Emergent Behavior Robot

Functional Requirements List and Performance Specifications

By:

Andrew Elliott & Nick Hanauer

Project Advisor:

Joel Schipper

December 6, 2009

Introduction

The objective of this project is to design and build a robot that uses a software architecture based on subsumption to demonstrate emergent behavior. Subsumption architecture is an approach for designing intelligent systems based on several behavior modules [1]. When the robot's environment matches the conditions required for a specific behavior, that behavior is executed. The robot's most basic behavior module is searching for and traveling to an ultrasonic beacon. Another behavior module is the tendency to evade loud noises by seeking low light areas for safety. When the environment is deemed safe the robot will resume pursuit of the beacon. Programming the robot to exhibit these simple behaviors produces an emergent behavior. The idea of emergent behavior is that multiple simple behavior modules combine to create a sophisticated, intelligent response that is greater than the sum of the parts [2].

Goals

The goal of this project is to build and develop a robot that will use a combination of simple behaviors that result in complex actions in response to its environment. Other goals include:

- Learning the development software for the ATmega128 microcontroller,
- Developing and constructing a robot platform, including mounted sensors, batteries, a microcontroller, motors, other and accompanying hardware,
- Using IR and bump sensors to avoid obstacles,
- Using microphones to detect loud noises (above 80dB) [3],
- Using photosensors to determine the ambient light at the robot's location and in close proximity of the robot,
- Developing the software that will give the robot its behavior
    - The robot shall detect and avoid obstacles
    - The robot shall be drawn to darkness
    - The robot shall evade loud noises
    - The robot shall seek out a beacon

Functional Requirements and Specifications

The success of this project depends on the hardware-software interface to correctly display an emergent behavior in response to the robot's surroundings. The interactions with the environment shall serve as the inputs into the system and shall dictate how the robot reacts. The robot will not be programmed to perform exact complicated tasks, but rather to perform many small tasks, which should display an emergent behavior.

The robot must be able to detect obstacles and avoid them while it is roaming and searching for the beacon. The robot shall use infrared sensors to avoid obstacles and will try to stay 15cm away from them, since the IR sensors minimum detection range is 10cm. The robot needs to be able to detect a loud noise, in which case the robot will travel away from the source of the noise, favoring dark areas. We define a loud noise as a noise above 80dB, which is above normal conversation volume level [3]. The robot must also be able to sense the ambient light above itself and the light levels in close proximity to enable the robot to travel in the darkest path. Using these objectives, the robot shall effectively seek out an ultrasonic beacon and get within approximately a 60cm of the beacon.

High-Level System Overview

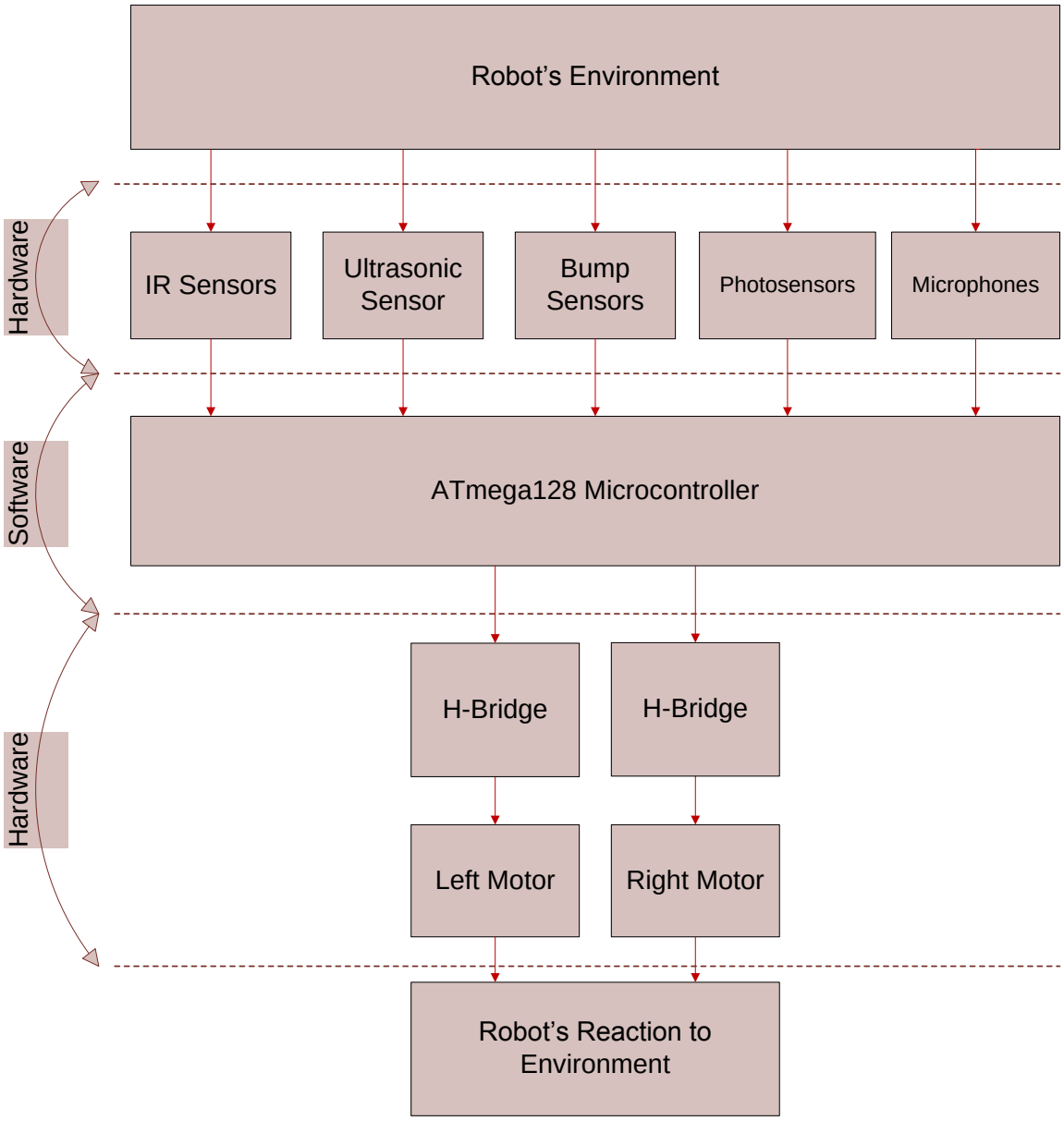

Figure 1: High-Level System Block Diagram

Figure 1 shows the how the robot will gather data about its environment using sensors and then react through movement. The robot platform will be built from the ground up to ensure that the design has the features necessary to perform its tasks successfully. The platform will be controlled by an ATmega128 microcontroller, which will be programmed in C. The microcontroller will utilize the input from several sensors to extract the environmental features necessary to react intelligently.

High-Level Software Block Diagram

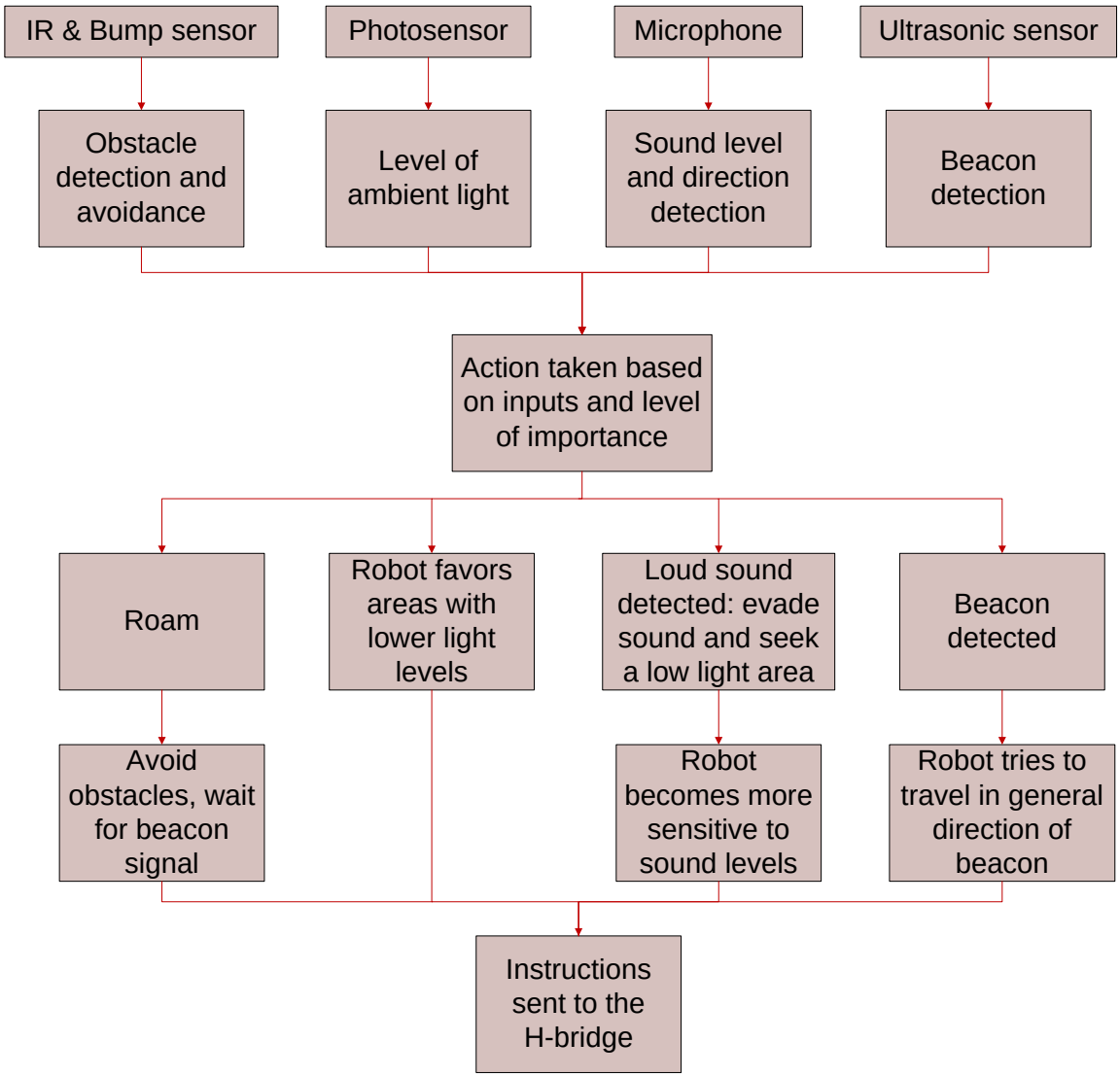

Figure 2: High-Level Software Block Diagram

The projected operation of the software is shown in Figure 2. The response of the robot depends on its environment and actions are weighted based on priorities, shown in Table 1.

Table 1: Task Priorities

Task	Roam	Travel in low light	Beacon found	Detection of a loud sound
Priority	5	4 (2 if in Evade mode)	3	1

Performance Specification Summary

The robot shall:

- Avoid all obstacles within 15cm
- Detect a loud noise (above 80dB) and determine the direction of origin
- Reach an ultrasonic beacon within a 60cm radius
- Determine which areas in its path are darker
- Travel at a speed of 60cm per second nominally
- Travel at a speed of 120cm per second when evading

References

[1] N. Nilsson, “Artificial Intelligence: A New Synthesis”, San Francisco, CA: Morgan Kaufmann, 1998.

[2] R. Cioarga, B. Ciubotaru, D. Chiciudean, M. Micea, V. Cretu, and V. Groza, “Emergent Behavioral Modeling Language in Obstacle Avoidance”, Warsaw, Poland, May 2007.

[3] Galen Carol Audio, "Decibel (Loudness) Comparison Chart," [Online document], 2007, [cited 2009 Nov 11], Available HTTP: http://www.gcaudio.com/resources/howtos/loudness.html