A wearable system for Work at Height Safety Management

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Motivation

- Explore the use of IoT wearables to improve safety for overhead lines workers

- Improve safety management in the absence of incidents or accidents

- Spanish TSO goal to become zero accidents group

Method/Approach

- Works at heights are normally carried out according to very detailed procedures
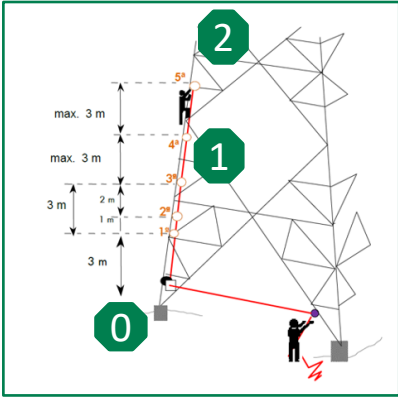
- System to monitor that worker behavior and the use of PPEs is carried out according to the safety procedure

Objects of investigation

- Initial comparison between CNNs and IMUs as most suitable technologies

- IMUs attached to PPEs are considered the best option to monitor safe behavior or misuse of PPEs


Sensor attached to safety body harness

Sensor attached to temporary anchor device

Sensor attached to mobile fall arrester

Sensor attached to safety rope

Experimental setup and test results

- A worker is equipped with standard PPEs with at least 7 sensors each one consisting of 3 axis Accelerometer, 3 axis Gyroscope, Barometer and Bluetooth radio

- Data from sensors is collected by a validation application.
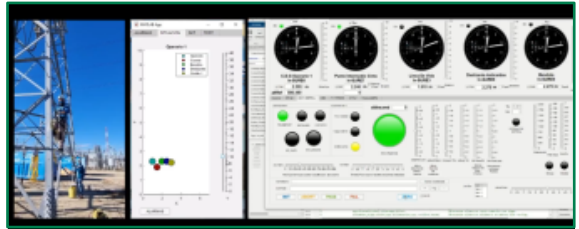
- From the video above, system detects correct use of PPEs as per safety protocol

Discussion

- Tests confirm correct tracking of PPEs and compliance with safety procedures

- Example of tracking and supervision of temporary anchors installation
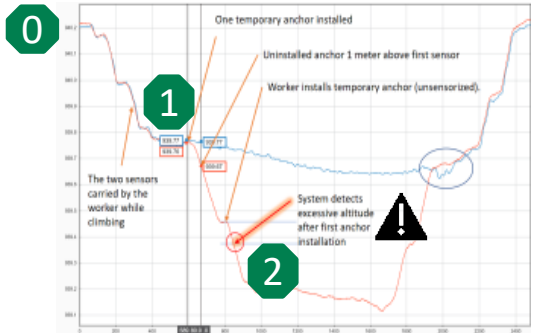
- Violations of safety procedures are detected and reported far beyond the detection capabilities of a ground visual supervisor, 30 or 40 meters away from the workers

Conclusion

- System has successfully detected safety protocol violations

- Real-time alarms capability to alert workers of unsafe situations

- Capture information normally not available to Health and Safety Managers

- Safety training improved based on actual data coming from the wearable system

http://www.cigre.org
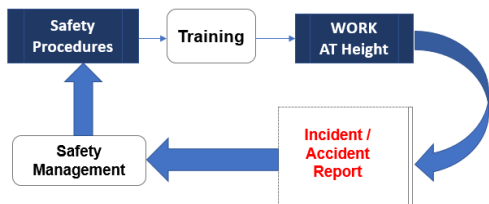
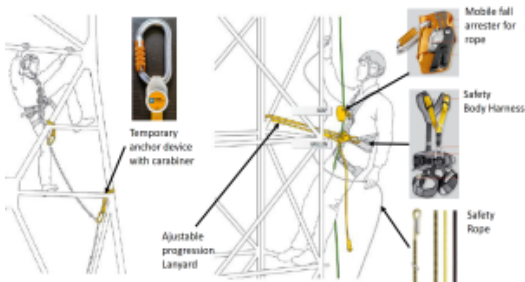# A wearable system for Work at Height Safety Management

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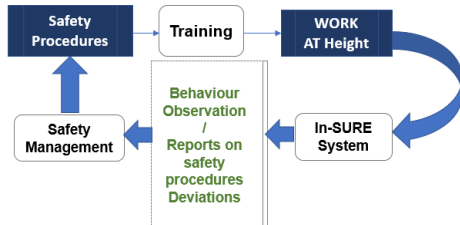
Safety Management Today: incident driven

- Continuous training
- Training modifications triggered by incidents or accidents

Proposed sensorization of PPEs

Examples of PPEs sensorization

Accelerations measured on PPEs

- Signal to Noise Ratio is enough for robust detection of PPEs states

Algorithms: Kalman Filtering

- For worker tracking during ascension
- For PPEs tracking
- For sensor fusion
    - e.g. Barometer an acceleration fusion for fast and precise altitude detection
- For maneuver detection
    - e.g. Fast detection of worker stops during ascension

Safety Management Improvement: workers behavior driven

- Continuous training
- Training fine-tuned triggered by system detection of:
    - Safety procedural deviations
    - Misuse of PPEs
    - Behavioral observations
- No need for an actual incident or accident to occur to improve safety procedures

Algorithms: State Machines

- Intermediate anchor point states and transitions example

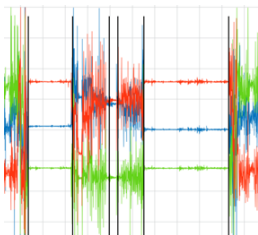## Algorithms: Hilbert transform

- Detects Accelerations in quadrature
- Used for detection of the process of Intermediate anchor points installation.

Intermediate anchor point, Pigtail type

- Insertion of safety rope detected by Hilbert transformed accelerations