# Enabling sensing and mobility on wireless testbeds[*]

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**Abstract.** The inherent inability of simulation models to adequately express factors such as wireless signal propagation etc., can lead to incomplete evaluation of wireless protocols and applications. Thus, testing of proposed schemes under real-life settings has become the de facto validation process. More specifically, in the context of testing scenarios that include mobility, evaluation in real environments becomes a prerequisite. Networking testbeds have recently extended their capabilities by providing the researchers with the ability to include mobile nodes in their experiments as well. Towards this direction, we have developed a prototype mobile node in NITOS, which features a mounted camera and wireless interfaces that enable remote access and control. The proposed mobility framework is also accompanied by a graphical user interface that allows the experimenter to observe the node's behavior remotely.

## 1 Introduction

As recent work has shown, mobility has positive impact on the behavior of wireless networks, as it improves coverage, helps security in ad hoc networks and helps with network congestion as well [7]. As a consequence, the extension of NITOS testbed with mobile nodes is indispensable, in order to allow for experimentation under real mobility conditions.

In this demo, we will present a custom mobile node, developed at NITlab which aims at upgrading NITOS, a large scale wireless testbed that currently consists of 50 operational WiFi nodes.

## 2 Mobile node parts

From a higher-level view, our mobile node consists of the following hardware parts:

– an iRobot Create [3, 2]
– an Alix board alix2d2 [4], which is a single board computer, highly power efficient, small and capable of running operating systems
– a webcam mounted on top of the robot
– an Arduino Uno[1], which is a small-size, programmable microcontroller board that also features a digital accelometer and an ultrasonic sensor as well.

In particular, the prototype features a custom designed tray that enables the iRobot Create to carry the Alix board. The board communicates with the robot over the serial port and

**Fig. 1.** Mobile node

is supplied power through the robot's own battery. The Alix board runs the Voyage Linux distribution, but it is able to run any light Linux distribution. The mounted camera is facing upwards and thus is used to recognize specific patterns that are placed on the ceiling, which provide the robot with the ability to detect its position and navigate around the room.

In addition, the Arduino board is connected to the Alix board through the USB port, and thus it provides for gathering of measurements from the attached ultrasonic and accelerometer sensors. The ultrasonic sensor aids in avoiding obstacles that may appear in front of the robot, while the digital accelerometer is used to get acceleration measurements during the movement of the robot.

## 3 Programming the robot

The Open Interface (OI) of iRobot Create consists of both an electronic and a software interface that enable the experimenter to manipulate the robot's behavior and access sensor measurements through a series of commands that are sent through the serial port by an external PC or micro-controller. In order to to interact with the robot we developed custom Python scripts [5], which are based on the iRobot Create Open Interface.

Regarding the image recognition we use the ARToolKit [6], which is a software library for building Augmented Reality(AR) applications. Using ARToolKit, our mobile node is able to recognize four different patterns that are placed on the ceiling and thus manages to detect its current position and send appropriate commands to the Robot.

## 4 Demonstration

In this demo, we will use one of the two available network interfaces of the Alix board, in order to wirelessly control our mobile node . This interface will be connected with an operating in range Access Point(AP) and will be used as the control interface. The second interface will be

used for the actual experimentation from the NITOS testbed users. Through a graphical user interface, which is presented in Fig.2, we will be able to observe the node's movement around the NITlab laboratory premises. At the right part of the GUI, we can see direction indicators, as well as a representation of the currenlty recognized pattern.
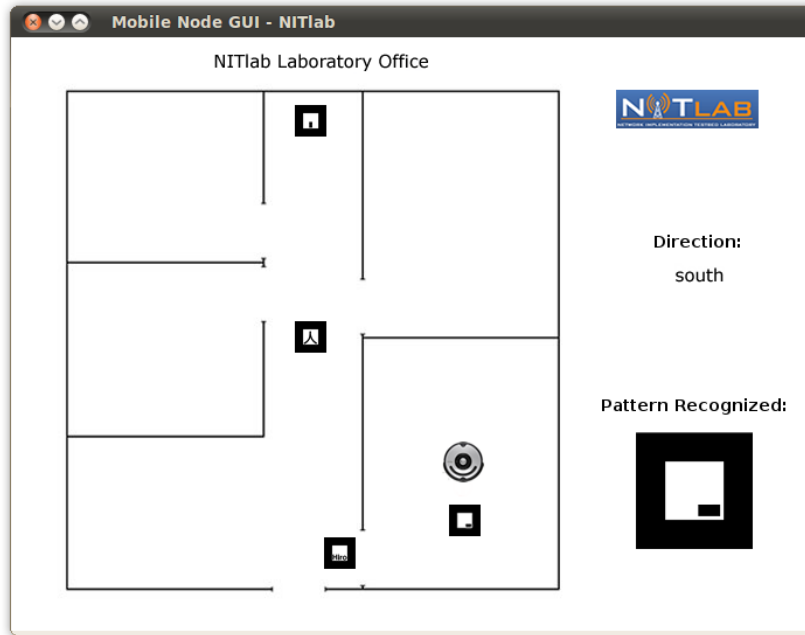


**Fig. 2.** GUI screenshot

## 5 Conclusion and Future Work

In this demo paper we will present an implementation of a location-aware mobile node that has been developed in NITOS wireless testbed. Expansion of the testbed capabilities with mobile nodes provides for more complex experiments in new research fields. Currently, we are in the process of expanding the abilities of our mobile node, by training the camera software so as to be able to recognize more patterns and moreover by using orientation tracking, in order to inform the user about the exact angle under which the specific pattern is detected.

## References

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