A New Architecture of Robotic Sensor Networks for Air Quality Monitoring

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Abstract**—**In this paper a new architecture of the RoboticSensorNetworks (RSNs) architecture for air quality monitoring is presented, due to air pollution is becoming a major concern for the health of the population. The proposed RSNs architecture usetwo direction monitoring proceess such as downloading data and uploading data between robots node and static nodes. In RSNs implementationsensornodeinverysmall dimensiontherefore thesensornodes have the limitationsboth ofprocessor andmemory. Hence, the simple algorithm for overcome problem of minimal memory resources is desirable. In the future works there are development research in software and hardware design for supporting proposed RSNs architecture

Keywords**—** air quality, architecture, robotic sensor network, static sensor node.

I. Introduction

NOWDAYS, the sources of air pollution can be from many activities such as industries, transportation, offices, and houses. These activities give the most contribution to the air pollution that releases to the air [1].The source of pollution can also be contributed by the environmental activities, such as forest burning the explosion of the mountain, poisonous gas, etc. The effects of the air pollution will reduce the air quality that can harm the human health.[2],[3],[4].The reduction of air quality caused bythe main pollutants monitored in the atmosphere including ozone (O3), nitrogen oxides (NO2), sulphur dioxide (SO2), carbon monoxide (CO), aromatic compounds and particulate matter. While CO, NO and aromatic compounds are mainly emitted by traffic, O3 and NO2 are originated by photochemical reactions [2]. Therefore to measure the level of air pollutionis needed.

Currently, the control and monitoring system for air qualityis developed by using sensor networks (SNs). Sensor networks promise to revolutionize sensing in a wide range of application domains because of their reliability, accuracy, flexibility, costeffectiveness and ease of deployment. Several SNs applications have been described using gas sensors; despite of the youth of these devices, i.e. fire detection [5], chemical processes [6] and air quality monitoring [7].In environmental monitoring, SNs are deployed to detect what is happening in it [8]. However, they are very limited in reacting to what they detect. On the other hand, if a large area is covered sparsely, the network may not be connected.

There has been a great deal of research on using mobility in SNs to assist in the initial deployment of nodes in air quality monitoring, due to under some conditions of weather and terrain, pollutants are accumulated in a confined area such as in street canyons and create local but intense pollution. In some situation, several target environments are often too dangerous or inaccessible to humans in such environment sensor network with mobile platform can make a significant contribution [9].It will provide real-time information about the level of air pollution in these regions, as well as provide alerts in cases of drastic change in quality of air. This information can then be used by the authorities to take prompt actions such as evacuating people or sending emergency response team [8].

II. Sensor Networks ARCHITECTURE

A. Static Sensor

Over the last decade a large number of routing protocols has been designed for achieving energy efficiency in data collecting sensor networks. Applicationswhichusesensorno destosensornetworksare characterized bylimited resourcesin terms of memory, computationalpower, andenergy [10].In the early days, a typical sensor network was composed of static sensor nodes and a static sink placed inside the observed region. In such a setup, the major energy consumer is the communication module of each node. In practice, multi-hop communication is required for sending data from sources to sink nodes.

Consequently, the energy consumption depends on the communication distance. One way to reduce the communication distance is to deploy multiple static sinks and to program each sensor node such that it routes data to the closest sink.However, a major problem with multiple static sinks is that one has to decide where to deploy them inside the monitored region so that the data relaying load can be balanced amongst the nodes. [11]. But, ifassume thatlocation-optimal staticsinkdeployment, the nodesclose tothe sinkwill drain their energyfaster.

B. Wireless Sensor

Anotherapproach istoextend thenodenear sensortosensoristhe use of mobile /wireless. In severalaspects, this similar to usingastaticsink-however, using somestatic sensor requiresglobal communicationtocollectadditional alldata on asingleendpoint [11]. In the contextto overcome the shortcomingsofthe static sinks, the use ofwirelesssensorshas

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been proposed [12]. Wirelesssensor canparticipate in varioustypes ofmobility patternsin thesensorfield, such asrandommobility, predictable/fixedroadmobility, orcontrolled mobility, whichhasconsequences forenergy efficiencyanddata collection strategies.

C. RoboticsSensor Networks

Robotics sensor networks are physical agents that move and interact continuously while embedded in a dynamic environment.As one of the key techniques in the applications of mobilerobots, autonomous navigation endows a robot with the capabilityof reaching expected positions without collisions for executing various tasks, e.g., transportation, surveillance, or exploration. Sincethe motion performance can strongly affect the task performance, reliable navigation architecture very necessary.

A typical autonomous robot must manage a large array of sensory information to determine its environment. Each sensor provides some input about the world around the robot; that input being incorporated into a knowledge base. From this knowledge base, appropriate rules about actions taken in response to input are generated. These rules allow the robot, to interact with its surroundings in a way that hopefully achieves some goal. However, creating and maintaining these rules, as well as gathering new data for the knowledge base poses significant challenges [13].

Currently RSNs have been widely applied to surveillance or monitoring scenarios However, only few researchers discuss how to exploit mobility to reduce monitoring cost and if the sensing locations are far apart. Integration mobility in sensor network have been intensively studied in [14].Other alternative is to use multi mobile robots as data mules to gather the data from the sensors. This approach has indicates two major benefits: The energy require for communication is minimized because the robots can move close to the sensors. This can improve the life-time of the stationary sensors significantly. Second, the robots can collect additional data along the way.

RSNs can be used and act as high-performance mobile node because robots equipped with various sensors and communication capabilities. If a robot can manipulate sensor nodes, that robot can change the range and topology of its SNs according to the communication conditions, sensing and adapting to the environmental situation. RSNs is expected to exhibit robustness superior to that of conventional SNs composed of fixed sensor nodes when sensing environments with remarkably adverse wireless communication conditions and wide ranges. Some research groups have begun to design robotics sensor network and have made some prototypes [9],[15],[16].

Nowadays, innovation ofresearch advancesall owsrobotstogeneratetheRSNsin low costandthe smaller size [17]. Fortherobot, a common goalis no easy task. This is causedthe constraintsthatcomewith a reduction insize, cheapsensors, sensorranges fromsmall, limited computingpower, less memoryandimprecisemovement. Thus, a developed control algorithm for low RSNs raisesan interestingwork. Inexpensive robotsusuallydo nothavelong-distancecommunicationskillsanddo not haveglobalinformation such asthe positionandheading [8],[17-19].

III. Proposed Architecture of Robotic Sensor Networks (RSNs)

The complete system architecture of a robotics sensor network includes a group of static sensor node and mobile sensor nodes, a base station, upper communication network infrastructures and clients as shown in Figure 1. The robots sensors node is in fact an enhanced sensor node. It not only has all the capabilities of the static sensor node, but also realizes mobility by adding a robotic base and a driver board. A base station is used to bridge the sensor network to another network or platform, such as internet.

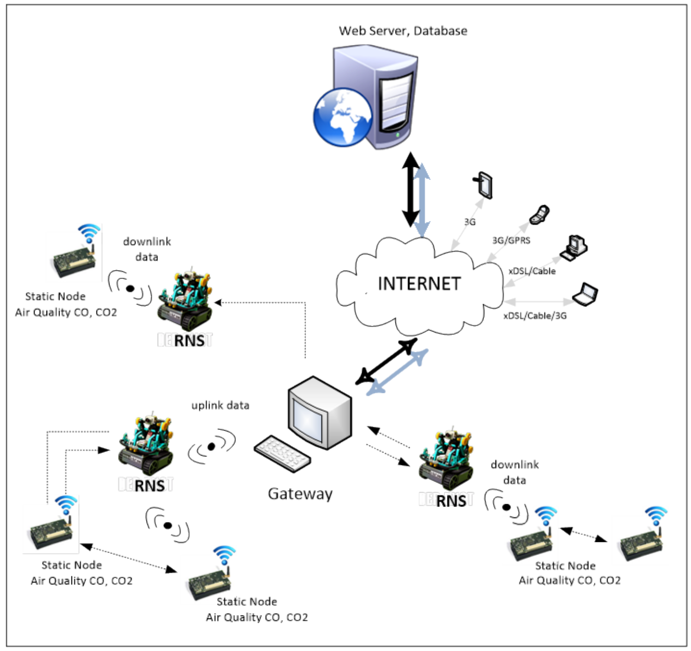

Fig 1.Proposed Architecture of Robotic Sensor Networks

The proposed architecture can be divided into three layers: nodes layer, web server layer and clients' layer. The nodes layer consists of all the sensor nodes that can be either static or mobile node. The server layer includes a personal computer or a single board computer for sensors data base. The clients' layer includes local clients and remote clients.

In the RSNs architecture use multiple channels for wireless control with data processing in two directions for downloding and uploaing. Robot Sensor Networksadoptedas a meanstoreduce the number ofsensors neededtoreachcertain areas, which cannot becovered bythe sensornode. Eachsensornode communicate with each otherandcooperateto gatheringdatafrom the environment around, such as temperature, air pressure, humidityand severalother airquality parameters. Forthis purposeanodeare equippedwith sensorequipmentusedtodetect ambient airqualityand communicationequipment usedtocommunicatebetween thesensornodes. In RSNsapplications, sensornodeshouldhave adimension verysmall, so that thesensornodes have the limitationsboth inprocessor, memoryor wireless.In the future, the devices of the clients' layer can be any smart terminals, such as PCs, PDAs, Pocket PCs and smart phones. The data base layer and the client layer communicate with each other and they form a typical example of Internet. Furthermore, smartphones and tablets with Android OS use their components to acquire contexts about air quality monitoring.

IV. Conclusion and Future Work

This paper proposesa new robotic sensor networks architecture. Initial results of RSNS rchitecture for monitoring environment with mobile platform is presented. Some of the mobile robot was set up as a robotic sensor node as pollution monitoring robot prototype. In the proposed architecture, RSNs node gather data autonomously and the data network is used to pass data to one or more base stations, which forward it to a sensor network server. The system send commands to the nodes in order to fetch the data, and also allows the nodes to send data out autonomously. Each sensor node communicate each other and cooperateto gathering data from the environment around, such as temperature, air pressure, humidityand severalother airquality parameters.

In the future ofthese systems can implement the visual behavior for navigating RSNs in real time. Many interesting future extension is feasible with our current set-up, among others are future these systems can be used in smart cities; the environmental data will provide useful information to citizens. For example, air quality, transportation information, emergency services, and so on. Citizens can access this information via the internet. Future is a vision-based system cooperative object detection, localization and tracking using mobile sensor node robot equipped with a camera with the purpose of extracting the location of objects in each image plane, which is transmitted to the sistem.

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