Claims

1. Handrail tension monitoring device (41) for a passenger transport system (1) designed as a moving walkway or escalator, the handrail tension monitoring device (41) comprising at least a distance sensor (34) and a signal processing unit (47) and the measurement signals (M) detected by the distance sensor (34) being able to be processed and evaluated in the signal processing unit (47), **characterized in that** the vibration frequency (f) of a scanned handrail (15) of the passenger transport system (1) can be determined in the signal processing unit (47) from the signal curve (MV) of the measurement signals (M) and the determined vibration frequency (f) can be compared to at least one lower threshold value (US) and/or upper threshold value (OS), an alarm signal (Z) being generated if the lower threshold value (US) is not reached and a warning signal (W) being generated if the upper threshold value (OS) is exceeded.

2. Handrail tension monitoring device (41) according to claim 1, wherein said device comprises a holder (37) which can be mounted on a stationary component (81) of the passenger transport system (1), wherein the holder (37) is designed such that in the operating state of the handrail tension monitoring device (41), the distance sensor (34) thereof is directed, in a freely suspended region (51) of the handrail (15), against a hand support surface (83) or against a rear side (85) of the handrail (15).

3. Handrail tension monitoring device (41) according to claim 2, wherein the holder (37) has adjustment means (73, 75) for aligning the distance sensor (34) relative to the hand support surface (83) or to the rear side (85) of the handrail (15).

4. Handrail tension monitoring device (41) according to any of claims 1 to 3, wherein the distance sensor (34) is a TOF camera, an infrared distance sensor, a laser distance sensor, an ultrasonic sensor with transit time detection, or a radar sensor.

5. Handrail tension monitoring device (41) according to any of claims 1 to 4, wherein the signal processing unit (47) is implemented in the distance sensor (34), in a controller (19) of the passenger transport system (1), or in a data cloud (95).

6. Handrail tension monitoring device (41) according to any of claims 1 to 5, wherein the alarm signal (Z) and/or warning signal (W) can be transmitted to a controller (19) of the passenger transport system (1) and as a result the driving operation of the passenger transport system (1) can be influenced.

7. Handrail tension monitoring device (41) according to any of claims 1 to 6, wherein said device has communication means (89) or can be connected to communication means (89) via which at least the detected signal curve (MV) of the measurement signals (M) can be transmitted to a digital twin data record (101) of the passenger transport system (1).

8. Passenger transport system (1) having at least one handrail tension monitoring device (41) according to any of claims 1 to 7.

9. Method for processing and evaluating measurement signals (M) of a handrail tension monitoring device (41) according to any of claims 1 to 7, characterized in that in the signal processing unit (47), the vibration frequency (f) of the scanned handrail (15) is determined from the signal curve (MV) of the measurement signals (M) and the determined vibration frequency (f) is compared with at least one lower threshold value (US) and/or upper threshold value (OS), an alarm signal (Z) being generated if the lower threshold value (US) is not reached and a warning signal (W) being generated if the upper threshold value (OS) is exceeded.

10. Method according to claim 9, wherein in order to verify the vibrating frequency (f), a number of successive amplitude heights (H) of the vibrating handrail (15) are determined from the signal curve (MV) of the measurement signals (M) and said amplitude heights are compared with a height limit value (HG) and a number limit value (n).

11. Method according to either claim 9 or claim 10, wherein the detected signal curve (MV) is transmitted to a digital twin data record (101) of the passenger transport system (1) and the effects of the vibrating handrail (15) on other components of the passenger transport system (1) are determined by means of static and dynamic simulations using the digital twin data record (101).

12. Method according to any of claims 9 to 11, wherein the threshold values (OS, US) are established depending on the direction of travel.