

SYSTEM AND METHOD FOR DETECTING ABNORMALITIES IN OBJECTS TRAVELING ALONG A TRACK

Field of the Invention

This invention relates to a system and method for detecting abnormalities in objects traveling along a track. In particular, the system and method is configured to detect any physical abnormalities in objects as the objects roll, revolve, slide and/or move along the track.

Summary of Prior Art

Movable steps and/or stairs, such as escalators or moving walkways, and such similar systems provide a way to quickly and conveniently transport people from one place to another. Such conveyors are ubiquitous transportation systems for passenger circulations and they are widely used in commercial buildings, airports, railway stations, and street to overhead bridges or underground tunnels etc. and may include vertical and/or horizontal conveyors.

Step rollers and/or step chain rollers that are located underneath such conveyor systems interconnect each of the steps in a continuous manner. Driven by a main drive shaft and their associated gears, the step rollers and step chain rollers move the steps along a predetermined path to transport passengers between locations. By controlling the direction of the step chains, the direction of the conveyors may then be controlled accordingly.

Because of their continuous motions, conveyors are prone to various internal failures, which may cause injury to passengers on or near the conveyor. It is of importance that such conveyor systems are properly maintained as it impacts millions of passengers daily, especially in large cosmopolitan cities. Such conveyor-related accidents can lead to injuries from mild sprains to fatal consequences. These accidents may be due to incorrect usage of the conveyor system by passengers, or due to inherent failures. The first cause can be addressed by educating passengers on the correct use of such conveyor system. The second cause, i.e. escalator failures, which is related to faulty conveyor system's parts such as steps, rollers, belt, balustrade, comb plate, brake and handrails are harder to detect as these parts are normally hidden within the system. Faults in these parts can lead to escalator failures such as a sudden stoppage, entrapments and broken or missing steps.

One of the main culprits for malfunctioning conveyors are de-bonded and/or cracked step rollers and/or step chain rollers. Although most conveyor systems typically schedule maintenance of the system's step rollers, such scheduled maintenance are unable to sufficiently and effectively ensure that the rollers of all conveyors are 100% fit for operation all

the time. While there are several existing systems which provide such safety control measures for conveyors that aim to accurately detect such faults, they have their drawbacks.

One method proposed by those skilled in the art would be use photoelectric sensors which use light or the interruption thereof to monitor the rollers of a conveyor. In such systems, a photoelectric beam of light is aligned to shine at the rollers as they pass by a point on the track. If a roller is de-bonded or cracked, the beam of light reflected will be altered and the control system then responds to the error. A disadvantage of such a scheme is that such photoelectric sensors have to be extremely sensitive to be able to detect minor cracks in rollers, and such cracks would have to be detected early on before catastrophic failure of the system occurs. Furthermore, such photoelectric sensors are susceptible to dust, debris, or anything else that may be present or that may collect in the system over time thereby interrupting the light paths.

For the above reasons, those skilled in the art are constantly striving to come up with a system and method that is able to detect faults and monitor conditions of steps rollers of conveyor systems in a continuous manner. Such a system and method is highly desirable and required to ensure the safety of the passengers travelling on the conveyor system.

Summary of the Invention

The above and other problems are solved and an advance in the art is made by systems and methods provided by embodiments in accordance with the invention.

A first advantage of embodiments of systems and methods in accordance with the invention is that the system is able to continuously detect abnormalities in objects that are traveling along a track such as the step rollers in conveyor systems.

A second advantage of embodiments of systems and methods in accordance with the invention is that the system is able to utilize either an accelerometer or a Fiber-Bragg-Grating sensor to continuously detect abnormalities in objects that are traveling along a track such as the step rollers in conveyor systems.

The above advantages are provided by embodiments of a method in accordance with the invention operating in the following manner.

According to a first aspect of the invention, a monitoring system for detecting abnormalities in objects traveling along a track is disclosed, the system comprising a sensor provided adjacent the track, the sensor configured to detect interactions between the objects and the track; a data acquisition module (DAQ) coupled to the sensor, the DAQ configured to:

receive signals generated by the sensor; normalize the received signals with baseline signals; and classify the objects as abnormal when periodic spikes are detected in the normalized signals.

With regard to the first aspect, the interactions between the objects and the track comprise vibrations generated when the objects interact with the track.

With regard to the first aspect, the classifying of the objects as abnormal by the DAQ comprises the DAQ being configured to: generate a threshold value based on the normalized signals, whereby periodic spikes that are less than the threshold value are removed from the DAQ.

With regard to the first aspect, the baseline signals comprise a baseline matrix R that is constructed by concatenating a baseline signal having a time-period P for N number of times.

With regard to the first aspect, before the DAQ normalizes the received signals with the baseline matrix R , the DAQ is configured to: divide the received signals into N number of blocks whereby each block comprises the time-period P , and whereby incomplete blocks are assigned values based on average values of the baseline matrix; and generate a signal matrix S by concatenating the divided received signals for the N number of times.

With regard to the first aspect, the normalizing the received signals with baseline signals comprises the DAQ being configured to: compute the energy difference between the signal matrix S and the baseline matrix R .

With regard to the first aspect, the generating of the threshold value based on the normalized signals comprises the DAQ being configured to: integrate the normalized signal over a time window t wherein the threshold value is set based on the integral result, and wherein the time window t comprises at least two of the time-periods P .

With regard to the first aspect, the normalizing of the received signals with the baseline signals comprises the DAQ being configured to: divide the received signals into N number of blocks whereby each block comprises a time-period P ; perform a Fast-Fourier Transform (FFT) analysis on each of the blocks of the received signals to convert the received signals in each block from a time-domain signal into a frequency-domain signal.

With regard to the first aspect, the sensor comprises an accelerometer and the DAQ comprises an accelerometer controller.

With regard to the first aspect, the sensor comprises a Fiber-Bragg-Grating (FBG) sensor and the DAQ comprises an FBG interrogator.

With regard to the first aspect, the sensor comprises a vibration or strain sensor, a proximity sensor and a module configured to acquire a windowed signal for individual rollers based on signals received from the vibration or strain sensor and the proximity sensor.

According to a second aspect of the invention, a method for detecting abnormalities in objects traveling along a track using a monitoring system comprising a sensor provided adjacent the track and a data acquisition module (DAQ) coupled to the sensor is disclosed, the method comprising: detecting, using the sensor, interactions between the objects and the track; receiving, using the DAQ, signals generated by the sensor; normalizing, using the DAQ, the received signals with baseline signals; and classifying, using the DAQ, the objects as abnormal when periodic spikes are detected in the normalized signals.

With regard to the second aspect, the interactions between the objects and the track comprise vibrations generated when the objects interact with the track.

With regard to the second aspect, the step of classifying of the objects as abnormal by the DAQ comprises the steps of: generating a threshold value based on the normalized signals, whereby periodic spikes that are less than the threshold value are removed from the DAQ.

With regard to the second aspect, the baseline signals comprise a baseline matrix R that is constructed by concatenating a baseline signal having a time-period P for N number of times.

With regard to the second aspect, wherein before the step of normalizing the received signals with the baseline matrix R , the method comprises the step of: dividing, using the DAQ, the received signals into N number of blocks whereby each block comprises the time-period P , and whereby incomplete blocks are assigned values based on average values of the baseline matrix; and generating, using the DAQ, a signal matrix S by concatenating the divided received signals for the N number of times.

With regard to the second aspect, the step of normalizing the received signals with baseline signals comprises the step of: computing the energy difference between the signal matrix S and the baseline matrix R.

With regard to the second aspect, the step of generating the threshold value based on the normalized signals comprises the step of: integrating, using the DAQ, the normalized signal over a time window t wherein the threshold value is set based on the integral result, and wherein the time window t comprises at least two of the time-periods P.

With regard to the second aspect, the step of normalizing the received signals with the baseline signals comprises the step of: dividing, using the DAQ, the received signals into N number of blocks whereby each block comprises a time-period P; performing, using the DAQ, a Fast-Fourier Transform (FFT) analysis on each of the blocks of the received signals to convert the received signals in each block from a time-domain signal into a frequency-domain signal.

With regard to the second aspect, the sensor comprises a strain sensor, a proximity sensor and an acquiring module, the method comprising the step of: acquiring, using the acquiring module, a windowed signal for individual rollers based on signals received from the strain and proximity sensors.

Brief Description of the Drawings

The above and other problems are solved by features and advantages of a system and method in accordance with the present invention described in the detailed description and shown in the following drawings.

Figure 1 illustrating a block diagram of modules in the monitoring system in accordance with embodiments of the invention;

Figure 2 illustrating a flowchart setting out the process for monitoring abnormalities in objects traveling along a track in a conveyor system in accordance with embodiments of the invention;

Figure 3 illustrating plots of a detected signals in accordance with embodiments of the invention including the plot when a cracked object in a conveyor system such as a cracked roller is detected;

Figure 4 illustrating plots of a detected signals in accordance with embodiments of the invention including the plot when an abnormal object in a conveyor system such as a de-bonded roller is detected;

Figure 5 illustrating plots of a detected signals in accordance with embodiments of the invention when a conveyor system is under normal operating conditions;

Figure 6 illustrating plots of a detected signals in accordance with embodiments of the invention when a conveyor system is under abnormal loads;

Figure 7 illustrating plots of a detected signals in accordance with embodiments of the invention including the plot when a de-bonded object in a conveyor system such as a de-bonded roller is detected;

Figure 8 illustrating the detection of an object and the capturing of signals based on the interaction of the object and a track in accordance with embodiments of the invention;

Figure 9 illustrating the acquisition of signals to define a time window to capture signals based on the interaction of the object and a track; and

Figure 10 illustrating a process for determining baseline signals and detecting abnormalities in accordance with embodiments of the invention.

Detailed Description

This invention relates to a system and method for detecting abnormalities in objects traveling along a track. In particular, the system and method is configured to detect any physical abnormalities in objects as the objects roll, revolve, slide and/or move along the track. In embodiments of the invention, the objects may comprise step rollers or rollers that are configured to revolve or move along a track in a conveyor system. However, one skilled in the art will recognize that the objects are not limited to such rollers only and may include any other types of objects that are configured to travel along a fixed track or rail.

The present invention will now be described in detail with reference to several embodiments thereof as illustrated in the accompanying drawings. In the following description, numerous specific features are set forth in order to provide a thorough understanding of the embodiments of the present invention. It will be apparent, however, to one skilled in the art, that embodiments may be realised without some or all of the specific features. Such embodiments should also fall within the scope of the current invention. Further, certain process steps and/or structures in the following may not been described in detail so as to not obscure the present invention unnecessarily.

One skilled in the art will also recognize that certain functional units in this description may have been labelled as modules throughout the specification. The person skilled in the art will recognize that a module may be implemented as circuits, logic chips or any sort of discrete component. The choice of the implementation of the modules is left as a design choice to a person skilled in the art and does not limit the scope of this invention in any way.

An exemplary process or method for detecting abnormalities in objects traveling along a track in accordance with embodiments of the invention is set out in the steps below.

Step 1: detect, using a sensor provided adjacent a track, interactions between objects and a track;

Step 2: receiving, using a data acquisition module (DAQ) coupled to the sensor, signals generated by the sensor;

Step 3: normalizing, using the DAQ, the received signals with baseline signals;

Step 4: classifying, using the DAQ, the objects as abnormal when periodic spikes are detected in the normalized signals and optionally, classifying the objects as normal when periodic spikes are not detected in the normalized signals.

In accordance with embodiments of the invention, the steps set out above may be performed by the modules and components illustrated in Figure 1. As illustrated, the monitoring system comprises objects 110 with abnormal object 125 that are configured to travel along tracks 112a and/or 112b, a sensor 115 connected to a data acquisition module (DAQ) 105 through line 120 whereby sensor 115 is configured to detect interactions between objects 110 and tracks 112a and/or 112b. The interactions between objects 110 and tracks 112a and/or 112b may comprise objects 110 rolling along, sliding along, revolving along, or any other similar motion, along these tracks. As these interactions take place, vibrations, sounds, and/or heat may be generated by objects 110 and/or tracks 112a/b and depending on the type of interaction that is to be detected, DAQ 105 and sensor 115 may be selected accordingly.

A process performed by a computation/signal processing device such as, but not limited to, DAQ 105 may be used to detect abnormalities in objects 110 as objects 110 travel along tracks 112a/b as illustrated in Figure 2. Process 200 begins at step 205 with process 200 calibrating a sensor system connected to DAQ 105. In embodiments of the invention, the sensor system comprises a sensor that is provided adjacent objects 110 and tracks 112a/b. During this calibration process, process 200 will generate baseline signals based on the interactions between the objects 110 and tracks 112a/b whereby these baseline signals are signals that represent the normal operation of objects 110 with tracks 112a/b.

Once this is done, process 200 proceeds to step 210 whereby it continuously acquires data from the sensor system. This data is then used to generate normalized signals at step 215. If process 200 determines at step 220 that periodic abnormalities exist in the normalized signals, process 200 then proceeds to step 230 whereby it determines that one or more of objects 110 is faulty. Conversely, if process 200 determines that periodic abnormalities do not exist in the normalized signal at step 220, process 200 then proceeds to step 225 whereby it determines that all the objects in object 110 are normal. Process 200 then ends.

Embodiment 1: A monitoring system comprising a DAQ, a Fibre-Bragg-Grating (FBG) interrogator and a FBG sensor.

In accordance with embodiments of the invention, the DAQ comprises a FBG interrogator such as, but not limited to, the Micron Optics SM130 whereby its sampling frequency is set as 1 kHz while the FBG sensor(s) comprises the Technica S.A. Acrylate Fibre FBG. The FBG sensor(s) may be mounted via, epoxy mounting or wax mounting to one or more of the tracks as required. Further, the FBG sensors are connected to the FBR interrogator through optical fibres. In this embodiment of the invention, objects 110 are taken to be the step rollers in a conveyor system while tracks 112a/b comprise the rails of the system. One skilled in the art will recognize that the conveyor system may comprise a traveller, an escalator or any form of movable horizontal/diagonal/vertical walkway.

As the rollers move along the rail, the interactions between the rollers and the rail generate vibrations. These vibrations may be detected as changing wavelengths by the FBG sensors.

During a calibration step, a baseline measurement is conducted for a conveyor system that is operating normally. This baseline measurement which was obtained using the FBG sensor and the FBG interrogator is then used as a reference/baseline signal for the conveyor system. The baseline signal is then stored as a baseline matrix R that is constructed by concatenating the baseline signal having a time period P for N number of times, i.e. $R: R_1=R_2=\dots=R_N$ where the time period P is a characteristic value of the conveyor system, and is obtained when the conveyor system is in operation. Such a baseline measurement is illustrated as plot 302 in Figure 3.

Subsequently, measurements were carried out on defective rollers having cracked and/or de-bonded rollers to generate the received signals. It should be noted that as the conveyor continuously adjusts its speed, the moving parts inside the conveyor will adjust its speed accordingly, e.g. the rollers, chains etc. will adjust their speeds. As a result, the received signals may not be directly compared to the baseline matrix R . To address this, the received

signal is initially divided into N blocks, i.e. $S_1, S_2, \dots, S_N$ where each block corresponds to a signal having a time period P . Due to this division, there is the likelihood that the first block and the final block would be incomplete, as these blocks would be less than one period P in length. Hence, these incomplete blocks will be assigned values based on the average values of the baseline matrix. The blocks $S_1, S_2, \dots, S_N$ are then concatenated to form a signal matrix S . Such a received signal is illustrated as plot 304 in Figure 3.

The signal matrix S is then normalized with the baseline matrix R by computing the energy difference between these two signals. In embodiments of the invention, the energy difference is obtained by the following equation: $|S-R|$. Once the signal matrix S has been normalized, the normalized signal is then analysed for periodic spikes. Such a normalized signal is illustrated as plot 306 in Figure 3 whereby it was found that periodic spikes 310 are present in the normalized signal implying that the detected roller contains defects.

In embodiments of the invention, in order to correct the misalignment of signals in the normalization process, the normalized signal is integrated over a time window t and the resulting threshold value I_{th} is used to identify signal spikes in the normalized signal whereby normalized signal spikes that are equal to or above the threshold value, I_{th} , are considered as strong signal spikes and logged as a new data set for further processing. Otherwise, when the normalized signal spikes are less than the threshold value, I_{th} these signals are considered as weak signals and will not be logged for further processing. Such a threshold value I_{th} is plotted as line 315 in Figure 3. The logged data set will then be checked for periodicity relative to a complete period of rotation of the conveyor system. If no periodicity of signal spikes are detected in the logged data set, this means that a defective roller has not been detected. Otherwise, if the logged data set comprises periodically recurring signals (such as spikes 310) relative to the conveyor period, this implies that a defective roller is present.

Hence, it can be said that when abnormalities in the rollers are detected, the normalised signal $|S-R|$ would have peaks that occur periodically relative to the period of the conveyor. In embodiments of the invention, the threshold value may be used to set the minimum value of the recurring spikes that is to be logged.

The plots in Figure 4 illustrate the plots that are used to determine whether the rollers in the conveyor system comprise de-bonded rollers. In particular, plot 402 represents the baseline plot, plot 404 represents the plot of the received signal and plot 406 represents the normalized received signal. As plot 406 shows a number of periodically occurring signal peaks 410, this implies that the received signals associated with the rollers in the conveyor system comprise de-bonded rollers.

As a reference, the plots in Figure 5 illustrate the plots that are obtained when a normal roller is used in the system. In particular, plot 502 represents the baseline plot, plot 504 represents the plot of the received signal and plot 506 represents the normalized received signal. As plot 506 only shows a single signal peak 510, i.e. there are no periodically occurring signal peaks, this implies that the received signal associated with the rollers in the conveyor system comprise normal rollers.

Additionally, it should be noted that non-periodically occurring signal peaks could be caused by factors such as passengers or objects that are loading the conveyor system, or noise from neighbouring conveyor systems. The plots in Figure 6 illustrate such a scenario whereby plot 602 represents the baseline plot, plot 604 represents the plot of the received signal and plot 606 represents the normalized received signal. As plot 606 shows two randomly occurring groups of signal peaks 610a and 610b, this implies that the received signal associated with the rollers in the conveyor system comprise normal rollers and the variation in the normalized received signal is due to the loading of the conveyor system or noise from other external sources that were detected by the FBG sensors.

Embodiment 2: A monitoring system comprising a DAQ, an accelerometer controller and an accelerometer.

In accordance with embodiments of the invention, the DAQ comprises an accelerometer controller and accelerometer(s) that may be mounted via, epoxy mounting or wax mounting to the bottom of one or more of the tracks as required. One skilled in the art will recognize that the accelerometer may comprise any device that is able to measure acceleration and may include, and is not limited to, a microelectromechanical system (MEMS) accelerometer. Further, the accelerometers may be connected to the accelerometer controller through electrical cables or any other type of cables that may be configured to transfer data from the accelerometers to the controller. In this embodiment of the invention, objects 110 are similarly taken to be the step rollers in a conveyor system while tracks 112a/b comprise the rails of the system. One skilled in the art will recognize that the conveyor system may comprise a traveller, an escalator or any form of movable horizontal/diagonal/vertical walkway.

As the rollers move along the rail, the interactions between the rollers and the rail generate vibrations. These vibrations may be detected as data logged in the time domain by the MEMS sensors.

During a calibration step, a baseline measurement is conducted for a conveyor system that is operating normally. This baseline measurement which was obtained using the

accelerometer and the accelerometer controller is then used as a reference/baseline signal for the conveyor system to compute the threshold values for the system.

Subsequently, measurements were carried out on defective rollers having de-bonded rollers to generate the received signals. The signals received from the accelerometers are logged in time domain as illustrated in plots 705 and 710 of Figure 7 whereby plot 705 is an expanded view of a period in plot 710.

A Fast-Fourier-Transform (FFT) is then applied to the received signals plotted in plot 710 and the resulting frequency domain signals are plotted over a time domain as plot 715. The frequency domain signals are then analysed for periodic spikes and as it was found that periodic spikes 720 are present in plot 715, this implies that the detected roller contains defects.

Figure 8 illustrates an expanded view of rollers 805 as configured in both embodiments of the monitoring system. In particular, Figure 8 shows that when a roller 810 of rollers 805 passes sensor 815 (which may be an accelerometer or FBG sensor), the vibrations generated between roller 810 and track 813 may be captured as signals by sensor 815.

Figure 9 illustrates the signal acquisition steps performed by the monitoring system in accordance with embodiments of the invention by which the strain/vibration signal for each roller is cut into windows based on the timing of the roller passing by the sensor. As illustrated, at step 940, the roller track is set up to sense signals from the track. At step 935, a strain/vibration sensor picks up the continuous strain/vibration signal and this signal is stored at step 930. In embodiments of the invention, the strain sensor may comprise a strain gauge or any other type of device that may be used to measure strain on an object. At the same time as step 940, a proximity sensing point provided with a proximity sensor is configured to detect a proximity signal at step 905 and this signal is used to indicate the timing of the movement of the conveyor's steps. The proximity signal is stored at step 910 and at step 915, the timing of each roller passing by the track's sensing point is stored so that it can be derived at step 920, which may or may not take the average step running speed into account. The derived timing of each roller as obtained from step 920 is then provided to step 925 which uses this information to cut the continuous vibration signal obtained at step 930 into fixed time windows for each specific roller and this happens at step 925.

Figure 10 illustrates the process 1005 of conducting roller condition data calibration and the process 1010 of roller condition monitoring as performed by the monitoring system in accordance with embodiments of the invention. Process 1005 is conducted when the rollers are in normal condition, e.g. after replacing new rollers, and only need to be done once. As for

process 1010, this process is conducted continuously when the conveyor is in actual operation and being monitored.

For process 1005, it is assumed that the conveyor runs at a specific direction and speed, e.g. upwards in normal speed, for N loops. Each loop is defined as the time it takes one specific conveyor step to travel a complete cycle. The signal acquisition for the roller data calibration process begins at step 1010 using an acquiring module to acquire the signal whereby the signal (strain/vibration) is obtained in a fixed time window for each individual roller S^R_N at step 1015, which consists of $R \times N$ windowed signals where R is the total number of rollers in one loop.

In other words, each roller r ($1 \leq r \leq R$) comprises N acquired signals S^r_n , ($1 \leq n \leq N$). The features are extracted from the signals at step 1020 which performs a time frequency decomposition at this step. At step 1025, the features obtained from step 1020 are stored as $R \times N$ features F^R_N . In accordance with embodiments of the invention, a time frequency decomposition method that may be utilized involves the calculation of the short time interval Fourier transformation, which produces a spectrogram of the windowed signal. The N features stored at step 1025 for each roller is then used to estimate a model G^R for the normal condition of that roller and this takes place at step 1030. In embodiments of the invention, the model may comprise a statistical normalized distribution model $G(\mu, \sigma^2)$, where μ and σ^2 are the mean and variance of the N values. Hence, once step 1030 has ended, each of the R rollers would be associated with a statistical model G^r where ($1 \leq r \leq R$).

In the roller condition monitoring process 1010, the conveyor runs at a same direction and speed as in the calibration process 1005, such that the signals acquired from the two processes are comparable. The number of loops K may or may not be the same as N , as in the calibration process. Process 1010 begins at step 1055 by acquiring the signal using an acquiring module.

Similar to process 1005, the signal is obtained in a fixed time window for each individual roller S^r_k at step 1050, which consists of $R \times K$ windowed signals where R is the total number of rollers in one loop. In other words, each roller r ($1 \leq r \leq R$) comprises K acquired signals S^r_k ($1 \leq k \leq K$). The features are extracted from the signals at step 1045 which performs a time frequency decomposition at this step. In accordance with embodiments of the invention, a time frequency decomposition method that may be utilized involves the calculation of the short time interval Fourier transformation, which produces a spectrogram of the windowed signal. At step 1040, the features obtained from step 1045 are stored as $R \times K$ features F^R_k . Additionally, at step 1440, the K feature vectors F^R_k are compared to the statistical model G^R for each roller, which produces a distance D^r ($1 \leq r \leq R$). The distance computation relies on

the mean and variance values. By setting a threshold of D^R at step 1060, the detection of faulty rollers may be performed at step 1065. By analysing the trending of D^R at step 1070, process 1010 is able to predict roller conditions at step 1075 and this is done based on the rate of degradation if sufficient amount of experiment data are available.

Numerous other changes, substitutions, variations and modifications may be ascertained by the skilled in the art and it is intended that the present invention encompass all such changes, substitutions, variations and modifications as falling within the scope of the appended claims.

CLAIMS:

1. A monitoring system for detecting abnormalities in objects traveling along a track, the system comprising:
 - a sensor provided adjacent the track, the sensor configured to detect interactions between the objects and the track;
 - a data acquisition module (DAQ) coupled to the sensor, the DAQ configured to:
 - receive signals generated by the sensor;
 - normalize the received signals with baseline signals that represent normal operation of the objects along the track; and
 - classify the objects as abnormal when periodic spikes are detected in the normalized signals.
2. The monitoring system according to claim 1 whereby the interactions between the objects and the track comprise vibrations generated when the objects interact with the track.
3. The monitoring system according to claim 1 wherein the classifying of the objects as abnormal by the DAQ comprises the DAQ being configured to:
 - generate a threshold value based on the normalized signals, whereby periodic spikes that are less than the threshold value are removed from the DAQ.
4. The monitoring system according to claim 1 wherein the baseline signals comprise a baseline matrix R that is constructed by concatenating a baseline signal having a time-period P for N number of times.
5. The monitoring system according to claim 4 wherein before the DAQ normalizes the received signals with the baseline matrix R , the DAQ is configured to:
 - divide the received signals into N number of blocks whereby each block comprises the time-period P , and whereby incomplete blocks are assigned values based on average values of the baseline matrix; and
 - generate a signal matrix S by concatenating the divided received signals for the N number of times.
6. The monitoring system according to claim 5 wherein the normalizing the received signals with baseline signals comprises the DAQ being configured to:
 - compute the energy difference between the signal matrix S and the baseline matrix R .

7. The monitoring system according to claim 3 wherein the generating of the threshold value based on the normalized signals comprises the DAQ being configured to:
 - integrate the normalized signal over a time window t wherein the threshold value is set based on the integral result, and wherein the time window t comprises at least two of the time-periods P .
8. The monitoring system according to claim 1 wherein the normalizing of the received signals with the baseline signals comprises the DAQ being configured to:
 - divide the received signals into N number of blocks whereby each block comprises a time-period P ;
 - perform a Fast-Fourier Transform (FFT) analysis on each of the blocks of the received signals to convert the received signals in each block from a time-domain signal into a frequency-domain signal.
9. The monitoring system according to claim 1 wherein the sensor comprises an accelerometer and the DAQ comprises an accelerometer controller.
10. The monitoring system according to claim 1 wherein the sensor comprises a Fiber-Bragg-Grating (FBG) sensor and the DAQ comprises an FBG interrogator.
11. The monitoring system according to claim 1 wherein the sensor comprises a vibration or strain sensor, a proximity sensor and a module configured to acquire a windowed signal for individual rollers based on signals received from the vibration or strain sensor and the proximity sensor.
12. A method for detecting abnormalities in objects traveling along a track using a monitoring system comprising a sensor provided adjacent the track and a data acquisition module (DAQ) coupled to the sensor, the method comprising:
 - detecting, using the sensor, interactions between the objects and the track;
 - receiving, using the DAQ, signals generated by the sensor;
 - normalizing, using the DAQ, the received signals with baseline signals that represent normal operation of the objects along the track; and
 - classifying, using the DAQ, the objects as abnormal when periodic spikes are detected in the normalized signals.

13. The method according to claim 12 whereby the interactions between the objects and the track comprise vibrations generated when the objects interact with the track.
14. The method according to claim 12 wherein the step of classifying of the objects as abnormal by the DAQ comprises the steps of:
 - generating a threshold value based on the normalized signals, whereby periodic spikes that are less than the threshold value are removed from the DAQ.
15. The method according to claim 12 wherein the baseline signals comprise a baseline matrix R that is constructed by concatenating a baseline signal having a time-period P for N number of times.
16. The method according to claim 15 wherein before the step of normalizing the received signals with the baseline matrix R , the method comprises the step of:
 - dividing, using the DAQ, the received signals into N number of blocks whereby each block comprises the time-period P , and whereby incomplete blocks are assigned values based on average values of the baseline matrix; and
 - generating, using the DAQ, a signal matrix S by concatenating the divided received signals for the N number of times.
17. The method according to claim 16 wherein the step of normalizing the received signals with baseline signals comprises the step of:
 - computing the energy difference between the signal matrix S and the baseline matrix R .
18. The method according to claim 14 wherein the step of generating the threshold value based on the normalized signals comprises the step of:
 - integrating, using the DAQ, the normalized signal over a time window t wherein the threshold value is set based on the integral result, and wherein the time window t comprises at least two of the time-periods P .
19. The method according to claim 12 wherein the step of normalizing the received signals with the baseline signals comprises the step of:
 - dividing, using the DAQ, the received signals into N number of blocks whereby each block comprises a time-period P ;

performing, using the DAQ, a Fast-Fourier Transform (FFT) analysis on each of the blocks of the received signals to convert the received signals in each block from a time-domain signal into a frequency-domain signal.

20. The method according to claim 12 whereby the sensor comprises a strain or vibration sensor, a proximity sensor and an acquiring module, the method comprising the step of:
- acquiring, using the acquiring module, a windowed signal for individual rollers based on signals received from the strain or vibration sensor and the proximity sensor.