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# Air Pollution Monitoring Using Swarm Robotics

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**Abstract**:Thispaperdescribesamodelprojectfordeterminingtheenvironmentalconditionsthatexistinanareausinganarmyora swarmofrobots.Theserobotsrelocatethemselvesindependentlyofeachother,intheirownprescribedpath.Thisprojectisinspire dbytheextentoftaskthatarecollectivelyaccomplishedbyaswarmofantsorbees,theswarmofrobotsfindtheirutilityinareaswher eenvironmentalconditionsaretobemonitored.Monitoringofenvironmentalconditionsusingsatellitetechnology,stationaryga ssensorshavetheirowndrawbacks.Satellitetechnologyformonitoringfailswhenanareaistobemonitoredwheresignalsfailtorea ch.Similarly,stationarygassensorscannotbeinstalledateverylocation.

**Keywords**: Pollution Monitoring, Swarm Robots, Environmental Conditions Monitoring, RF Module, Sensor Array

## I. INTRODUCTION

Pollution and environment conditions in which we live have become a vital issue off late. Significant number of research work is being carried out on ways to monitor environmental conditions, both in normal and severe conditions, in a cost effective and efficient manner. Swarm robots are generally used for ad hoc purposes, but can be also used otherwise. Scalability is an important reason why swarm robots are deployed in monitoring air pollution. Each robot is initially located at distinct position and is required to move independently from each other. It can only detect the pollution intensity within its limited path range. The objective of this paper is to find a simple & easy to implement prototype for an army of robots which would monitor air pollution. As illustrated in Figure 1, the prototype consists of 3 robots, 2 to monitor air pollution and one master to collect and map the findings of the slave robots. These findings can be represented in spatial or digital form and intended action can be taken accordingly.

## II. IMPORTANCE

This model attempts to find a way of monitoring air pollution and environmental condition with the help of robust robots. The quality of air that we live in is getting deteriorated at rapid pace and has reached a critical stage, especially in metro cities. Pollutants like isobutane, sulphur dioxide, nitrogen dioxide along with carbon dioxide which is the major greenhouse gas are at a rise, which not only have adverse effects on lives of people but also contribute to global warming. At world level, the recently concluded COP-21 at Paris tried to address these grave concerns and India voluntarily Presented its Intended nationally determined contributions - INDC's, under which it pledged to reduce its greenhouse emissions significantly and take steps to improve the quality of air in coming years. In such circumstances a need is felt for a system which can monitor the environmental conditions effectively in areas which are highly prone to adverse air conditions. An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

## III.MOTIVATION

Nature has always enjoyed a complementary relation with innovation. The sight of swarm of bees or ants, working together in huge numbers and ultimately accomplishing a colossal task, seems inspiring, a task which is seemingly impossible for a single insect to accomplish. If robotics is somehow coupled with the 'swarm' phenomenon, their utility is found to be maximum. With the appealing concept of 'swarm' and a dire desire to address some of the problems of air pollution which is prevailing in our cities, motivated us to design this prototype model. Along with it, we find today that not much technology is utilized in hazardous areas like coal mines, where workers and labourers are constantly prone to adverse air conditions and even fire due to which a large number of poor people have lost their lives. Not much is done to address these issues. All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

## IV.PROBLEM STATEMENT

Todesignaprototypemodelforeffectivemonitoringofairpollut ionandenvironmentalconditionswhichprovideshigherlevels ofrobustnessandflexibility.Thisprototypemodelmustbeablet oextendto‘n’numberofrobotswhicheffectivelymonitorsandp resents its finding sover a large area. Theperformanceoftheswarmofrobotsmustbebetterthananysi nglecomplexmachinery,atthesametimebeingcosteffectivean dpractICallyusableincertainsituationsinwhichconventional& commonlyusedsystemsfail.

## V. PROPOSED METHODOLOGY

For applying our methodology on a prototype of two robots we follow a three-step procedure .The same can be extended for ‘n’ number of swarm of robots. Initially, the second or inferior robot monitors the condition in its own path using gas sensors and the data is communicated with the first robot. This robot is higher in hierarchy than the second robot as he has data regarding area that he has monitored on his own added with the data which is collected from the second robot.

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We denote the robot 1 as 'r1' and robot 2 as 'r2', where each robot in initially placed in the desired location. This is illustrated in Fig.1.

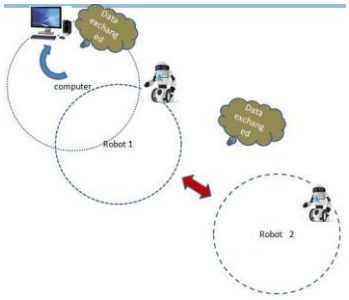


Fig.1 - Swarm robots interaction model for pollution monitoring via data exchange between robots

Robots 'r1' and 'r2' equipped with gas sensors, performs two functions. First, it displays the data collected by it in digital form on its own screen. Secondly, transmitting the data through the swarm to ultimately reach to a machine where the data can be mapped and utilized accordingly. The first robot combines the information and transmits it to administrative robot. A large area is covered by similarly applying 'n' number of swarm of robots.The total area covered can be sketched by various figures accordingly. One of the way in which this can be done is shown in Fig 1.In this approach, an area which records more pollution relatively to other can be highlighted using someortheotherform.


Fig.2-Threerobotsshowingconditionsoftheirprescribedarea

## VI. BLOCK DIAGRAM

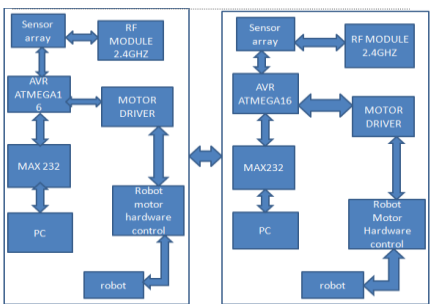


Fig.3 – Block diagram

## VII. IMPLEMENTATION

ThelevelsoftoxicgasiscontinuouslysensedbyMQ6andLM35 andisdisplayedonLCDwhichisrefreshedeverysecondAtmega16arepreprogrammedtomoveinadesiredpath.Additionally,relevantalgorithmscanbeprogrammedaccordinglyforadhocpurposes.Robotscommunicateintwofoldway.Firstly,withenvironmentasdiscussedaboveandsecondly,therobotscommunicatebymeansofwirelesscommunicationmoduleswhichareresponsiblefortransferofmonitoreddata.Independentdatacollectedfromindividualrobotsiscommuniatedtorobotwhichishigherinhierarchythanhim.Ultimately,senseddataoveralargerareareachestheadministrativerobotwhereitcanbedisplayedinmultipleanddetailedform,dependingonthepurposeitisbeingusedfor.ThebasicblockdiagramforimplementationisshowninFig.3.

## VIII.RESULTS

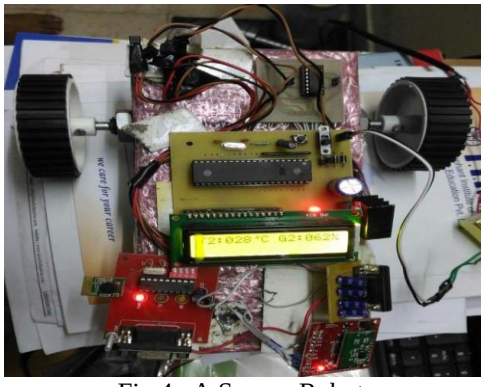

Fig.4 –A Swarm Robot


Fig.5 – Slave Robot displaying its own data


Fig.6 – Master Robot displaying the data of itself as well as the slave

## CONCLUSION AND FUTURE SCOPE

Muchresearchhasbeendoneandnumerousalgorithmshavebeendevelopedforefficientutilizationofswarmrobots.Allthesere


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searcheshaveshowntheadvantagesthatswarmrobotshaveover conventionalsinglerobotsystem.Wearecurrentlydeveloping theprototypemodelfortworobotsusingthecomponentsthatha vebeenmentionedinthispaper.Thisswarmcanbeexpandedto' n'numberofrobots,accordingtotherequirementsoftheuser.Al ongwiththis,thesensorswhichareinstalledmustbechosenacco rdingtotheapplicationandenvironmentforwhichitisusedfor.F urtherdevelopmentcanbedonebyusingavariablepathusingsel flocatingorpathfindingalgorithmssuchasDijkstra'salgorithm .Thiswouldhavesignificantadvantage,astherobotwouldonly moveinareaswheretheneedformonitoringispresent,insteadof movinginafixedprescribedpath.Butsincesignificantresource swouldbeneededforextendingthisprojecttomultiplerobots,an yproposedmodelmustbefirstsimulatedonavailablesimulatio nsoftwareandshouldbeimplementedonlyafteranalyzingtheef ficiencyforthatparticularapplication.

## ACKNOWLEDGMENT

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