Multi-Agent Decision Making Over Wireless Network

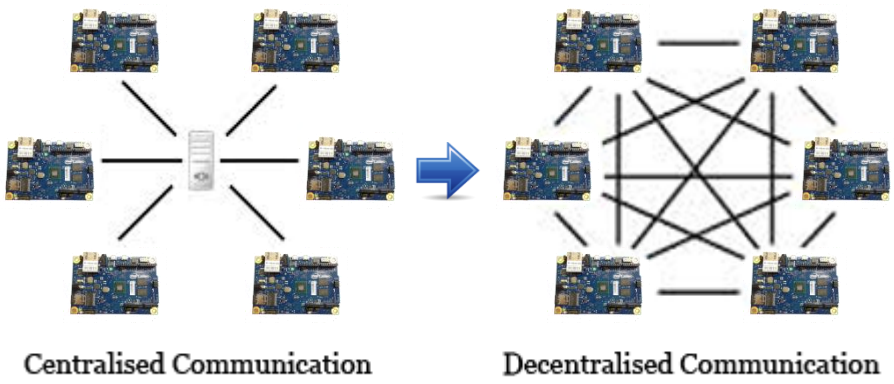
Martin Bullman

Centre for Data Analytics

Insight

Introduction

Real time decision making based on heterogeneous data is becoming increasingly important in a wide range of industry sectors. For many applications, this involves gathering data from widely distributed sensors, making appropriate decisions, and transmitting them back out to remote actuators. This process of centralisation is often too slow for real time decision making. Most existing research in distributed reasoning ignores the issues of wireless sensing, communication and actuation.



Centralised Communication Decentralised Communication

Background

The need to consider wireless networks in distributed reasoning has been identified [1]. Intel have released Galileos [2], which are microcontroller boards based on the Intel Quark SoC X1000 application processor. The Intel Galileo also has wireless capabilities and are Audrino compatible. This is a step beyond traditional embedded microcontrollers, which were standalone.

Problem Statement

Construct a test bed using multiple Galileo's which would demonstrate the principle of sensing, communication, actuation and coordination using wireless networks, and which would allow researchers to implement and test new algorithms on this wireless platform.

Proposed Solution

Wireless Test Bed

The proposed solution is to implement a network of devices which sense sounds and based on the sound levels, communicate with each other to determine which device is closest to the sound. This could then be extended to localize and track sound sources. We extended the Galileo's by adding microphones to each unit for sensing sound. For wireless communication we attached an Intel Centrino wireless-N35 Wi-Fi card and antenna to each board and configured the Galileo's cards to generate an ad-hoc Wi-Fi network which enabled wireless communication between all devices. To indicate the conclusion of the decision process we also added LED's to each board.

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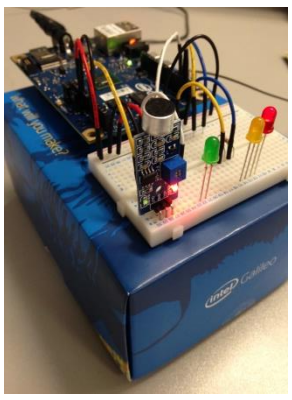
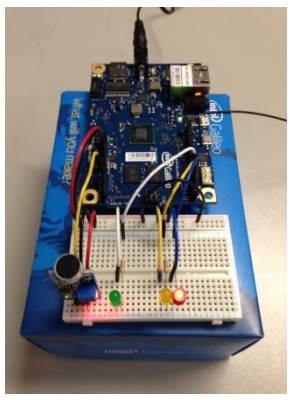
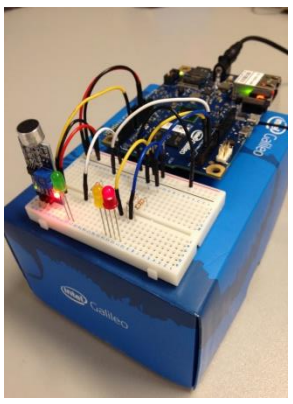
Coordinated Protocol

For the coordinated protocol, any device that hears a sound above a threshold can initiate the process by broadcasting a message to all devices (usually, we assume a fully connected network). To visually indicate a device has detected a sound above the threshold the green LED will flash, all devices will then begin a synchronous communication sequence in which each device will broadcast its sound level. The node with the lowest ID will broadcast its sound level first, each node will then transmit in ID sequence until all nodes had broadcast their level. After the communication sequence completed, each node could then decide who was the closest to the sound. We could then actuate and show the result by turning on a green LED for the node that had the highest sound level.

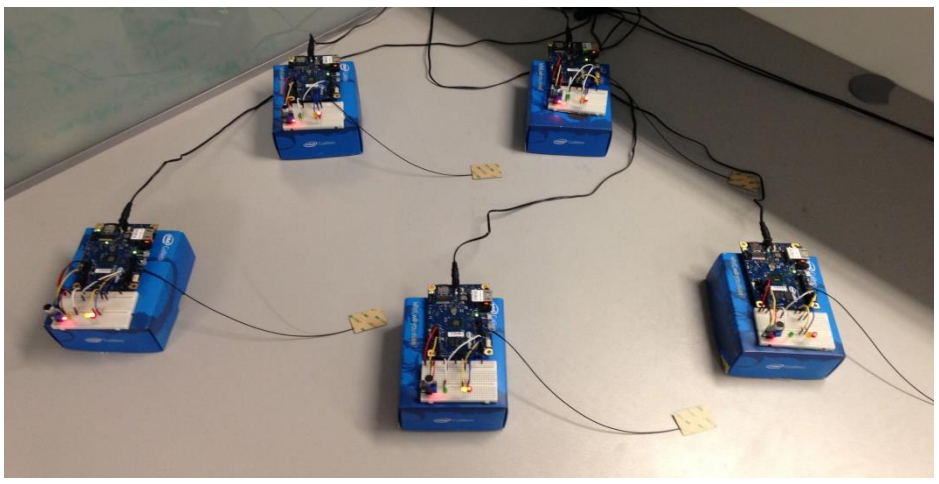






Evaluation

We successfully assembled an Intel Galileo wireless test best on which researchers can now try to test and implement new protocols and algorithms. We also constructed a demonstration application on top of our wireless test bed to test our coordinated protocol. We found that when we have a small number of devices (three to four) our protocol for sensing, communicating and actuation will work reliably but when we increase the number of devices and increase the speed at which they are communicating over our ad-hoc wireless test bed, collisions and packet loss will cause data to be lost. This can dramatically increases the time each node takes to complete the decision process as we have to resend the data we are missing to the devices that requested it, therefore slowing down performance.



References

[1] Mohamed Wahbi and Kenneth N. Brown "The impact of wireless communication on distributed constraint satisfaction "CP 2014, 20th Intl Conf on Principles and Practice of Constraint Programming, Lyon, September 2014.

[2] Intel Galileo Data Sheet: https://communities.intel.com/docs/DOC-21835

Contact: martinbullman@live.ie, k.brown@cs.ucc.ie