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Ambient intelligence assignment 2

1/ For each discussion topic outlined above, write a short paragraph (minimum 5 Word-like lines) summarising your beliefs.

T1/ From a conceptual standpoint, what are the major implications in using ‘standard’ or ‘event-based’ cameras on the data flow, i.e., data acquisition, processing, inferences?

Event cameras output an asynchronous stream of events triggered by changes in scene illumination. Each pixel stores a reference brightness level, and at each step compares it to the current level of brightness. If the difference in brightness exceeds a threshold, that pixel generates data.

Advantages in using this kind of device are that we reduce power, data storage and computational requirements.

Disadvantages may be the difficulty to pick up small motions, if the brightness change does not exceed a threshold. Moreover, the flow of data is not continuous, and this would be a problem for example if we are using a publisher-subscriber structure instead of a service-client one.

T2/ From a conceptual standpoint, what are the major implications in using cameras or accelerometers/gyroscopes on the data flow, i.e., data acquisition, processing, inferences?

Data from cameras needs to be post processed to gain information, while data from sensors comes in the form of numerical raw data that describe for example the accelerations of an object. Moreover, cameras can control the movement of multiple objects but have problems with rotations since they cannot distinguish properly this kind of motion. Sensors can instead control one object only but perfectly measure velocity/accelerations. They also need to be physically mounted on the object, while cameras can be installed everywhere but need to be objects in its field of view.

T3/ How is it possible that such a simple sensor as a ‘switch’ can provide an AmI system with so reliable information about presence? May be the case that the inherent assumptions are no longer valid?

Switches are very simple and can provide a binary output (on-off), with almost no signal disturbance. They are small, cheap, reliable and can be embedded in everyday objects such as fridges. These are some of the reasons why they’re widely used in AmI. Another very important characteristic they have is that they don’t have privacy problems like cameras, and are activated only if the user wants too.

T4/ Why is it difficult to design and develop smart artefacts? What are the design and/or implementation principles that one should consider when defining their functionalities?
In designing a smart artefact we must take into considerations some practical parameters such as reliability, cost, power consumption, communication with other artefacts, but also how people interact with them through interfaces and how they perceive them. For this reason, they should have a good interface or in general a friendly appearance.

T5/ In your opinion, why we decided to provide three possible classification scales for sensors (e.g., dimension/domain, 'simplicity', ability to localize)?

I think we need different scales because there are many facets of the problem of classification to look at. Since the number of existing sensors is always increasing, we must be specific when referring to them, and we need to have standardized ways to categorize them. So, a part from physical implementation, we must describe other characteristics to understand which sensor we should use for our projects. For example, if we need to make a 3D reconstruction we need to perfectly know the position of the vision systems, hence we need a sensor with a good self-localization.

T6/ What are the reasons why is so difficult to design a 'Douglas Engelbart detection camera'? Are they related to a specific 'sensing problem' or are they a sign of a more profound problem?

A Douglas Engelbart detection camera is difficult to implement because face detection data can change due to the environment conditions or perspective. A possible approach is to have a very high number of samples of the subject face (in this case Douglas Engelbart) and to compare this data. The difficulty of the approach is in the high number of requested samples and in the fast comparison that needs to be done among them.

T7/ Recall Definition 2. It links the notion of 'simple' device with the level of abstraction commonly used by humans. What can we say about this level of abstraction?

Definition 2. A sensing device is 'simple' if it says something about entities and facts of the World at the level of abstraction commonly used by humans to describe it. For example: A switch reports that 'somebody has turned the light on', or a PIR sensor reports that 'somebody is present in the room'. Those are things that every human being can understand, it's the level of abstraction that we always perceive with our senses. For example, in the case of a switch, we translate ON/OFF or 0/1 into a sentence which is familiar for us.

T8/ Why do we have a 'symbol grounding problem'?

We have this kind of problem since learning, which is a task that comes easily to humans, is not intuitive for computers. This means that feature-detectors must be based on trial and error induction, guided by feedback from the consequences of correct and incorrect categorization. It is linked to the problem of meaning: a computer sees an object, and through segmentation can identify its border, for example, but can't give it a physical meaning until we label it. Then it will recognize the object again if it's in the same exact conditions as before (ex same picture), but in order for it to understand an entire class (or the same object from another perspective), it must see hundreds and thousands of pictures, since it can't use its conscience to understand.

T9/ Why do we have a 'Tree of Knowledge'? Do we need it in practice or is it just scientists-bullshit?

We introduced this concept to talk about how sensors provide us with information. First of all: what is the tree of knowledge? The Tree of Knowledge System is a map that traces cosmic evolution across four different planes of existence: Matter (material objects), Life (living beings), Mind (mental behaviours) and Culture (sociolinguistic behaviours) that are mapped respectively by the physical, biological, psychological and social domains of science.

In our discussion, as we previously stated, we consider the tree of knowledge in order to classify sensing devices with reference to their level of complexity. We classify a sensing device as 'simple' if it provides reliable information about entities in the domain ontology or 'complex' if it provides reliable information about entities belonging to an ontology at a lower level of abstraction and it requires further processing to describe higher level entities on the basis of lower level ones. As the tree of knowledge this kind of definition is based on dividing knowledge in subsets (domains) and each domain in subcategories (entities).

I think the tree of knowledge is very useful to classify sensors. In fact, it's easier to compare sensors (with reference to cost for example) if we know they belong to the same level. Moreover, it's important, in the phase in which we define the implementation of our projects, to understand which level of complexity we need for our sensors.

T10/ Such sensing devices as switches, accelerometers and gyroscopes, as well as RFID tags, exploits a 'principle of locality', i.e., they provide information about objects they enter in contact with. How do they differ from each other?

Switches: they need power, are very cheap and small. They only have a binary kind of output which is very reliable.

Accelerometers: they need power, are expensive and small. They can have different kinds of outputs which are reliable but also depend on the implementation of the accelerometer.

RFID: they may need power in certain cases, are cheap and very small. They can have different kinds of outputs which have reliability that depends on the range.

2/ Pickup one class of sensors we surveyed, and draft a minimum 2-page Word-like document with a description of a/its functioning principles, b/benefits and drawbacks, c/its classification according to the three dimensions we introduced, and d/how you would use in a smart home scenario.

RFID sensors

The RFID sensors use electromagnetic fields to identify and track tags attached to objects. Tags are made of three parts: a micro-chip, an antenna for receiving and transmitting the signal and a substrate. They are small and cheap and thus can be attached everywhere, as previously stated. When tags are triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, they transmit digital data back to the reader. Data usually is an identifying inventory number, but much more information can be sent. The tag information to be sent is stored in a non-volatile memory.

There are two types of tags. Passive tags are powered by energy from the RFID reader's interrogating radio waves. Active tags are powered by a battery and can be read at a greater range (up to hundreds of meters) from the RFID reader.

Benefits:

- Sensors are very small and flexible, which means that they can be embedded into labels and attached to objects.
- They are cheap.
- They don’t have to be in sight of the reader to be perceived (so they are better then barcodes in this sense).
- Passive tags don’t need power.
- Each label has the possibility to store and transmit different kinds of useful information.

Drawbacks:

- They do not guarantee any privacy-safety if used for identification reasons.
- Their use can cause data flooding if the label is read by sensors that are in the range by chance.
- The signal reliability depends on the distance from the reader.

Classification:

- Dimension/domain : Depends on the kind of data, in general the output is a 1x1 integer number (the identification number)
- Simplicity: simple, returns a number.
- Ability to localize: it can localize the presence of a tagged object in a certain range around the sensor.

Possible usage in a smart-home environment :

A possible usage could be with house alarms. The idea is for each family member to have an object, maybe a ring (or even the mobile), with an embedded RFID sensor in it. Whenever every person is outside of the apartment, the alarm switches on automatically. If a family member arrives home it switches off. And if all family members are home, it switches on partially, so that just the door entrance is monitored. Of course, this idea implies that all people always bring the mentioned object with them, so this must be carefully chosen.

Another possible application could be a smart fridge such as the Family Hub fridge from Samsung, in which you can keep track of different foods, expiration dates, missing ingredients in recipes and many more kinds of information. But it could also keep calories and nutritional information into account if a person desires to follow a certain diet.

Moreover, RFID sensors could be used to signal the usage of electricity in a house in order to not exceed a decided threshold. They could send a signal every time a plugged electrical device is used and the reader, in particular the signal should have information about ON/OFF state and the power consumption of the object. The reader should then use the data to save information about the energy used to power the object. Whenever a threshold is exceeded, a notification could arrive to the user, to remind to decrease the usage of electricity.

Another application is for waste disposal, to keep track not only of the waste production of each family, but also to help the user recycling objects by telling him through the interface of a mobile, for example, where to trough garbage.