Assignment 3 – Block Definition diagram

Embedded System Modelling
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Case Study: Automatic Detection of Driving Distractions

1.- System Definition

DESCRIPTION OF THE PROBLEM

According to different studies, one of the main causes of road accidents is driver distraction, either due to the use of electronic devices, drowsiness or other actions that lead the driver to not pay attention to driving.

OBJECTIVE OF THE SYSTEM

The general objective of the system is to detect the lack of attention of the driver from different sensors installed in the vehicle. The system will analyse the information obtained from the sensors to detect possible symptoms of distractions. The system will perform different actions to make the driver react.

SENSORS:

- **Gyroscope**: Two-axis (X,Y) rotation detector to control the position of the head. The inclination will be measured in degrees, between -90º and + 90º. The X axis controls the inclination of the head forward or backward. The Y axis controls the inclination of the head to the sides (right or left). In both cases, when the head is completely upright the value will be very close to 0º on both axes.
- **Steering wheel rotation**: The sensor (DC converter) provides values between 0 and 1023. These values must be transformed to interpret them as the position of the steering wheel in the range of -180º to +180º. If the steering wheel is not turned, it will have a value of 0º. Negative values will represent left turns and positive values right turns. It will serve to detect possible erratic driving or sudden turns of the steering wheel. This is based on the idea that when a driver has a lack of attention (for example, by looking at the mobile phone or suffering from slight drowsiness) he tends to make small, sudden corrections in the direction. In a normal situation, the steering wheel turns are more uniform.
- **Speedometer**: Provides the current vehicle speed. The A/D converter provides values between 0 and 1023, representing the speed range from 0 to 140 km/h.
- **Distance sensor**: Ultrasound sensor located at the front of the vehicle to measure the distance to the preceding vehicle. It is able to measure the distance in the range of 1 to 100 metres. It will be used to detect that the driver is not keeping an appropriate safe distance, due to inattention or lack of caution.

ACTUATORS:

- **Warning lights**: there will be 2 lights, one yellow and one red light to indicate higher risk situations.

- **Display**: It will be used to display data that will be visible to the pilot and co-pilot.
- **Automatic brake activation**: Activates the brake at different intensity levels.

SYMPTOM DETECTION

The system shall read and analyse the data collected from the sensors to detect the following indications that may lead to a risk situation.

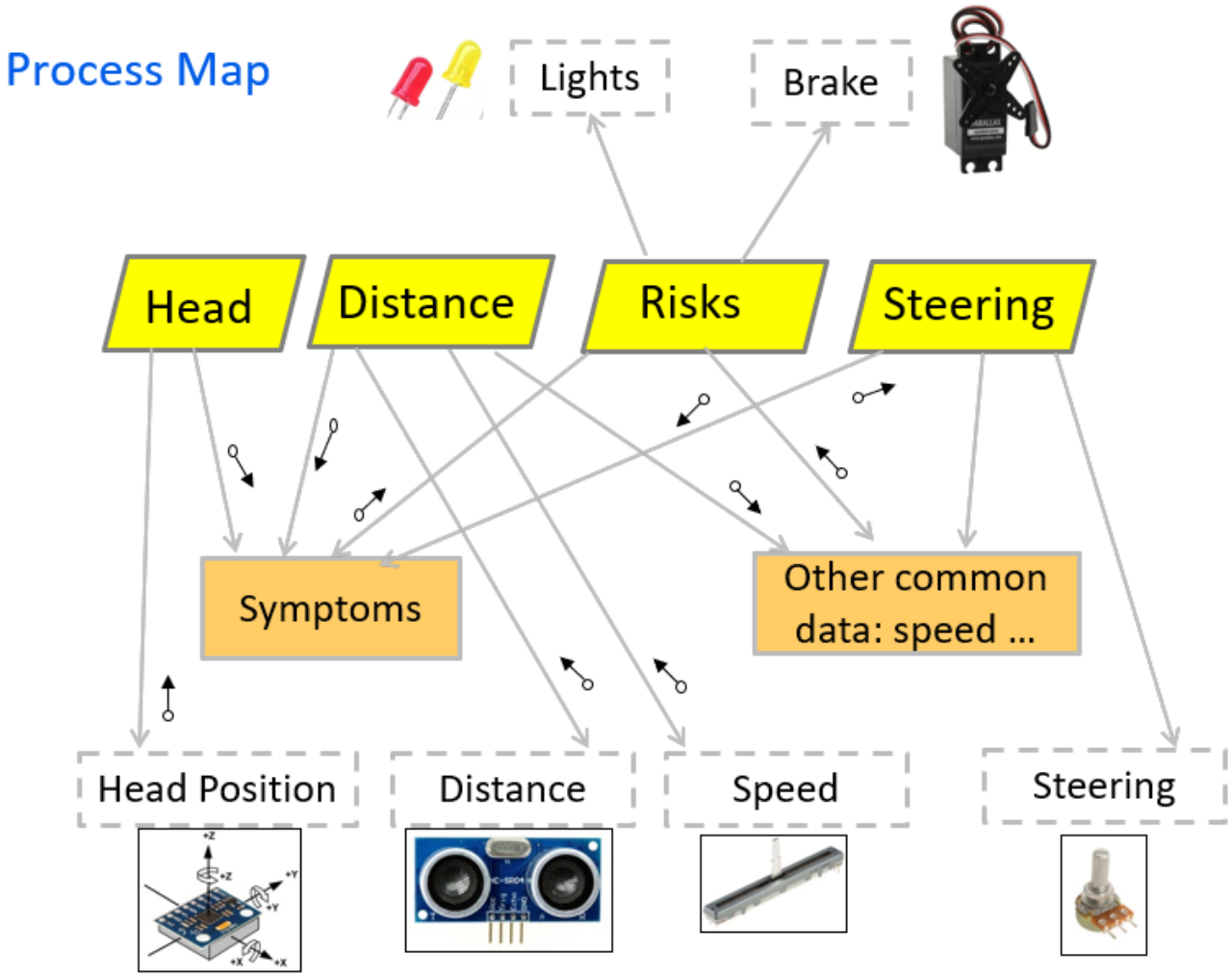
- **Head Tilt**: The Gyro shall be read every 400 ms. If the tilt in the X-axis is greater than 30 degrees in at least two consecutive readings, the driver shall be interpreted as having **"HEAD TILT" (S1)** Forward (+30°) or Back (-30°) and may be exhibiting symptoms of drowsiness or distraction. In the case of the two consecutive Y-axis tilts to the left (-30°) or to the right (+30°), if the driver is turning the steering wheel in the same direction as the head tilt, this will not be interpreted as drowsiness. In this case, it is assumed that when a driver is turning the steering wheel, he/she instinctively follows the trajectory of the vehicle with a head movement. However, if the driver tilts his head laterally by more than 30° and is not turning the steering wheel, this is interpreted as a possible symptom of drowsiness. The "HEAD TILT" condition is no longer true when the head position is corrected.
- **Safety Distance**: Every 300 ms the system shall measure the distance between you and the vehicle in front. If the distance is less than the recommended safety distance, being equal to (Speed / 10)2, the symptom is considered as **"INSECURE DISTANCE" (D1)**. If the distance is less than half of the recommended safe distance, it shall be interpreted as **"IMPRUDENT DISTANCE" (D2)** for not keeping the safe distance. If the distance is less than one third of the recommended safety distance, it will be interpreted as **"DANGER COLLISION" (D3)**. The symptom disappears when the described situation is no longer fulfilled, going back to the state **"CORRECT DISTANCE" (D0).**
- **Steering wheel turns**: The position of the steering wheel shall be read every 350 ms. If there are sharp turns between two readings (there is a difference higher than 20° between two consecutive values) and the vehicle speed is higher than 40 km/h, it is interpreted that the driver is making short and anomalous corrections, and therefore the symptom is considered to be **"SHARP TURN" (S2)**.

ACTIONS

• Every 200 ms. the symptoms will be analysed to detect possible risks, to which the system will have to react by carrying out some actions:

  - when (S1 or S2) and D0: turn on Light 1
  - when (S1 and S2) and D0: turn on Light 2
  - when (S1 or S2) and D1: turn on Light 1 and Light 2, activate brake level 1
  - when (S1 or S2) and D2: turn on Light 1 and Light 2, activate brake level 2
  - when D3: activate brake level 3

• In all cases the actions are maintained until the corresponding risk situation disappears.



2. Submission procedure for Deliverable 3

- Deliverable 3.1 **Block Definition Diagram** developed in Enterprise Architect. Submit both, Enterprise files and an image file with the diagram (pdf, jgp etc.).
- Deliverable 3.2 **Source code** developed in Raspberry Pi corresponding to the Process Map
- Deliverable 3.3 (optional) **State Diagram** corresponding to the task “Risk” and the shared resource “Symptoms”

IMPORTANT

- Only one of the students in the group will upload the documents.
- The name of the documents must be the surname of the student who submits the document (please do not use generic names such as "assignment 3").
- The name of all the students in the group must be indicated at the top of the source code.
- The documents will be submitted in Moodle (Assignment 3) before May 19th at 23:55h.

Process Map with Statechart

Lights

Brake

Symptoms

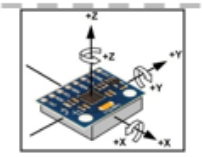
Head

Distance

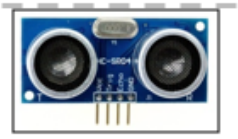
Steering

Other common data: speed ...

Head Position



Distance



Speed

Steering