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The Manchester Remote Mobile Robotics Laboratory[1]

Abstract

Remote access to robotics facilites allows robotics research to be conducted even if resources are not available locally. To investigate the feasibility of robotics experimentation via internet, we have conducted two independent experiments in which the Manchester mobile robot *FortyTwo* has been operated from a remote site,using a standard internet connection. In the first experiment ("Channellink") experimenters at Bremen University explored and mapped the robotics laboratory at Manchester, in a second experiment ("Atlanticlink") the Manchester robot was controlled from Pittsburgh and performed exploration, mapping and object manipulation tasks.

1 Introduction

The interaction of a robot with its environment is governed by a large number of factors, many of which are unknown, and some of which are unknowable ([Oreskes *et al.* 94]). In order to conduct robotics research, therefore, we consider it necessary to conduct experiments with real robots, rather than resort to numerical modelling of robot-environment interaction.

The purpose of the Manchester Remote Mobile Robotics Laboratory is, firstly, to provide access to mobile robot resources so that robotics experiments can be conducted even if no local robotics facilities are available.

Secondly, we aim to improve remote robot control through machine learning techniques. In work reported elsewhere ([Nehmzow 92, Nehmzow & McGonigle 94, Martin & Nehmzow 95]) we have used artificial neural networks for acquisition of fundamental sensor-motor competences; first experiments show that such learning controllers can be used for remote robot control as well.

Thirdly, a collaborative project between the Robotics Group at Manchester and the Advanced Interfaces Group at Manchester addresses the area of human-computer interaction and the design of robot control interfaces using three dimensional data visualisation techniques for remotye robot control.

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Figure 1: The Manchester Mobile Robot, *FortyTwo*

1.1 The Robot Platform

We use a Nomad 200 mobile robot, called "FortyTwo" for our telerobotics experiments (see figure 1).

The robot is fully autonomous and operates independently from any external components, such as power supplies or computers. The robot is 75 cm high, weighs 60 kg, and uses a distributed controller hardware with a 486 PC as main controller. The robot has 16 long-range ultrasonic sensors (range up to 10.6 m), 16 short-range infrared sensors (range up to 60 cm), 20 tactile sensors, wheel encoders and a visual sensor (monochrome camera, 492 x 512 pixels, focal length 12.5 mm).

1.2 Control Interface

Currently, the robot is controlled through the interface designed by Nomadic Inc. (see figure 2). This displays the current readings of infrared and sonar sensors, as well as a floor plan obtained by combining these range sensor readings with an estimate of the robot's current position, obtained by dead reckoning.

The robot's three motors (for turret rotation, base rotation and translation) are controlled through this interface as well.

2 Experiments

A number of experiments have been conducted to establish that it is actually feasible to conduct robotics experiments via the internet. In the "Channellink" experiment the robot in Manchester was controlled from Bremen University, in the subsequent "Atlanticlink" experiment the operator controlled the robot from Pittsburgh, Pennsylvania. In both experiments the robot was used to explore an environment, map it, negotiate narrow doorways and manipulate objects (figure 3 shows the various stages of the robot negotiating a maze).

2.1 Results

At no time made the robot any unintended contact with objects, but stayed well clear of obstacles throughout the experiments. Robot motion appeared smooth in Manchester, but was jerky on the remote computer screens during times of heavy network traffic.

The mapping experiment showed that accuracy is sufficient to obtain faithful qualitative maps of the environment, with the qualitative measurements accurate within about 10 %.

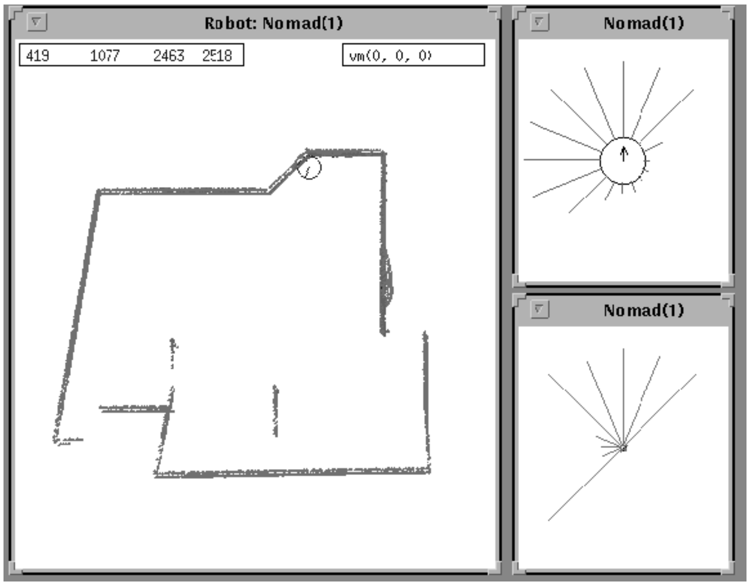

Figure 2: The control interface

Motion control of the robot proved to be fine enough to allow the negotiation of narrow doors and object manipulation.

We found, however, that network delays have to be taken into account if the robot is controlled exclusively from the remote site. Here, a wait-and-see strategy was successful. If local control is used, network delays (which were, in our case, in the order of 5 to 10 seconds maximally for the return trip of the signal) are less of a problem.

We have conducted some initial experiments in which the robot moves autonomously, under local control, whilst merely being monitored from the remote site. These experiments indicate that using mobile robots over the internet is possible for certain applications, notably applications in which finegrained motion control is not needed.

References

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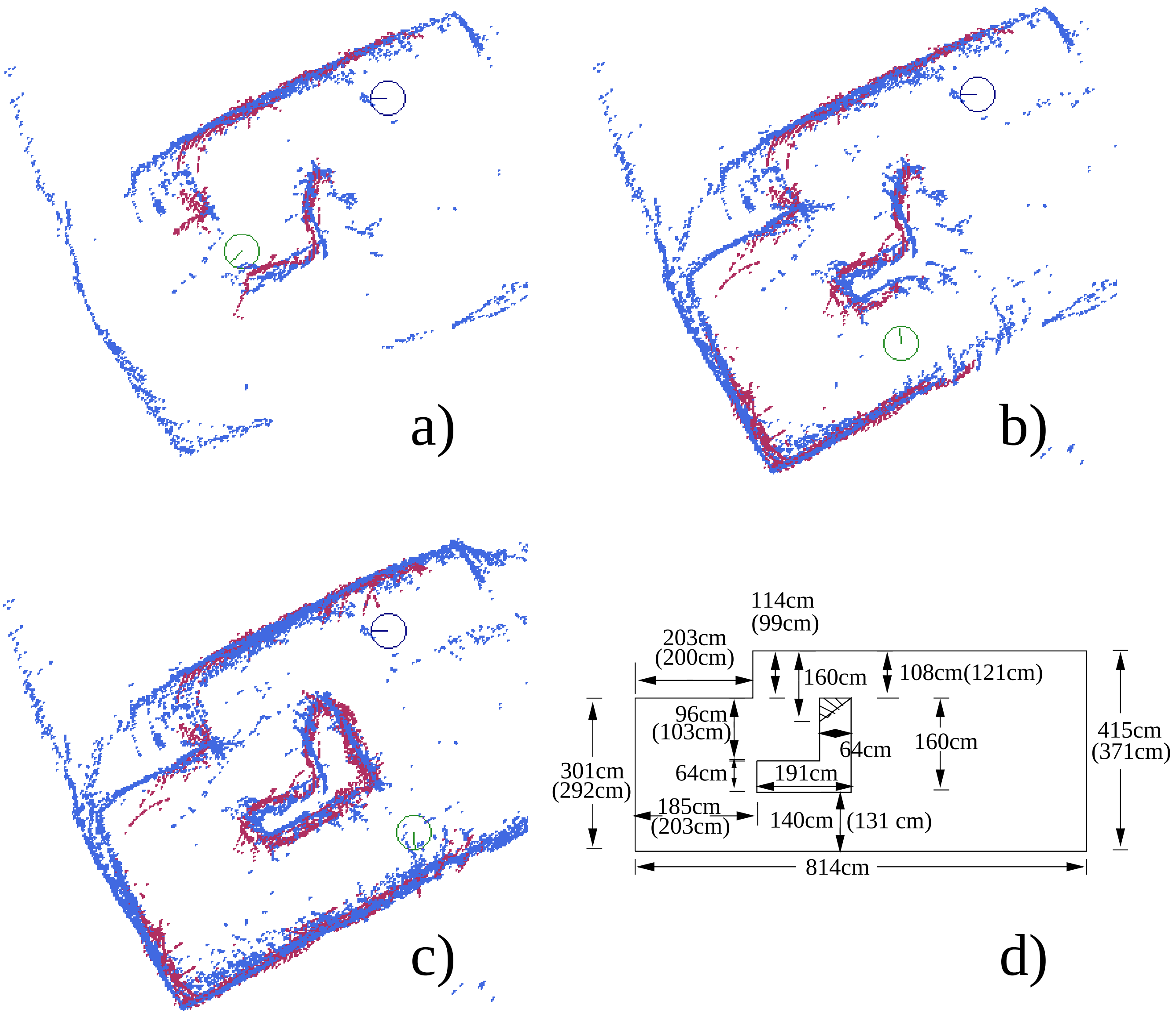

Figure 3: The robot negotiating a maze