural economy of countries where they are grown. Countries like India have built a strong industrial base in textiles based on the availability of cotton raw material. India has 130.61 lakh hectares under cotton cultivation. This is around 40% of world area of 324.16 lakh hectares. Approximately 67% of Indian's cotton is produced on rain-fed areas and 33% on irrigated lands. In terms of productivity, India is on 39th rank with yield of 447 kg/ha, according to ministry of textiles for the year 2022-23.

According to the note on cotton sector, by ministry of textiles, the following is provided:

India is the only country which grows all four species of cotton *G. arboreum* & *G. herbaceum* (Asian cotton), *G. barbadense* (Egyptian cotton) and *G. hirsutum* (American Upland cotton). *G. hirsutum* represents 90% of the hybrid cotton production in India and all the current Bt cotton hybrids are *G. hirsutum*. In India, majority of cotton production comes from 9 major cotton growing states, which are grouped into three diverse agro-ecological zones, as under:-

i) Northern Zone - Punjab, Haryana and Rajasthan

ii) Central Zone - Gujarat, Maharashtra and Madhya Pradesh

iii) Southern Zone - Telangana, Andhra Pradesh and Karnataka.

Apart from the above the cotton is also grown in the state of Odisha and Tamil Nadu.

3. Cultivation of cotton:

Cultivation of cotton is based on the type of soil; water availability and climatic conditions and practices may vary between countries or growth areas. A typical cultivation process in India is as described here:

- Clearing the land of weeds and other vegetable growth; preparing the soil
- Tilling the soil as required using mechanised machinery
- Planting of cotton seeds either manually or using specific built machinery
- Emergence of plant from cotton seeds (within 2 weeks. These must be secured from disease attacks by providing adequate fertiliser and irrigation.
- Emergence of flower buds in about 6 weeks and after development the pod emerges after flower falls off, called a cotton ball.
- Maturity of bolls within 8 to 12 weeks; fibres within the pods continue to develop.
- Once balls mature, leaves are removed from the cotton plant.
- Harvesting: either manual harvesting or machine harvesting by pickers/strippers are followed. To pull the cotton from the plant, the picker system uses wind & guides, leaving behind leaves & the rest of the plant. To separate garbage from the cotton, the stripper device chops the plant & uses air.
- Harvesting (picking) may be repeated depending on bolls maturing at different time stages
- Seed cotton (called *Kapas*) is store graded and sold
- Seed cotton is taken through Ginning process, where cotton fibres are separated from the seed.

Cotton fibre with plant

4. Cotton Harvesting

4.1 Manual Picking:

Traditionally cotton is harvested manually. The fully grown cotton bolls are picked manually by farm workers using hand or cutting machines. This process is laborious and time consuming. However, the following are the advantages with manual picking: Minimal loss of cotton as all bolls are hand-picked. Because of hand picking, the quality of cotton bolls is good as well as clean. However, the manual picking is not considered due to high labour cost as well as non-availability of farm workers.

Cotton bolls are stored on the intermediate shoulder bags, and then pooled as heap with proper storage and protection.

4.2 Machine Picking:

When cotton is cultivated over large area, harvesting can be done using cotton picking machines. However, smaller, and divided plantation area in countries like India, suing machines over smaller area would be a challenge as well as not possible in certain cases.

With the development of technology, a second method was developed against manual cotton picking. The entry of modern machinery into the cotton sector has led to changes in the cotton harvest. As with manual assembly, there are advantages and disadvantages to this method.

Cotton can be harvested faster by machine. Compared to manual harvesting, when cotton is harvested by machine, the cost of the production is reduced by up to 30%; When harvested by machine, the field is freed from the cotton crop in time and there is enough time for the next sowing. There would however be problem if cottons grow at different rates. When cotton is harvested by machine, if the height of the plant is more than 1m, the plant will lie on the ground during harvesting and the quality of harvesting will decrease. From this point of view, low-growing, fast-growing and mass-opening cotton varieties adapted to machine harvesting should be cultivated.

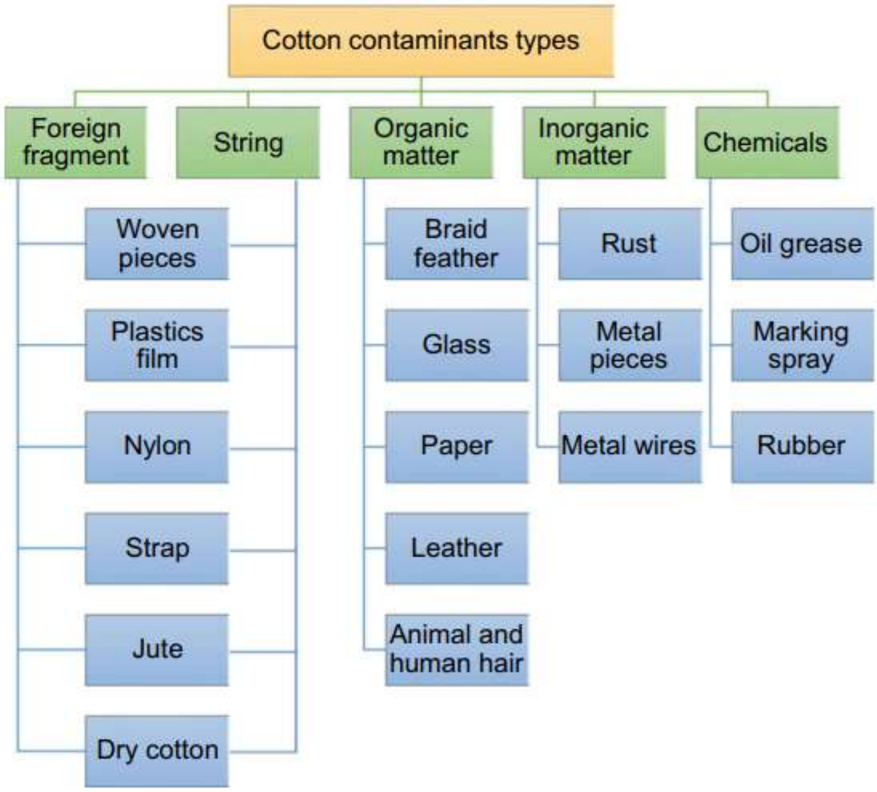
Other demands of machine harvesting are: The land on which the combine is used must be clean and smooth. A field free of weeds is a must. The weeds in the field pass between the spindles of the combine and the combine cannot fully harvest the cotton, and the harvested cotton turns green; If there are cotton plants in the field, they must be cleaned. If not cleaned, the combine becomes difficult to assemble and the quality of work decreases.

5. Contaminants in Cotton:

A brief discussion on what cotton contamination is and constitutes, the origins and kinds of cotton contaminants, effects of contaminants on cotton processing, and the different methods used to detect cotton contaminants is made here. Cotton contamination can be presence of an impurity, or another undesirable component that spoils, corrupts, infects, makes unfit, or makes inferior a quality textile product. Therefore, detecting and eliminating cotton contaminations as timely as possible before processing or within the process is essential. The different techniques of detecting contaminants are discussed in detail. The methods used for detecting cotton contaminations are generally classified as manual, gravimetric, electro-optical, and machine vision methods.

5.1 What is Contamination?

Contamination, as stated earlier, can be defined as the presence of an impurity, or another undesirable component that spoils, corrupts, infects, makes unfit, or makes inferior a product, body, natural atmosphere, and workplace. In the field of textile, cotton contamination is often defined or expressed in numerous ways in which the most acceptable typical conception of cotton contamination is that the presence of trash/foreign matter (organic or inorganic) within the cotton fibre foreign material is associated with impurity, which gets unintentionally mixed with cotton within the harvest and post-harvest processes. The mixing of foreign materials through the product at the production, handling, in the storage is termed as contamination. Some cotton fibre contaminants are like animal fibre, polypropylene twines, field sheets, plant leaves, human hair, plastics, and leather (Source: ITMF Survey)



5.2 Origin and Kinds of Cotton Contamination:

Cotton contaminations cannot originate or grown inside cotton balls within the cotton plant; instead, contaminations to raw cotton come almost at each stage, which means from cotton harvesting area to the ginning and spinning processes. Personal operations all through picking, ginning and baling, and even in spinning processes, may add many types of cotton contaminants into the cotton bale. Some of the common categories of cotton contaminants are shown in Figure 1. ITMF, in its survey of cotton contaminants from spinning mills, categorize cotton contamination sources in to five basic source categories consisting of varieties of contaminations (as shown in Fig. 2). The contaminants may come from a couple of sources, for instance, fragments of seed coat can be due by and large to an inherent tendency for portions of the seed coat to come back unfastened through fibre or else might be due to an insufficient ginning method typically which routinely breakdowns the seeds. The primary source of immature fibres is vegetative in the case of genetic or climatic reasons are dominant; it can be because of insect harm to the growing cotton bolls. In the ITMF survey, the furthermost cotton contaminants are fabrics, strings, organic matter, inorganic matter, and chemicals as main categories. Under fabrics, contaminants, woven and plastic films, jute, and cotton are included. String types of contaminants are made up of plain-woven plastics, film, and jute. Organic contaminants include paper, leaves, feathers, leather, whereas inorganic

White contaminants	Alien fibers	Colored objects	Oily substances	Dense objects
White plastic fabric White plastic strings White/transparent Plastic film	Hair Feather Colored cotton fibers Coir fibers Colored plastic fibers	Colored cotton fabric Colored cotton yarn Jute fabric Jute yarn Coir yarn Colored plastic fabric Colored plastic string, film	Sticks/twigs Leaves Oily/rusty/black cotton clumps Stamp colored/yellow cotton Tar/crease-affected cotton clumps	Metal pieces Paper Stand, stones Leather bits Wooden pieces

contaminants include sand, dust, rust, metal wire, and chemicals contaminants contain rubber, grease, oil, tar, stamp colour.

Fig 2: Categories of contaminants:

Fig 3: Different Cotton Contaminants

6. Effect of Cotton Contamination on Cotton Processing:

There is a negative impact of contamination in the cotton process, yarn, and fabric. The contaminants can increase processing downtime, damage machine parts, increase workload, increases manpower, decreases product quality resulting in lower in the price of the product, decrease efficiency, and performance of the spinners and weavers. If the cotton is contaminated, there is a tendency of cotton to develop sticky that makes the interruption of different rollers, the dying material to be wastage which needs additional energies on cleaning that increase cost, also next to cleaning the remaining embedded contaminated yarn segments might affect the quality and values of cotton fibre. If there is excess oil on cotton lint, the cotton could stick and wrap on machines instead of going proficiently, which causes processing problems in textile mills. Contamination, even a particular foreign fibre, might lead to a quality reduction of yarn, fabric, or garments or the total rejection of an entire batch. It may cause roughness of the relationship between the cultivators, ginners, suppliers, and textile and clothing factories.

6.1 Measures to reduce cotton contamination are:

- Introducing uniform cotton-picking storage and marketing.
- Using cloth bags instead of jute and fabric.
- Picking cotton fibres in the appropriate time.
- Use metal body open trolleys for quick transportation of cotton from field to factories.
- Luggage must be unfastened by unsewing as a replacement for cutting twine into small pieces, and luggage should not be beaten on the heap; instead, it should be done separately, and obtained cotton should be adequately cleaned to be added in a heap.
- Cotton fibre moisture must be preserved at 8% and must be perceived carefully by a moisture meter

Table 1: Various sources of contamination, their effect and remedial stages:

Source of contamination	Effect	Remedies
Strings/fabrics of jute/hessian	hessian Increased end breakage rate at ring/rotor. Poor yarn appearance differential dye pick-up.	Avoid use of hessian for transport at farms and ginning. Use of cotton cloth for bales.
Strings/fabrics of cotton	Poor quality yarn/cloth.	Manual picking, automatic transportation, training.
Strings/fabrics of woven	Differential dye pick-up. Very	Avoid use of plastic material,

plastics/plastic film.	Poor-quality yarn/cloth. Damaged to machinery.	better housekeeping and practices.
0rganic matter - Leaves, feather, paper, leather etc.	Increased waste at spinning Damaged to machinery.	Use of pre-cleaner at ginning, use of gravity trap, better housekeeping.
Inorganic matter 1. sand dust 2. metal/wire	Increased waste at spinning Damaged to machinery.	Use of pre-cleaner at ginning, use metal detector, better housekeeping.
Oily matter 1. Stamp colour 2. Grease/oil	Mars yarn/fabric appearance	Avoid use of stamp colour, better housekeeping.
Hair- human	Increased end breaks at ring rotor Poor yarn/fabric appearance	Use of caps, automatic transportation, education/training.
Seed coats	coats Increased waste at spinning Poor yarn/fabric appearance	Use pre-cleaner and post cleaner at ginning.
Pouches - Gutkha	Damaged to machinery	Better practices, education/ training.

7. CONTAMINATION DETECTION SYSTEM:

7.1 Manual process:

Contaminants like jute, chindies, HDPE, gutkha packs, etc. can be removed by the workers. It is difficult to detect the contamination -due to their unpredictable size, shape, material and position as some of the contaminants get inside the cotton fibre layer and become invisible. This system is costly, time consuming and chances of human error are more. The accuracy of this system is also very poor.

7.2 Gravimetric method:

In this system the contaminated material is removed because of gravity only. In this method of detection of cotton contaminants, a mechanical model is used. For the vision system and the sorting system, synchronized with the movement of cotton on the conveyor, an encoder is installed at the shift of the conveyor and driven by the belt. In this system only heavy contamination can be removed. Efficiency of this system is less due to lot of mechanical parts.

7.3 Electro-optical method:

Electro-optical method used for cotton contaminant is based on the High-Volume Instrument (HVI). This system is suitable for the extensive quality control of all the bale proceeds in a spinning mill. In this system Digital Image Process Technique is used, and this is the one of most efficient method of removal of contaminations.

Working Principle:

7.3.1 Contamination detection by optical means:

All systems detect contamination by optical means. Yarn clearers and the" sorter of Loptex use photo sensors and detect the contamination as being darker than the cotton. Optical sensor can only see what visible means is, it cannot detect the contamination which is hidden within the cotton tufts. This permit detection of colourless contamination namely, packing material in polypropylene.

7.3.2. Contamination ejection by ultrasonic means:

The degree of reflectance of acoustic waves depends on the surface structure of the object in their path. The sensor consists of a number of emitters of ultrasonic therefore not hearable waves. The receiver will receive waves which are reflected by the contamination contained in the lose cotton. If no contamination is present, the ultrasonic wave will be absorbed in the absorber box located on the other side of the system.

7.3.3. Contamination ejection by pneumatic valves:

In case of the detection of a contamination by the optical or the acoustic system, the electronic control will activate pneumatic valves which are variable. It depends on the size of contamination. It takes into account the transportation speed of the raw material and releases the air blow after the necessary delay. The air blow will be targeted since only the valves are activated, which are located in front of the passing contamination.

8. Cotton Contamination Measurement Systems:

8.1 The Visible Light with UV, Polarized Light, and Multiple Detectors Method:

This technique is grounded on an optical method, which uses three light sources, visible (white) light together with UV and polarized light sources. This system combines light sources having different wavelengths (both visible and UV light) and different polarization states, meaning that polarized/unpolarized states to notice and detect contaminants in cotton fibre. Here the detection is using combined different lighting states without the use of cameras, inspection chambers, glass channels, or evaluating components having to be present in duplicate or without the UV light and polarized light interfering with one another. This system is built and suitable in the early-stage blow room lines opening, cleaning for cotton spinning mills, and short staple carding machines. This method is commercially manufactured by Trutzschler GmbH & Co. KG.

8.2 Using Different Illumination Methods:

The kind of illumination used is another essential factor to determine and detect contaminants. Techniques by using cameras and the human eye would only detect contaminants that differ from cotton in terms of colour, contrast, or lustre structure. Because of this reason, a different illumination can be applied in the detection of foreign fibres in cotton. Nowadays, using a standard illumination with fluorescent tubes operating in reflected light mode is standard and best practice.

Polarized transmitted light can detect differences in surface lustre with polarized reflected light, and corresponding camera filters differences in the surface lustre of foreign materials. This is an ideal technique used for detecting transparent and semi-transparent contaminants like pieces of polyester fibres/fabrics or polypropylene fabric from cotton bale packaging. In the system, the raw cotton passing through will be illuminated under polarized light, ultraviolet (UV) light, which makes the foreign plastic fibre to appear as coloured, in this time, these foreign fibre will be often distinguished from the raw cotton and can be separated easily. The system has some limitations that there are dull contaminants that cannot be detected by this system.

Another illumination method is using a diffused illumination method which uses ultra-fast CCD cameras to detect cotton fibre contaminants. Four high-resolution CCD line cameras will observe the individual cotton tufts and obtain cotton images from both edges simultaneously, hence improves the detection efficiency of foreign fibre within the cotton tuft. The technique features a transparent channel where cotton tufts are diffusely illuminated within the inspection zone. The deviation in colour and size expressed by contaminant width (number of pixels) and length (number of scan lines) describes the contaminants in cotton fibre. There is a tolerance in colour, which is defined by threshold levels (limits). Therefore, objects with a colour value lower than this limit are considered as being a contaminant. The Cotton Sorter develops this technique by Barco Vision; existing blow-room lines have often installed this technique without adding any fan capacity to elevate the cotton and drop it through the inspection place.

8.3. Optical Reflective Techniques:

This system is fundamental to detect plastic contaminants having a different reflective surface than cotton fibres. Plastic contaminant’s surfaces are more likely to be secularly reflective or shiny surfaces while the cotton-based surface, like the surface of a fabric or natural contaminants, is more likely to be diffuse in its physical reflection characteristics. Here there are two detection systems developed by Jossi Systems AG, located in Switzerland. Vision Shield is one system that detects coloured contaminants, and another system is called Magic Eye M1, which can detect white and transparent cotton contaminations.

The cotton flow is irradiated alternately at many various orientations using various ways of illuminating and capturing contaminants to increase the chance of catching contaminant reflectance. One method is using two sorts of cameras, one is colour, and the other is black and white cameras, synchronized with the lighting system, which comprises an alignment of LED light sources. All LEDs must be activated to make a balanced level (two dimensional) illumination can be achieved to detect coloured contamination by the colour camera.

8.4. Infrared and Near-Infrared Spectroscopy Technique:

Some researchers develop a technique using an optimal wavelength imaging system to detect foreign fibre within the near-infrared spectroscopy area, i.e., from 750 to 2500 nm wavelength, the attempted is using infrared or near-infrared radiation for detecting cotton contamination. The technique is based on the truth that the spectral absorption and reflectance properties of different fibre are different.

There is a device developed which can measure the reflection or absorbance of wavelengths within the range of 400–2500 nm, i.e., by using a combination of the light wave of 400–700 nm and a near-infrared wave of 700–2500 nm patented by Jossi Systems AG in 1997. So far, it has never been commercialized or verified in profitable manufacturing.

There was also research that was done that uses fast Fourier transforms on the spectra, the optimum wavelength to detect foreign fibre, and, consequently, an optimum wavelength to illuminate and image contaminants. In this experiment, the best suitable wavelength taken was 940 nm, chosen for detecting and imaging of the proper range of foreign fibre of cotton. This technique comprises near-infrared CCD camera, double light sources (couples of LED array light sources within 940 nm band), and a computer equipped with a frame grabber. As soon as the cotton sample illuminated through light radiation of 940 nm, clear images of contaminants can be seen. But most of these kinds of techniques are within the research stage, and they may be used for laboratory studies. Near-infrared and infrared chemical spectra application is also investigated to detect contaminants, though the signal response is unfulfilled by noise and resolution difficulties. Besides, spectrometer instruments are costly and generally impractical to use in tough ginning process applications.

Another research verified the use of an attenuated total reflectance—Fourier transform infrared spectral database and to amend the signal loss and insensitivity of direct radiation transmission/reflection techniques to recognize foreign matter in cotton. In the research, Fourier transform infrared spectra (reflectance mode) of retrieved foreign matter were collected and subsequently rapidly matched to an authentic spectrum during a spectral database. For the research, in the database, contaminants comprised are called “trash”, cotton parts and grass plant parts; “foreign objects and materials”, synthetic materials, organic materials, sugars, and inorganic materials. In the research, the pattern region from 1800 to 650 cm^{-1} or 5500–15,500 nm was selected to give the impression since it, in general, gives the upper matches. Nevertheless, the spectra of samples where the fingerprint region is weak or showed little features, the addition X–H stretch region of the spectrum from 3700 to 2700 cm^{-1} or from 2700 to 3700 nm to the search improved match quality to the database library.

8.5. Machine Vision Method:

White and other contaminants that are similar to cotton fibre are tough to detect, and separate in cotton processing, thus require effective detection methods. A good solution for the detection and removal of these kinds of contaminants is the use of machine vision with a suitable algorithm, with recent advancements in the image capturing systems, segmentation, and feature extraction process.

The simple machine-vision based foreign fibre detection technique primarily contains a line scan camera, frame-grabber, personal computer, and high-pressure gas nozzle. The camera will capture the cotton fibre image, and then the image will be manipulated to diminish noise and to improve contrast. The manipulated images are segmented to differentiate foreign fibre based on the differences in image features of the cotton sample. The foreign fibre positions in the processed images are transferred to the separator to control the solenoid valves that switch the high pressure compressed air to be on or off to blow the foreign fibre off the cotton tufts. The system has main limitations on the PC, as the central processing unit takes a long time; this leads to foreign fibre to be undetected in the actual time of examination.

In this technique of detection, in image processing, image segmentation is a necessary stage that will extract features of objects by the partition of the image into meaningfully connected components. In current research developments, there are many image processing techniques algorisms proposed, such as using co-occurrence matrix features, x-ray microtomographic image analysis, wavelets, colour space model, and optimal wavelength imaging.

One algorithm is through x-ray microtomographic image analysis using computer vision algorithms to detect and to classify the cotton contaminants with high resolution and accuracy. This method generates numerous views of cotton then reconstructed by a computer to obtain cross-sectional portions. These portions are then stacked up to produce a 3D view of internal and external structural details. This technique can be used with the fuzzy-logic-based classification scheme to create a highly accurate contaminant analysis tool.

The wavelet image analysis method has outstanding features in terms of signal and image processing. Multiscale wavelets with different scales can examine cotton fibre images for the detection of contaminants. It can detect many signal characteristics such as signal trends, signal's high order discontinuous points, and self-similar properties, which is ignored by other analysis systems. There are different wavelengths for imaging of cotton and foreign fibre. The optimal wavelength imaging uses different wavelength values of cotton and foreign fibres to detect foreign fibres from the cotton sample. The near-infrared imaging technique can detect a wide range of foreign fibres in cotton, and an optimal wavelength imaging system will be developed with an image-processing algorithm.

Contamination detection based on colour space is another method like the RGB space model, YCbCr model, and HIS model. The colour space model uses the extracted features of the standard cotton and channel background. The RGB space model uses three basic component values R, G, and B representing colour which will be collected by image acquisition devices, then finally, these are used by colour display devices. As the main limitation of the RGB colour space model, the visual difference between two colours cannot be expressed as the distance between two colour points, and a correlation between RGB is much high, and RGB space is sensitive to noise in the low-intensity area. Therefore, the YCbCr model is developed. In the YCbCr model, the pixel values of RGB space transferred into luminance Y, chrominance of blue Cb, and chrominance of red Cr. Therefore, the YCbCr model can process luminance and chrominance information separately by excavating the useful information of the original image as more as possible. There is an analysis done to compare HIS and YCbCr models and found that the HSI model is better than the YCbCr model in the way that the YCbCr model is unable to distinguish the white-coloured contaminant fibre from standard cotton while HSI model could detect white-coloured contaminant from cotton fibre.

Since the white contaminants have the same colour or close to the cotton colour, they canot efficiently be detected under the illumination of visible lights using existing machine vision systems. The solution to this problem is using an imaging method based on line lasers, under the illumination of a line laser the white contaminants and cotton will show a difference in optical characteristic on their surfaces. The algorithms are used according to features of the intensity of their reflected lights or distribution of the fluff around surfaces in images.

A new high-speed foreign fibre detection system is developed with machine vision for removing foreign fibres from raw cotton using optimal hardware components and appropriate algorithm designing. The system applied digital signal processor and field programmable gate array on image acquisition and processing illuminated by ultraviolet light using the specialized lens of the 3-charged coupled device camera. It is done to identify transparent objects like polyethylene and polypropylene fabric from cotton tuft flow under the fluorescent effect, until all foreign fibres that have been blown away safely by compressed air. To identify blocks like foreign fibres from cotton, an image segmentation algorithm based on a fast wavelet transform is developed. And canny detector is also developed to segment wire-like foreign fibres from raw cotton. The procedure naturally provides a colour image segmentation method with a region growing algorithm for better adaptability.

9. Scope for future works

Complexities arise in terms of machinery configuration and parameters, and due to positioning of contamination detection system in the blow room line, impact efficiency of contamination detection. Combined with these parameters, the presentation of material (size and spread of tufts as well as its density) where in the contaminants are present in either fully exposed form, or partially exposed or totally hidden, also impact detection efficiency.

It is expected that technological advances in terms of lighting, sound and detection systems combined with improved detection algorithms can improve the efficiency further. Now, determining the efficiency of these systems remain difficult.

There exists scope for developing standard test methods as well an evaluation arrangement placed off-line to test the efficiency of a detection system. Cottons collected from a detection system can be subjected to off-line evaluation arrangement. Such evaluation arrangements (equivalent of a testing equipment) can also be used in the evaluation of raw materials. The only caution would be on the sample size of materials to be used since contaminants are irregular in nature in terms of their presence in the cotton. Hence, an optimum sample size is critical to determine types and quantum of contaminants present in the cotton.

There is also lack of literature evidence of how exactly the contaminants are detected (not the use of light source and techniques, but on the detection algorithm) which is rightfully held by the manufacturer of contamination system. Any additional information on how contaminants react with various light and sound sources can help in understanding the detection logic and accordingly demands on placing higher performance from contamination detection systems.

10. Conclusion

Contaminants present in the cotton affect yarn quality. From manual picking, we have many modern on-line contaminant detection and election systems used in the Blow Room line. These systems use a combination of various light sources and sound waves, as well as detection arrangements line (camera and sensor). Literature review and observations provide an opportunity to develop an off-line evaluation system which can test the on-line performance of the machinery with respect to detection and ejection efficiency. It would also be used in raw material purchase decision making processes.

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