Problem solutions 3

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1 Solutions

Exercise 1:

The duty cycle would be:

Table 1: Duty cycle

Second (s)	Action
0	Measure temperature and humidity, suddently start and wake up MOX.
4	Operate LSP.
5	MOX and LSP are now heated. Calibrate sensors.
6	Measure LSP and MOX, then start MOX sleeping cycle.
16	MOX in sleep mode, end of the cycle.

It is important to measure temperature and humidity before MOX starts, to avoid the surrounding air to be heated up by that sensor, which has to reach high temperatures.

Exercise 2:

Table 2: Sensor classification (1)

Name	Category
Temperature (thermometer)	Passive, contact (air), non-visual, exteroceptive.
Temperature (camera)	non-contact, proprioception, visual, active
Relative humidity	Passive, contact (soil), non-visual, exteroceptive.
Air pressure	Passive, contact (air), non-visual, exteroceptive.
Gas and particulate matter (IR)	non-contact, proprioception, visual, active

Duty cycle

Table 3: Sensor classification (2)

Name	Category
Infrared	Non-contact, proprioception, visual, active.
Sound	Exteroceptive, passive, contact (sound waves), non-visual.

1. We use a photoacustic CO sensor (does not require calibration), a MOX sensor for NO_2 and a LSP sensor for the particulate matter. We have a similar duty cycle as that of task 1.

Table 4: Duty cycle

Time	Action
0	Measure temperature and humidity and air pressure, then wake up MOX.
4	Operate LSP for 1s, measure temperature, humidity and air pressure.
5	MOX and LSP are now heated. Calibrate sensors.
5	Shut down temperature, humidity and air pressure.
6	Measure LSP, MOX and CO.
6	Start MOX sleeping cycle and shut down LSP, CO sensor.
16	MOX, LSP in sleep mode. Check values, compute and save next wake up time.

In the last step, if the values are under the threshold value, the sensors are reactivated the next ten minutes in this case, the cycle will last 10 minutes, plus time to warm up MOX. If not, the sensors are reactivated in two minutes.

2. The criticality of recording cow moves, is that we could have noisy recordings due to other agents moving in the environment. For this we should use the IR to detect movement, and the noise detector to check, if the moved agent is the desired animal.
The passive infrared sensors are always on and located in strategic locations, similarly as is done for burglar alarms. Ideally they should cover all the area where the animals pass. After one IR sensor is triggered, the nearest sound sensor is awaken and starts recording to establish if the desired animal passed near the sensor. Between 10PM and 5AM, the device should not trigger, if the IR detects another movement and the last registration was recorded less than 10 minutes ago.

Pipeline

(a) The input are the IR sensor trigger, which wakes up the sound sensor that records the noise, inferences the sound by classifying it with the know data of possible sounds and returns a Boolean value.

(b) Classification, since the given data is trained on a high-end computer and then we deploy the knowledge on a low-end system, which matches a recording against the model.

(c) Various sounds of the animals can be recorded in the preceding months and those could be edited at computer to introduce common atmospheric agents. We can then train a model using an unsupervised network that matches our recordings against known sounds of that animal.

(d) We could use a Bayesian network to establish a probability that the sound matches the given data. Implementing a more sophisticated neural network or a vector machine would be hard, due to the reduced size of the device and of the difficulty to use a internet connection in a forest.

Exercise 3:
Analyzing [Lu+09].

Ground data pre-collected and classified data is used from third-party sources. As reported, "SoundSense leverages the existing body of work on acoustic signal processing and classification (e.g., [24] [34] [21] [14]) and takes a systems design approach to realizing the first such system for a mobile phone".

Metrics First, the sound is classified and as one of the three category: voice, music and ambient sound. Second, in case of voice and music, the system can do a finer discrimination. Third, the agent learns in an unsupervised way the ambient sound. SoundSense does not aim to identify all the sound, instead, it aims to identify only the most useful sounds. When SoundSens detects a new sound, it prompts the user to label this sound, asking to provide a textual description.

Improvements **Labeling** The labeling process proposed is not perfect, since the implementation is left to the OS manufacturer.

Microphone as mentioned by the article, the microphone recordings become inaccurate when it's obstructed, for instance when the phone is in the pockets. One solution can be using external microphones, such as the one of headset or of the linked smart assistant. The analysis part of the article could be extended when using one of these auxiliary devices. Another problem is the limited microphone on smartphone, which is designed for human voices and not for ambient sounds. Hopefully, modern smartphone can integrate ambient microphones.

Potential risks If misused or in case of data breaches from the smartphone, this system could leak sensitive information. It is important that it is implemented in the OS alongside appropriate security features.

References

[Lu+09] Hong Lu et al. "SoundSense: Scalable Sound Sensing for People-Centric Applications on Mobile Phones". In: *Proceedings of the 7th International Conference on Mobile Systems, Applications, and Services*. MobiSys '09. Kraków, Poland: Association for Computing Machinery, 2009, pp. 165–178. ISBN: 9781605585666. DOI: `10.1145/1555816.1555834`. URL: `https://doi.org/10.1145/1555816.1555834`.