Title: METHOD AND DEVICE FOR ASSESSING THE SURFACE CONDITION OF RUBBER OR PLASTIC STRANDS

Abstract: A device for assessing technical condition of the surface of strands made of rubber or plastic comprising temperature generator, temperature detector, interface, image analyzer, and decision element is characterized in that it has an infrared detector (3) located over the examined structure of strand (1) at appropriate distance (h) and in an antireflection shield (4), whereas uniformity of the temperature gradient over the whole surface of the examined structure of strand (1) is ensured by a temperature generator (2) after which temperature sensors (6 and 7) are located. A method of assessing technical condition of strands made of rubber or plastic is characterized in that that signals from sensors (6, 7) measuring the temperature gradient and the signal from the transducer (5) providing non-contact and/or contact measurement of velocity of strand (1) and the image from interface of detector (8) are transmitted to image analyzer (9) and decision element (10).
METHOD AND DEVICE FOR ASSESSING THE SURFACE CONDITION OF RUBBER OR PLASTIC STRANDS

The subject of the present invention is a device for assessing technical condition of the surface of strands made of rubber or plastic and a method of assessing technical condition of strands made of rubber or plastic offering the possibility to implement the solution also for assessing technical condition of the surface of the belt rubber mantle of belt conveyors used in the mining industry.

Known from description of Polish patent PL 181202 is a device for measuring of stretching and breaking force of strands that has hydraulic actuators attached by their bases to the front plate of a frame, with piston rods of said actuators mounted in a transversal movable beam moving on guides by means of carriages provided with rollers. In the middle of the movable beam, the front catch is mounted. In the rear plate, a rear catch is installed with grooves for edged ring locking position of the catch in the rear plate. The front catch is attached to the beam by means of a pin on which a bushing is mounted with strain sensors glued on it. The rear travelling catch allows to bring the catches close to each other for the required distance so that both short and long elements can be tested.

In the framework of modernization of lift technology, steel-polyurethane strands are used instead of steel cables. To asses the quality of such structure in the course of service it is necessary to determine both technical condition of steel cords and the state of polyurethane mantle surface. The presented idea allows to assess condition of the surface and possible presence of structure cracks or gaps in the mantle. The problem of carrying out inspection of the rubber mantle surface in belt conveyors where people can be occasionally transported on the belts, also remains unsolved. Before each running cycle in which people' are to be carried, the belt must be inspected visually for possible cracks which is obviously a time-consuming procedure. Application of the present invention would eliminate human intervention and increase detectability of defects.

The device for assessing technical condition of the surface of strands made of rubber or plastic comprising temperature generator, temperature detector, interface, image analyzer, and decision element is characterized in that it has an infrared detector positioned over the examined strand structure at appropriate
distance and in an antireflection shield, whereas uniformity of the temperature
gradient over the whole surface of the examined strand structure is ensured by
a temperature generator after which temperature sensors are located.

The method of assessing technical condition of the surface of strands made
of rubber or plastic is characterized in that signals from sensors measuring the
temperature gradient and the signal from the transducer for non-contact and/or
contact strand motion velocity measurement as well as the image from the
detector's interface are transmitted to an image analyzer and to a decision
element.

The device for assessing technical condition of the surface of strands made
of rubber or plastic comprises the following components:

The invention concerns a machine vision system in the infrared range; as
opposed to the computer vision that is focused mainly on image processing on
the hardware level, the machine vision requires the use of additional I/O
(input/output) devices and computer networks for transmitting the resulting
information to other elements of the analyzing system. The machine vision falls
into the category of engineering dealing with computer science, optics,
mechanics, and industrial automation. Machine vision systems are used on a
continuously increasing scale to solve industrial inspection problems, allowing
for full automation of the inspection process at improved precision and
efficiency.

The invention is shown in an example embodiment in the Figure presenting
its schematic view.

The device is equipped with infrared detector 3 located under the examined
strand 1 at distance $h$ and in an antireflection shield 4. The detector's
observation field depends on the distance $h$ guaranteeing appropriate resolution
of the image. In the strand 1, temperature gradient is generated by means of
generator 2. In the measuring system, temperature is measured by sensors 6 and
7 (in the MEMS technology — before and after the temperature gradient
generator) and temperature values are transmitted to image analyzer 9. The measured temperature provides the feedback used in the image analyzer.
The image from interface of detector 8 is also transmitted to the image
analyzer 9. This can be also e.g. an operator's computer in which qualitative
analysis of the image and localization of defects is carried out. For localization
of defects, non-contact or contact strand motion velocity measurement 5 is used.
The system operates in real time. A very important feature of the device is the method used to generate a temperature gradient in the inspected structure (continuous or pulsed).

The method of assessing technical condition of the surface of strands made of rubber or plastic is characterized in that signals from sensors 6, 7 measuring temperature gradient and the signal from the sensor 5 for non-contact and/or contact measurement of motion velocity of strand 1 as well as image from interface of detector 8 are transmitted to image analyzer 9 and decision element 10.

The device for assessing technical condition of the surface of strands made of rubber or plastic comprises the following components:

- sensor with infrared detector 3 (digital or analog camera with optics);
- camera interface for image digitalization 8 (the so-called "frame interceptor");
- image analyzer 9 (usually a PC computer or integrated processor, e.g. DSP); (In some cases, all elements listed above are components of a single device known as the intelligent camera which, besides the image capturing system, comprises a processor function of which consists in "picking up" required information from the image without necessity to implement any external image processing device and the interface sending the generated information to other devices.)
- I/O (input/output) device or communication links (e.g. RS-232) used to send reports on the system operation results;
- a specialized source of temperature gradient 2 adapted to the system;
- sensors 6, 7 verifying the image obtained in analyzer 8;
- a program for image processing and detecting common features of images.
Patent claims

1. A device for assessing technical condition of the surface of strands made of rubber or plastic comprising temperature generator, temperature detector, interface, image analyzer, and a decision element characterized in that it has infrared detector (3) located over the examined structure of strand (1) at appropriate distance \( h \) and in an antireflection shield (4), whereas uniformity of the temperature gradient over the whole surface of the examined strand structure (1) is ensured by temperature generator (2) after which temperature sensors (6 and 7) are located.

2. A method of assessing technical condition of the surface of strands made of rubber or plastic characterized in that signals from sensors (6, 7) measuring the temperature gradient and the signal from the transducer (5) providing non-contact and/or contact measurement of velocity of motion of the strand (1) as well as the image from interface of detector (8) are transmitted to image analyzer (9) and decision element (10).
## A. CLASSIFICATION OF SUBJECT MATTER

INV. G01N25/72 G01N33/44

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC.

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data, INSPEC, COMPENDEX

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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