Exhaust air monitoring sensor ("noxsenor")
Installation, operation and maintenance

Purpose

The exhaust air sensor is designed to monitor the function of the exhaust air system and to send an alarm signal in case of emergency. The occurrence of NOx gas / nitrous gas with typical orange-red color in the exhaust air or a failure of the fan in the exhaust air system is reported as an emergency. Due to its resistance, the highly corrosive and caustic gases in the exhaust air duct do not harm the sensor.

Usage

The device operates on the plug-and-play principle. As soon as the RPI is supplied with power, the automatic monitoring program starts. For more information, see the *Internal Processes* chapter.

Deployment requirements

- Raspberry Pi computer as central controller
- Color sensor module: TCS3200 (data sheet)
- Magnetic switch / reed module ("fan sensor"): KY-021
- a strong magnet for fan flap
- (optional) white background for better color recognition
- transparent window to exhaust air duct
- housing
- complete circuit
- internet connection via Wi-Fi
- power connection

Installation

0. For software maintenance, a developer must do an on-site update. For a connection to the Raspberry Pi (RPI) the login data is needed and an active internet connection in the customer's network. Connections can be established via VNC and SSH protocol. A private repository token is required for updates from the secured Git repository.
1. The RPI is delivered with the necessary software.
2. Wi-Fi connection can be set up in advance (wpa_supplicant.conf) or on site by a developer.
3. The contact list is customized for the customer and if necessary, also the email messages. Thus, the right information is sent to the right people in case of emergency.
4. Physical environment is set up on site during assembly (power and Wi-Fi - access, mount device with view of exhaust air).
5. Test setup: Run both scripts to verify assembly.

Internal processes

Processes in chronological order:

- START: Exhaust air sensor is supplied with power.
- RPI turns on automatically
- RPI connects to the Internet
- Cronjob starts 4 processes:
    1) Logging functionality is provided. (This writes down what is happening in the program).
    2) An email is sent to the saved customer addresses to report that the sensor is active.
    3) An email is sent to the developer with the current network data (IP, SSID - network name).
    4) Monitoring is started by launching two Python scripts (tcs3200.py and monitor-ventilator.py) and running them in parallel without interruption. These two programs are logged and can be read with a time delay.
- The Linux service *logrotate* ensures that the log files are rotated at regular intervals.

NOx gas sensor monitoring (tcs3200.py):

The color sensor now lights up and measures the color of its environment every second. More information about the sensor can be found [HERE](). As an alarm signal, an e-mail is sent to the persons concerned.

1. In the first 10 seconds the normal color of the environment is registered and stored as default value.
2. The following color measurements are calibrated using these default values. Thus, normal lighting conditions cannot affect the measurement, as they are "filtered".
3. Every 24 hours a new measurement of the standard values is performed, and the discoloration / wear of the plexiglass pane is measured. If the wear is too high, an alarm signal is sent. In this case, maintenance is necessary. More about this in the chapter *Maintenance*.
4. During the color measurements each second, the relative red content is determined. It is noted if this is too high, and these notes are counted.
5. If no high red content is detected for 10 seconds, the counter is reset.
6. If the number of high red content indications exceeds 30, a NOx gas emergency is signaled, and an alarm signal is sent out.
7. In the event of such an emergency, alarm emails will be sent every 15 minutes until the colored gas is no longer detectable.
8. The exhaust sensor simply continues to run after that and does not require any manipulation.

CAUTION: At each restart, the exhaust sensor detects and remembers the wear of the plexiglass window as a normal condition. If the window is too worn, the measurement will be distorted.

Fan operation Sensor monitoring (monitor-ventilator.py):

1. Monitoring of the fan function starts as soon as the fan is switched on.
2. The airflow pushes the flap with the magnet close to the sensor.
3. The sensor detects the magnetic field and notices that the flap is nearby. Thus, it knows that air is flowing through the exhaust system. More information about the sensor can be found [HERE](#).
4. If the damper moves away from the sensor for more than 60 seconds, an alarm signal is sent, and it is assumed that the fan has been switched off or has malfunctioned.
5. The sensor will not become active again until the fan is running, and the airflow pushes the damper towards it.

NOTICE: Every time the fan is turned off (when the exhaust sensor is powered), exactly one alarm email is sent. The exhaust sensor requires no manipulation and simply continues to run after an alarm.

Maintenance

Maintenance case: Plexiglas window pane

If the window pane of the exhaust air sensor housing is discolored, dirty, worn, or the view is otherwise impaired, it must be replaced.

Maintenance case: Contact change

If the list of alarm contacts needs to be updated or other changes to the e-mail alarm system are required, a developer on the same network must make the changes in the program code.

Additional links

- [TCS3200 data sheet](#)
- [KY-021 Information](#)