# AVINSOR

(A Visually Intelligent Navigation System for Application in Robotics)


**Tej Birring**

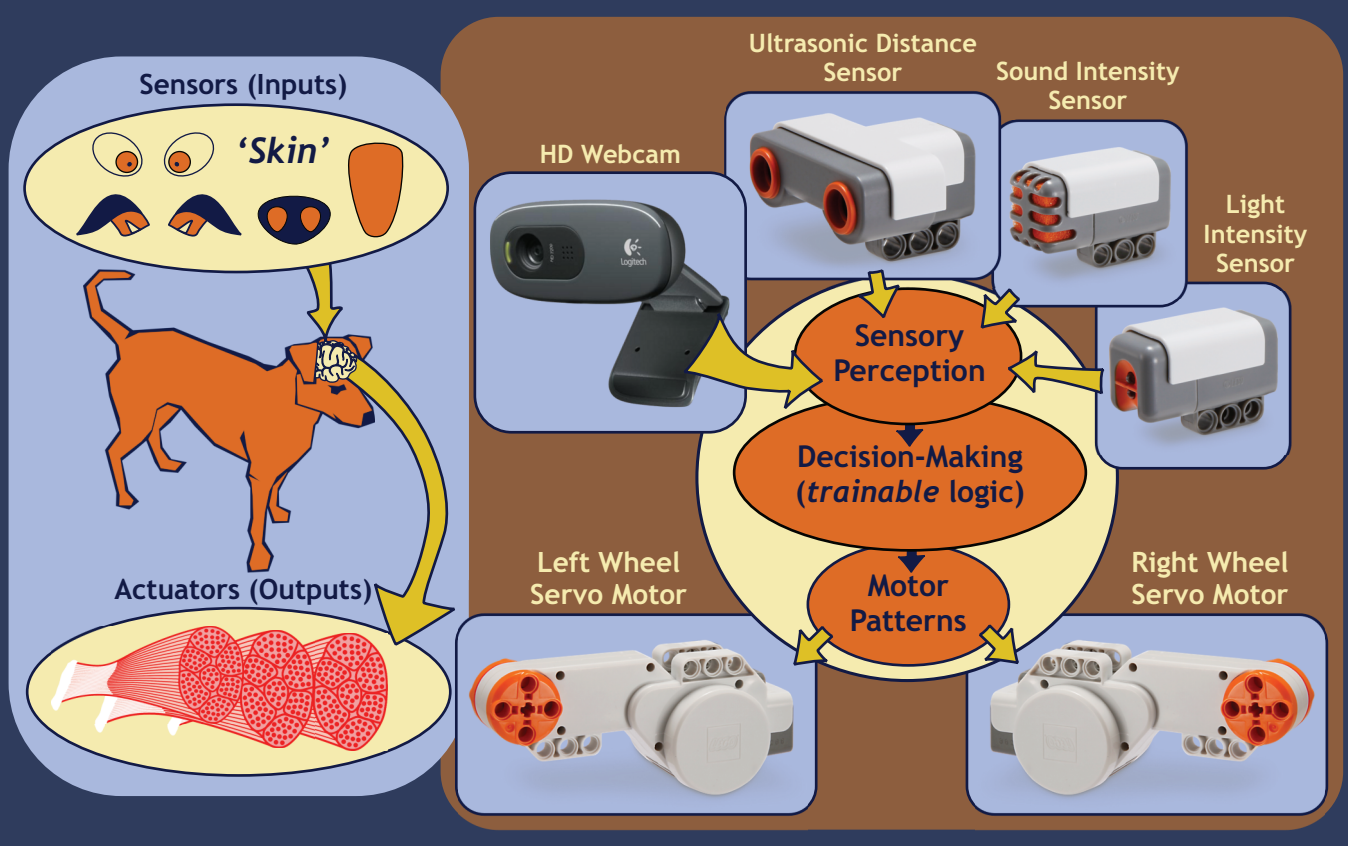
Email gsb4@kent.ac.uk

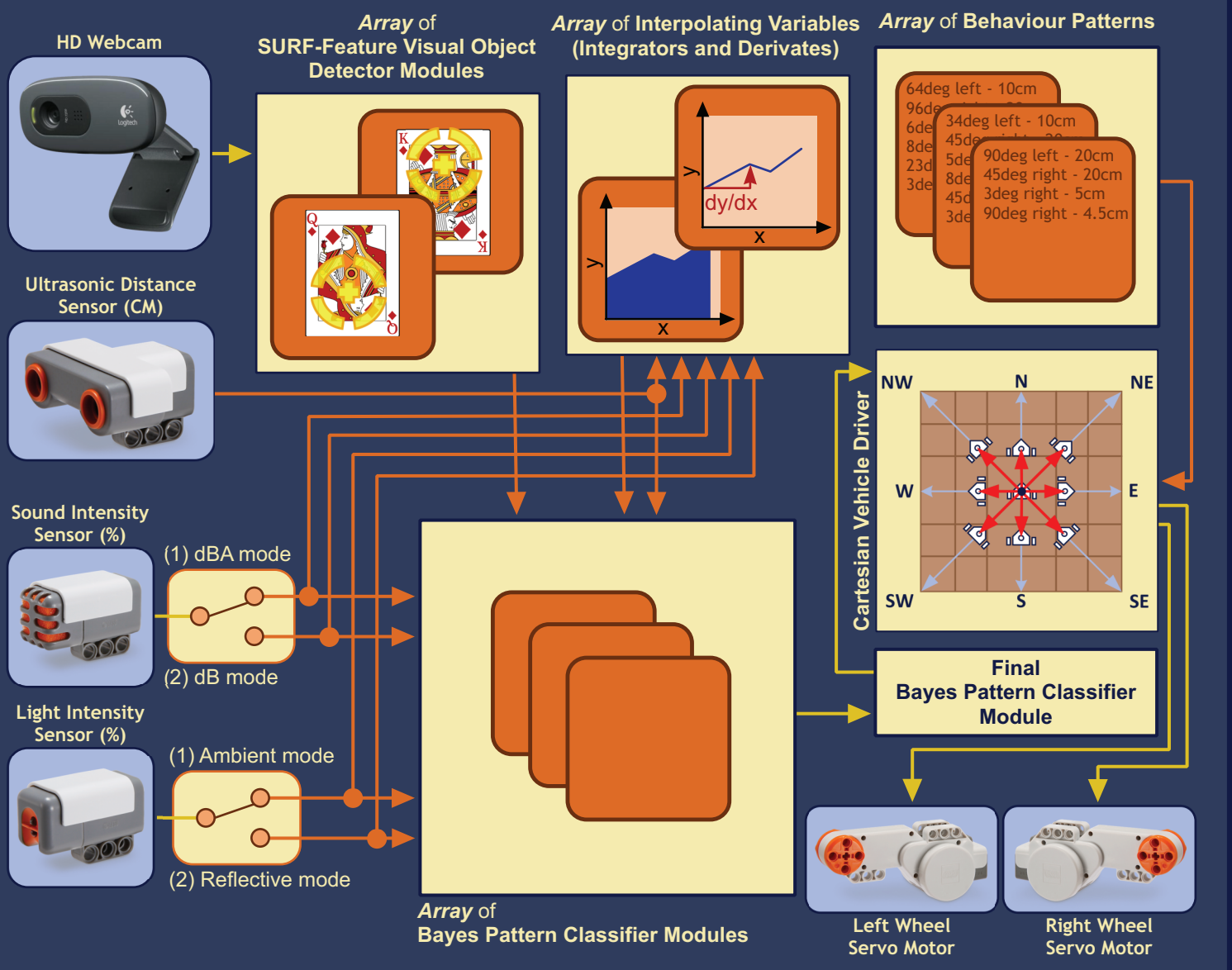
Supervisor Dr. Peter Lee


The (philosophical) aim of the project was to allow the ability to **"train a robot as one would a pet dog, or rather, an obedient pet dog." (for the purposes of exploratory navigation).**

The AVINSoR concept was formulated on the foundation established by the preliminary 6-week research phase *briefly* covering a range of different fields including **(1)** *physiology of vision*, **(2)** *the psychology of visual perception*, **(3)** *simulation of (psychological) cognition models*, **(4)** *machine learning* and *pattern-classification methods*, and (5) *methods of accurate steering in miniature ground vehicle robots*.

The **objective of the *initial* prototype** was to ***establish a hardware/software framework*** such that would allow a LEGO® Mindstorms® NXT based robot assembly to demonstrate ***'user-trainable'* interactive movement**.




## DELIVERABLES

- AVINSoR Library for NXT
- Client Application
- Robot Assembly

*Ask for a demonstration!*

**Left:** A non-technical diagram illustrating the data flow concept of the system. Inputs from the various sensors eventually lead to a number of software components - which ultimately function to ***emulate learning*** and ***produce output signals*** for the two servo motors. Note that the **orange lines represent user arrangement of inputs into the user-configurable modules** such as *'Bayes Pattern Classifier Modules'*, *'Interpolating Variable (Modules)'*, *'SURF-feature Object Detection Modules'*, and the *'Behaviour Patterns Memory'*.

## FEATURES

- *Modularly-structured* ***library*** (and ***client application***). Written in C#, utilizes ***MATLAB® COM Automation Server*** for ***background processing***.
- ***Intelligent* SURF-feature visual object detector module** associates object detection success with *likelihood probabilities*; useful for making autonomous decisions via 'reinforced learning'.
- **Multivariate, multicategory, Bayes pattern classification operations** are *encapsulated* in a MATLAB® class. Complementary C# class for easy integration in application(s).
- **Cartesian Vehicle Driver** converts (harware or software generated) cartesian input coordinates into **motor output signals** - *allowing tachometric control of both wheels* to control vehicle's position.

## USER-DEFINED INPUTS VARIABLES

Apart from system inputs from any NXT robot(s) that may be connected*, the AVINSoR software framework allows **users to define their *own* input variables** into the Bayes Pattern Classifiers they create, configure and arrange to form a *cognition system*. **Such input variables include SURF-Feature Visual Object Detector Modules** that operate by detecting and comparing SURF features between a (recently captured) *test frame* and that of a *reference frame* (captured earlier) - the module is designed to be trained so that it can accurately indicate a **successful (on unsuccessful) match (finding the particular object it is created to detect)**.

Another type of input variable that can be created is an *interpolating variable* (i.e. *a numeric differentiator* or *numeric integrator*). Differentiators are useful at ***deducing rates of change between variables***, and integrators can be used to ***classify quadratures of variables***. Interpolating variables can also be configured to take the average of the last 'n' number of samples before producing an output (for performance).

* Consideration of the use of more than one robot in an application was taken into account when designing the library.

## WHY SURF?

Speeded-Up Robust Features is a scale-invariant feature detection method i.e. its ability to detect objects is not affected by a change in the scale of the object. Hence, the SURF-Feature Visual Object Detection Module has been developed so that it can be instantiated to detect the presence of a particular object in a frame or snapshot captured by the webcam.

## BAYES PATTERN CLASSIFIER MODULE

This software module allows multiple input streams of data (let's call these the *variables*) to select an output from a finite set (the *categories*). The outputs are dependant on matrices of probabilities which can be manipulated (through GUI abstraction) to adjust how the module classifies patterns of the values of the *input variables that it has been associated with*. Allowing **(1) trainability through a GUI (interactive graphs)**, and **(2) the ability to freely create, configure and arrange these objects** (to allow the output of any module to become an input of any other) makes this feature seem like a compromise between *fuzzy logic* and *networks of perceptrons*.