March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

Smart Autonomous bot to bot Communication through Datamining and Wireless Ad-Hoc Networks for Emergency Scenarios

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Abstract
Robotics and automation industry which has created many advancement in the field of automation using robotics and it cater the needs of automation industry to house hold application purposes in our proposed method we have created an automation using robot to robot communication in an survilence network environment.Nowadays, the surveillance of a single robot can be controlled by a Nordic radifo frequency device and a Master Base station. Here we designed a Ad-networked robots consists of one master base station connected with NRC and two surveillance Slave Robots. If one of the surveillance Slave robots (slave) is out the coverage range of the NRC master base station connected with Wi-fi , then the nearest robot acts as a base station (master) with their secret security authentication code. If the nearest Master Survillence robot were unable to acts as a base station because when slave robot goes out of coverage area at that what ever commands/response transmitted by the master robot will not be accecpted by the slave survilance Robot, in this situation by using Adhoc networks the neareast surveillance slave robot will act as a master Connected with NRC and then it Retransmits the commands/response lost by previous conversation between Master/Slave. By using these Ad hoc networked robot connected with NRC we can monitor all the commands/ response between master and slave robots are stored in a common cloud environment. By using Wi-fi based Adnoc-network connected with NRC node with Master and slave robots we can detect bomb, land mines, gas, and fire using different kinds of sensors. In our proposed model, we have used proximity sensors, PIR sensor, gas sensors, and fire sensors. The created networked robots are connected via RF protocol, NRC node and it is monitored using camera TV output port and Tracking of master/slave communication can be done by using common cloud database. But in our proposed method we can view the enimies position by using web app Application but the robots should be in 300 meters coverage Area.To track the commands/response of master/slave robot informations are stored in a common cloud database we have implemented a data mining technique.

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March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

I. Introduction

During hazardous and disaster Environment in order to save the life of the human beings we can use this robots in emergency response processes connected via Wi-fi based Adhoc Network and connected along with NRC(Nordic Radio frequency(NRF24101)) connected via IOT module.The commands/response communication between the master /slave robot can be stored in common cloud database environment. By using common cloud base database we can track the commands, response and data transmission between the Master and Slave robots. The movement of Slave robot can be monitoried by using a Web App connected by suing wi-fi based wireless ad hoc network connected along with NRC (Nordic Radio frequency) Module. In our proposed method our robot can able to move easily in hazardous environment and it establish a full duplex mode of network communication between the enemies zone and base station within 300metres of diatance away from master node .*In our proposed model*If one of the surveillance Slave robots (slave) is out the coverage range of the NRC master base station connected with Wi-fi , then the nearest robot acts as a base station (master) with their secret security authentication code. If the nearest Master Survillence robot were unable to acts as a base station because when slaverobot goes out of coverage area at that what ever commands/response transmitted by the master robot will not be accecpted by the slave survilance Robot, in this situation by using Adhoc networks the neareast surveillance slave robot will act as a masterConnected with NRC and then it Retransmits the commands/response lost by previous conversation between Master/Slave. Generally the Robots lose its connectivity and Information when the slave robot goes out of the coverage area i.e grater than 300 metres. Our aim is to maximize the number of slaves connected to the adhoc network withinin 300metre radius. This cluster based adhoc network will provide the network connectivity between the master and slave nodes at enemies' zone.

Motivation of the Project

User can see visualize the enemy zone live streaming through camera connected in slave robot controlled by IOT based web application. We can open this application from base system computer through master robot and we can control, monitor, tracking, movement and to perform a task like fireing, shooting, blasting etc. In this IOT based web application has created like an android App and it consist of 4 control buttons such as forward button, backward button, left button and right button. Using this control buttons we can control the slave robot live motion and movement control operations.The master/slave robot is interfaced with inbuild sensors such as IR-Sensor,Proximity sensor,Ultra sonic sound sensor, Which is used to detect objects,obstacles,bio medical sensor is used for identifying living and non living things present near the surrounding environment,Humidity and temperature sensor is used to find the climatic conditions present in the enemies environment, Nano sensor is used to identify the detection of poisonous gas,fire in the surrounding environment.the slave node will measures all the parameter values through sensors and pass it to the master Node. Security is always important at all the time, so there is unique login ID and password to control the master/slave Robot. First user have to sign up and using unique ID they will able to control it from anywhere at any time.

The slave surivaliance robot can be easily moved from one place to another by using the control buttons such as forward, backward,left and right by the IOT based Andriod App connected with the Master Robo device. Robo can be used for security purpose with the installation of a camera. Communication is provided between robo to robo using nrf and wifi .It is used for the high speed communication

DESIGN OF THE PROJECT

In our proposed model we created a connection b/w master robot and slave robot and

March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

we make that how master robot will controlthe slaverobot using IOT based web Application.

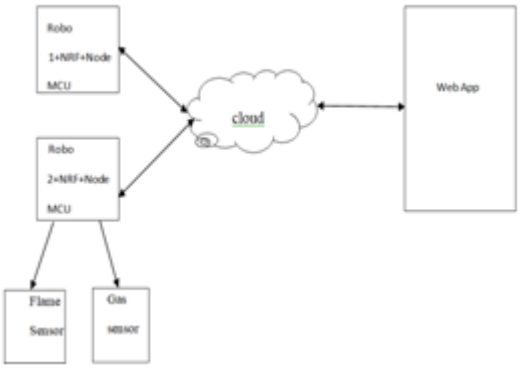


Figure 1.1 block diagram

WiFi enabled smart Master/slave robot can be controlled by using a custom designed Web APP Application system .To make this feasible, with software and hardware interface with a Master robot micro controller unit (Node – MCU) along with NRF(Nordic Radio Frequency) module is used to guides the slave survilance robot along the desired path. Master Robot (Node MCU) will control the slave survilance robot by sending commands like front,back,left and right to guide the slave robot to travel in a guided path .And it can be monitoried by master Node MCU by storing all the commands/response between Master MCU and Slave Node MCU in a common cloud base data environment system.

IMPLEMENTATION STEPS:

- The commands were designed as A (front), B (back), C (right), D (left) for master robot which controlled by Mobile App in Transmitting Node Sytem .
- The commands were designed as P (front), Q (back), R (right), S (left) for slave robot which controlled by NODE – MCU and NRF module. Inside the rescue zone, both robots were actuated in after connected to base station.
- Once both robots gets authenticated by the base station, their real time visual interpretation was viewed in LCD TV using wireless camera embedded in the both robots.
- As per the transceiver ability, both robots were controlled within the radius of 300 metres. Now the thing is, when any one of the robot exceeding the 300 metres limit, it will lose its connectivity from the base station leads to retrieval error of obtained data.
- So it is urgent scenario to make lost robot in action again by making the near-by robot to act as a master. Now nearby robot acts as a base station which can able to track and retrieve inside 300 metres.
- Therefore , the command from Master Node base station to lost robot was given to master robot which will transfer the command to slave robot as like we defined in the programming options.
- This mean, commands P, Q, R, S cannot be processed by master robot because it is defined to receive A,B,C,D only, therefore it transmits the unrecognized commands which easily received by nearby lost robot(slave).
- Now again both robots got activation again by the base station without losing connectivity and also by increasing range of connectivity.

Software algorithm implementation:-

STEP-1:- Plug and switch on the power supply

STEP-2:- Initialize the nodemcu and nrfmodule

STEP-3:- Initialize the web application

STEP-4:- Give the commands to the master robot through web application

STEP-5:- master robot will work according to the commands given by user

March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

STEP-6:- Sameas Master Robot give the commands to the salve robot and serial monitor display running command on thescreen.

STEP-7:- Control the slave robot with master robot using NRF module communication while wifi is off

STEP-8:- The Sensors with the Slave Robot gives the data to the cloud and the observed data is displayed on the web application

STEP-9:- Sensors Data Will Be Displayed In Graphical Form

STEP-10.Received Data Is Stored In the Common think speak cloud database system.

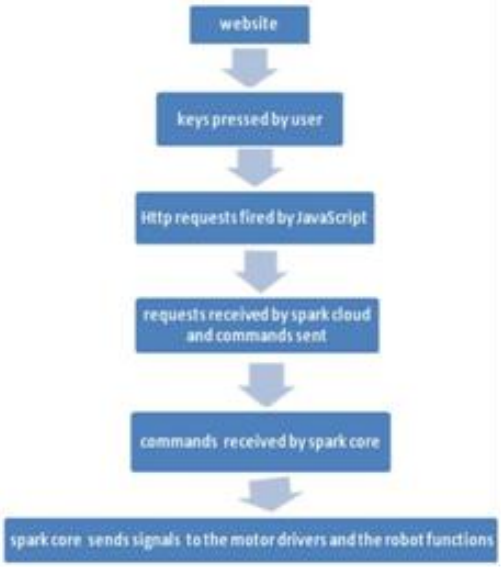


Figure 1.2 Flow chart for the proposed system

In our proposed method bot to bot communication has made successful in interfacing with the Arduino microcontroller and NRF module. Using this module it creates an adhoc based full duplex mode of communication between Master and slave node through Wifi and RF.All the communication between the Master node and the survilance slave robot commands and responses were stored in a common cloud database system.By using the web application through the Personal computer or using android mobile phone we track the position of the slave robot by using the datas stored in think speak cloud database. By using datamining algorithm technique we identify when the slave robot enters out of coverage area at that time nearest slave survilance robot having good battery power will in the adhoc cluster network will be configured as a master robot .By using think speak cloud database what ever commands lost in previous data communication between master /slave. That same command is transferred to Newly configured survilance slave robot. Again we can start to monitor and track enimiesposition new master robot through web app applicaton within the 300 meter radius.

Figure 1.3 shows the open the web application for giving the commands to therobots

When the command has susessfully received by the slave surivilance robot from master robot it will transmits an acknowledgement that the command has transmitted successfully to the slave survilance robot.

Figure 1.4 shows the command acknowledgement signal from slave robot

March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

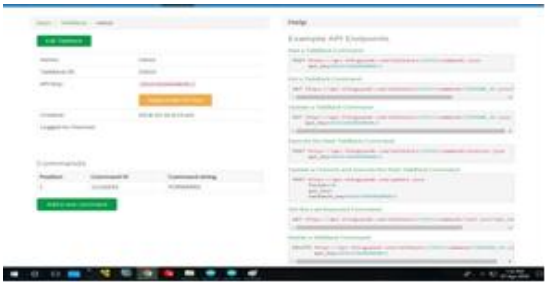


Figure 1.5 shows the talk back screen montoring process using think speak cloud

Figure 1.6 shows Robot Will Receive The Command From The Cloud Using Wifi

Hardware Requirements :-

Master/slave surivilance robots are mainly used in disaster management operations to reach areas that are hazardous and the human's beings feels difficult to enter the area. So in our proposed Master/ slave Robot systems were designed to investigate theenimies surrounding Environment andTo analize the structural integrity of buildings ,To detect hazardous materials present in the path of slave robots. The various Hardware components used in our proposed concepts

1. Arudino-uno Microcontroller
2. Nordic Radio Frequency Module(nrf24l01)
3. Wireless Camera
4. Robot ARM setup Model
5. DC Motors
6. RF Transciever 433 MHZ
7. Proximity, Fire and Gas Leakage Sensor
8. IC Max232 & IC L298

- To increse efficient Reservation in terms of time and energy during when slave node becomes unavailable to the master .Additional modification has to be performed according to which Robot will configureas Master/slave in the cluster network The Node which have more battery power most probably will be act as a Master in the cluster network.
- The Master and slave are monitored and controlled through Arudino uno IOT basedweb APPApplication.
- The command from Master node stationis transmitted to slave surveillance robots via NRF module and Wi-fi Adhoc Network connection.
- Movement of slave surveillance Robot depends upon the DC motor and it includes both its motion control purpose , wrist usage,Speed ControlAnd direction control purpose.
- In this research, Survilllance Slave Node contains arm setup, it is used to pick and place the obstacle things on its path.
- Obstacles are identified by using Proximity And IR Sensors and Poison Gas ,fire and poisonous can be identified by using nano technology based Gas sensor.
- We performed various parameters for simulations afrom that we calculated the efficiency and appropriateness of different situations.

a. Arduino UNO

The Arduino Uno is a microcontroller board operations are based on the ATmega328 and it

March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

supports IOT and open sources Platform for cloud computing. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. We can interface our Personal computer via USB Cable not through Serial Port because latest processor are not available with serial ports. The Uno differs from all Microcontroller boards in that it does not use the FTDI USB-to-serial driver chip. Instead of that it adapts the features of Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino.The circuit diagram of designed base station is shown in figure 4.

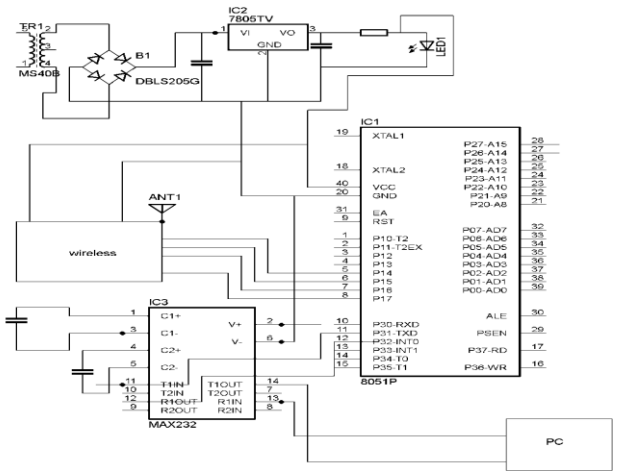


Figure 4. Circuit diagram (base station)

b.Nordic Radio Frequency Module(nrf24l01)

NRF is a Radio frequency module used to transmit the data between Master/slave node and it a single chip operates at 2.4GHz frequency used for IOT based ultra low power wirless applications. In our application it is configured at a serial port interface through its register map. The register map contains all modes of register operation and configurable setup. It supports Embedded base band protocol on packet communication and various modes from manual operation to advanced autonomous protocol operation. The embedded baseband protocol engine (Enhanced ShockBurst) is based Internal FIFOs ensure a smooth data flow between the radio front end and the system's MCU. The radio front end uses GFSK modulation. It has user configurable parameters like frequency channel, output power and air data rate. The air data rate supported by the nRF24L01 is configurable to 2Mbps. The high air data rate combined with two powers saving modes makes the nRF24L01 very suitable for ultra low power designs. Internal voltage regulators ensure a high Power Supply Rejection Ratio (PSRR)

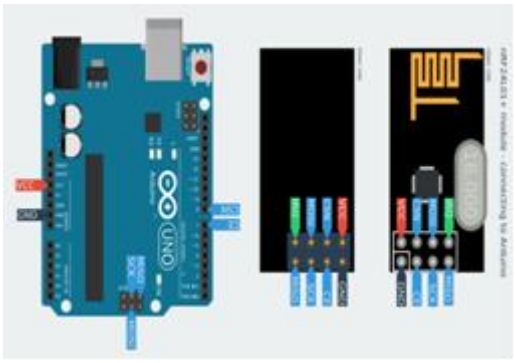


Figure shows interfacing NODE mcu with NRF module

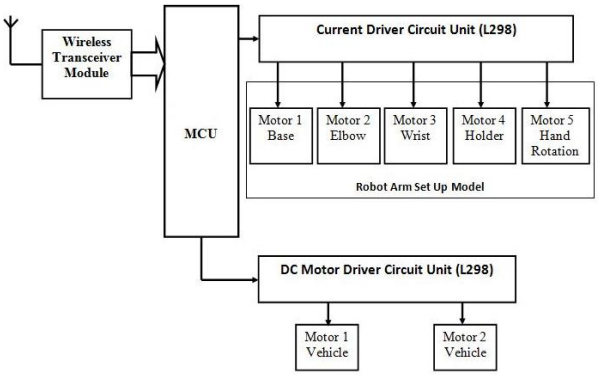


Figure 2. Reserve Station (Robot 1)

Wireless Camera :

Wireless security cameras (Lorex HD 1080p 12MP) are closed-circuit television (CCTV) cameras that transmit a video and audio signal to a wireless receiver through a radio band.For Raio band we are interfaced with RF 433 MHZ

March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

modules, it operates at Radio Frequencyrange between 30 kHz to 300 GHz. In this RF system, the digital data is transmittedby using Amplitude Shift Keying (ASK). Modulation Technique.Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications.

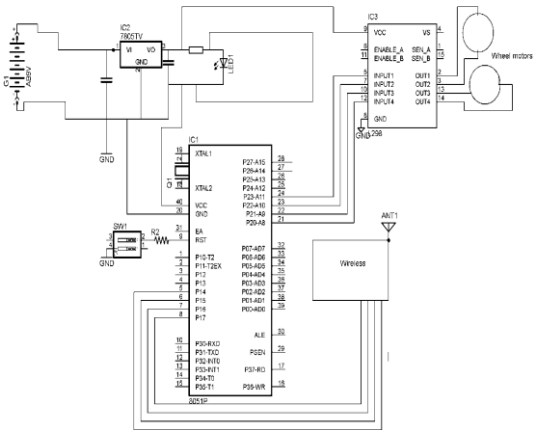


Figure Circuit diagram (Slave Surivallance nodesection)

DC Motors

L298 is a dual H-Bridge motor driver, using one IC we can interface two DC motors and it can be controlled in both clockwise and counter clockwise direction for Robot motion control and L298is a current driver control circuit module which produces an output current of 600mA and peak output current of 1.2A per channel used to operate the Robot ARM Set up Model for Pick and Place the obstacles present in the path.

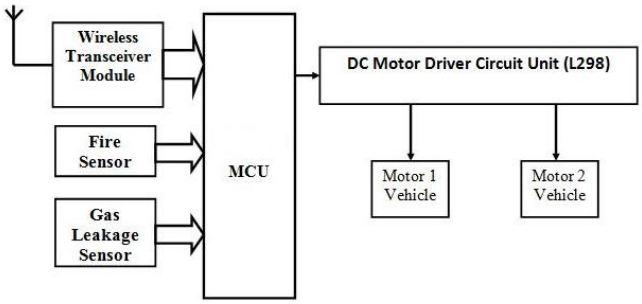


Figure 3. Reserve Station (Robot)

Nano Technology based Gas Sensors:-

In the present case, a nanotechnology based gas sensors used to detect the fire Exploxisives present in the Surivallance slave robotic path. Gas sensors for detectingFire gases as well as Poison gas pollutants present in the Enemies Path. The nano technology based gas sensors will operate stably under deleterious temperature conditions and thermal Attack or Chemical gas reactants which are explosive to fires. Nano technology based solid-state gas sensors appear have practical robustness to identify the fires in survilance environment. The sensors used for detecting gas pollutants, fires explosives using a Metal oxide layer and a substrate of two electrodes. Typical materials are tin oxide (SnO_2), zinc oxide (ZnO), titanium oxide (TiO_2) and tungsten oxide (WO_3) with typical operating temperatures of 200 to 400ºC.

Nano Sensor Statistical Analysis

RSM modeling combining with three-level BBD design were used in this experiment to validate its statistical analysis. Box Behnken Design is a self-determining quadratic design which needs fewer combinations of the variables to estimate a potentially complex response function than a full factorial design. In this analysis, BBD with three independent variables (x1: Temperature, x2: Particle fraction (% Vol), x3: Solution pH) at three-levels was performed.

$$X_i = (X_i - X_0)/\Delta X$$

Table 1. Coded and Actual Variables using BoxBehnken Design

Independent variables	Symbol	Coded and actual variable level		
		Low	Center	High
		-1	0	1
Temperature (℃)	X_1	30	45	60
Particle Fraction (%	X_2	1.5	3	4.5
Solution pH	X_3	4	8	12

March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

where Xi is a coded value of the variable, xi is the actual value of the variable, and X0 is the actual value of the ith test variable at the center point. The range and levels of individual variables are presented in Table 1. The whole experiment design consisting of 17 experimental runs is shown in Table 2. In the first step of RSM, a proper approximation is implemented to find the relationship between the dependent variable and the set of independent variables.

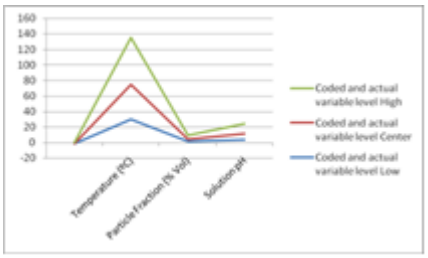
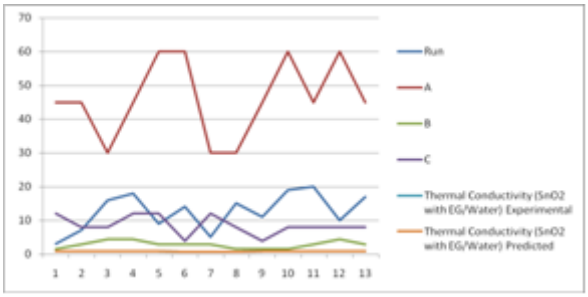


Figure Coded and Actual Variables using BoxBehnken Design line chart Represention.

Table 2. Experimental data

Std	Run	A	B	C	Thermal Conductivity (SnO_2 with EG/Water)	
					Experimental	Predicted
1	3	45	1.5	12	0.7921	0.7920
2	7	45	3	8	0.7914	0.7914
3	16	30	4.5	8	0.7924	0.7925
4	18	45	4.5	12	0.7931	0.7930
5	9	60	3	12	0.7920	0.7921
6	14	60	3	4	0.7897	0.7897
7	5	30	3	12	0.7899	0.7897
8	15	30	1.5	8	0.7859	0.7859
9	11	45	1.5	4	0.7909	0.7910
10	19	60	1.5	8	0.7928	0.7928
11	20	45	3	8	0.7915	0.7916
12	10	60	4.5	8	0.7949	0.7948
13	17	45	3	8	0.7915	0.7915



Hardware Control Operation

- The commands were designed as A (front), B (back), C (right), D (left) for master robot which controlled by Mobile App in Transmitting Node Sytem .
- The commands were designed as P (front), Q (back), R (right), S (left) for slave Survilance robot which controlled by Base NODE –MCU and NRF module. Inside the rescue zone, both robots were actuated in after connected to base station.
- When both Master/ slave robots gets authenticated by the base station mobile app, their real time visual interpretation was viewed in LCD TV using wireless camera embedded in the both robots.
- As per the transceiver ability, both robots were controlled within the radius of 300 metres. Now the thing is, when any one of the robot exceeding the 300 metres limit, it will lose its connectivity from the base station leads to retrieval error of obtained data.

March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

- The commands/response between Master MCU and Slave Node MCU in a common cloud base data environment system.
- In emergency situation if any one robot is destroyed by the enemies the additional slave survilance robot will perform the interrupt task
- The commands and data Transfer between the Master/slave robots can be montoried by using mobile base station Web application android App and the movement, position , tracking details are stored in a common think speak cloud Data base

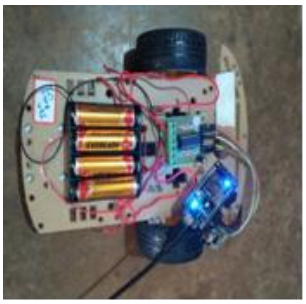


Figure Master Robot MCU Unit

- Whenever the survilance slave robot Excedding the out of coverage area above 300 meters and lost its connectivity means the Nearest slave robots in the cluster network having good battery power will be configured as a master MCU node and then it creates an authentication between Base node and slave node.
- After creating a successful authentication between base node and Master Node MCU will starts to transmit the lost commands and data which is interrupted to slave node

Fig Slave Robot

- To reterive and check the commands stored in the cloud database system.we have implemented a dataming algorithm for both master and slave node.
- In Dataming programming algorithm the commands P, Q, R, S cannot be processed by the master robot because it is designated to receive A,B,C,D only. Therefore it transmits an un-regonized command which is easily identified by nearest slave robot in the cluster network.

II. Conclusion

The adhoc based networked robots were implemented successfully. The adhoc networked robots not only created the clustering connection between the multiple robots, but also improved the range of connectivity higher without making change in the transceiver protocol. These kinds of mobile robots will be useful in hazaradous Environment and it can be handled inside the military zone to track the enemies' area Secertly and perform their mission easily .using these mobile robots we can save the life of the humans.These Mobile robots connected with camera will provide a live video streaming connection using VOIP protocol and By using web based application we can track the enemies environments to find obstacles and To pick move the obstacles from the robotic path. We can handle inside the rescue zone. so that the rescuers can better

March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

assess the condition of the civilians and plan their own actions of robots accordingly.

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March - April 2020
ISSN: 0193-4120 Page No. 114 - 124

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