EN2533 – Robot Design and Competition

Homework 3

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**Levels and Layers**

1. **Level of Competence**

Most engineering problems are solved by breaking down the problem into several subproblems and solving each of subproblem. Mobile robot builders have broken the problems into several parts namely sensing, mapping sensor data into a world representation, planning, task execution and motor control. But this is considered as a horizontal decomposition of a problem into vertical slices. The slices form a chain through which the information flows from the robot’s environment through robot and back to the environment via action.

Instead of this approach, the researcher suggests decomposing the problem vertically as the primary way of slicing the problem which the problem is sliced based on desired external manifestations of the robot control system.

To implement this, a number of **levels of competence** (which are known as an informal specification of a desired class of behaviours for a robot over all environments it will encounter) will be defined for the robot.

Higher level of competence states that it has a more specific desired class of behaviour and it has control over the bottom levels. They have additional constraints on that class.

Level 2

Level 1

Actuators

Sensors

Level 0

Figure 1

1. **Layers of Control**

In subsumption architecture, the key idea is constructing layers for the control system and adding a new layer on top of the existing layer to move to the next higher level of overall competence. A complete robot control system is started to build which achieves the level 0 competence and it is tested and debugged thoroughly. Without altering the system, the next layer is built on top of the 0th layer and it can access the data of level 0. With the aid of level 0, this level achieves the level 1 competence. Level 0 is unaware that there is a level above it. A working robot is there once level 0 is finished and additional layers can be added layer to improve the robot.

Here, individual layers can be working on individual goals separately and parallelly. The key feature here is no need to take early decisions on which goal should be achieved first. Therefore, this architecture has **multiple goals.** The subsumption architecture has **multiple sensors**. Looking at the sensors, the sensor fusion problem can be ignored here as all the sensors are not necessary to feed into the central representation. But the robot may use the sensor values at the same time. Other layers may process them in their own ways to achieve their own goals.

This architecture is said to be **robust** because of 2 reasons. Since it has multiple sensors, if their results can be used, the system is robust. The lower levels are well debugged, and they continue to run when higher levels are added. In case of a failure of a higher level, still, the lower levels continue to run, and some functionality is still happening in the robot. As the fourth feature, this architecture has **additivity**. It is handled by making each new layer running on its own processor. Also, each layer can be spread easily over many loosely coupled processors.

1. **Structure of Layers**

When decomposing each layer, the freedom is given to use different decompositions for different sensor – set, task – set pairs based on the intentions of the problem. Each layer has its own small processor which send messages to each other.