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DESIGN AND IMPLEMENTATION OF A REMOTELY CONTROLLED MOBILE RESCUE ROBOT

Mohammed Saifuddin Munna[1,*], Md. Kamrojjaman[2], Mohammad Ariful Islam Bhuyan[3] and Mosharaf Ahmed Chowdhury[4]

[1]Department of EEE, Chittagong University of Engineering & Technology, Chittagong, Bangladesh
[2-4]Department of EEE, Premier University, Chittagong, Bangladesh
[1,*]munna.puc@gmail.com, [2]kamruzzaman_puc@yahoo.com, [3]arif.ajtfs@yahoo.com, [4]engrmosharafahmed@gmail.com

Abstract*-The recent natural and man-made devastations have urged the research on the rescue robot systems. This paper presents a novel shape-shifting remotely operated mobile robot system rescue application with live video telecasting. In current situation rescue system is not so well trained & well equipped. As maximum rescue operations are operated by going there it takes time & sometime it was impossible to reach the accident spot with huge system. So Author's presents a paper where these factors are in main aim to solve. This paper describe a robotic system which is controlled by joystick, Xbee, gear motor servo motor and motor driver which are processed by Arduino UNO and Arduino MEGA Combination from a remote location in addition to remote monitoring using camera. By watching video in a monitor with the help of Boscom Video tx-rx device this robot can be operated with joystick. Xbee system is used here as Communication purpose.*

Keywords: Rescue, Robot, Shape-shifting, Joystick, Arduino, Camera, Servo Motor, Xbee.

1. INTRODUCTION

Natural calamities do occur and they are exceptional and unstoppable event which damage both economic and social balance. In common situations that employ rescue robots are mining accidents, earthquakes urban disasters can all result in large scale damage to buildings. These collapsed buildings contain many trapped victims therefore humanitarian search and rescue operations are very important. Search robots equipped with advanced sensors for human search and surrounding sensing have been found to be more efficient in these operations. By using rescue operation we can help victim people and in that case rescue robot plays a vital role.

Our system is based on wireless sensor network technology to help people in natural calamity like disaster, mining accidents, earthquakes, flood etc. This system consists of many sensor, controller, transceivers, camera module, good capability and battery powered. This system is controllable from remote cockpit and pilot can visualize environment through wirelessly. Pilot is also capable to send instruction wirelessly. The concept of rescue operation increase day by day to save people and others lives during natural calamities which may not be stoppable [1,3]. A timely rescue can only save the people who are buried and wounded. The rescue system must collect the location information and status of victims, stability of the structures as quickly as possible so that medics and firefighters can enter the disaster area and save people. These types of dangerous situation handle with human and trended dogs [4].

2. RELATED WORKS

Remote Operated and Controlled Hexapod (ROACH): ROACH is a design that provides significant advantages in mobility over wheeled and tracked designs [5]. It is equipped with cameras which transmit live audio and videos of the disaster site, as well as information about locations of objects with respect to the robot's position to the interface on the laptop. Kohga: University of Tokyo - The most complicated task for most of the USAR robots has been working on a rough terrain [2]. Specialized robots have been designed for these types of environments such as KOHGA the snake like robot [6]. The robot is constructed by connecting multiple crawler vehicles serially, resulting in a long and thin structure so that it can enter narrow space.

System for disasters made up of four parts sensor, mobile rescue robot, transmission network, monitoring center. When victims are trapped inside debris, it will be difficult to search and rescue them quickly. At this situation Mobile robots are use that can go inside the building and detect if any victim is present and then signal the crewmembers for recovery. The purpose of using mobile rescue robots is to track the victims in disaster area. Disasters come with many obstacles for the rescue team that makes it hard for them to reach the victims, for example rainstorms, collapsed buildings, obstructions and dangerous substances. The rescue team must fast and securely find information of the disaster areas, so disaster area is covered by mobile rescue robot to rescue people which are injured survivor, unconscious survivors etc.

3. PROPOSED DESIGN

3.1 System Overview

The total design divided into two parts. One is transmitter section and another is receiver section. From transmitting section user sends specific instruction to the sending end for performing specific tasks. For remote control IEEE standard Xbee protocol has been used. Xbee used direct sequence spread spectrum which is more convenient than other wireless system. Its topology is used point to point communication. Its PAN id, channels and addresses are also important for this operation. Each section contains processing unit, signal conditioning system, data evolution unit and data sending receiving unit.

User sends command using joystick. Then this command sends to microcontroller for processing and eliminating noise. In that case for better signal mapping and most popular kalman filter an important agent. Then signals transmit through wireless xbee protocol. These instruction received by receiving end xbee. Xbee transfer this command to microcontroller. Then microcontroller evaluates it and sends to driver. For arm control here mapping also used for quick response and kalman filter used to eliminate noise. By performing this tasks robot start moves. In case of servo motor, signal transfer from microcontroller as required command. Then arm moving it desire position. For viewing environment a wireless video transmitter placed in robot end. Then video received by receiver in user end. An ultrasonic sensor used to measure target distance and evaluate its environment condition. This way robot perform it specific rescue tasks.

Fig.1: Real view of Robot section.

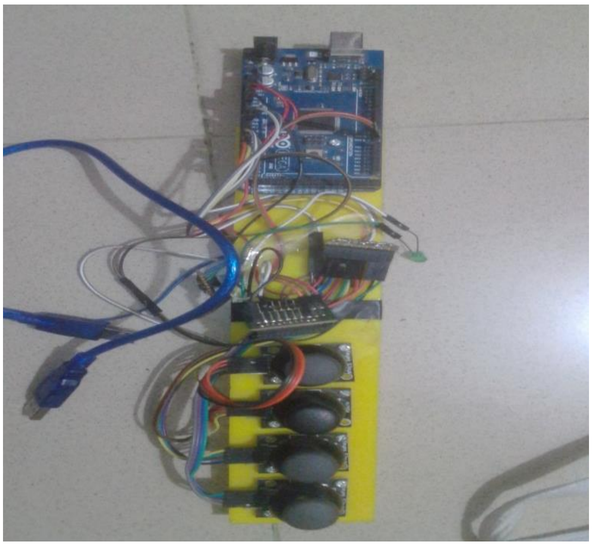

Fig.2: Real view of controller section.

3.2 Block Diagram

At first joystick data goes to microcontroller. Then this data is processed and sends over wireless xbee protocol. Then this data received by another xbee which works as receiver and then transfer data to receiving end microcontroller. Microcontroller evaluates this data and filer it using kalman filter. At last this data mapped and control different servos which is used for arm control. Movement control data fed by motor driver and control the robot movement.

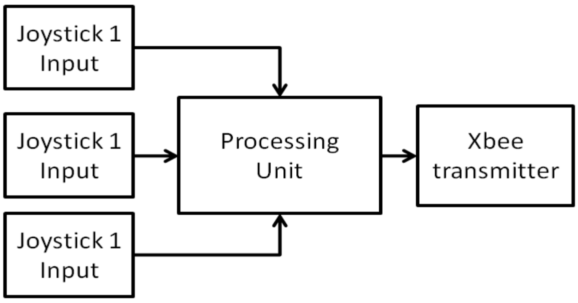

Fig.3: Block diagram of transmitting section.

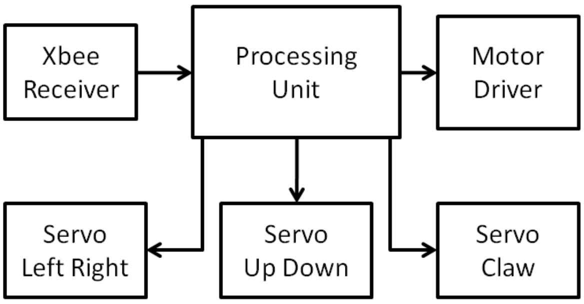

Fig.4: Block diagram of receiving section.

4. OPERATION STRATEGY

4.1 Distance Measurement

An ultrasonic electric telemeter module can measure a Distance within 0.03-3M effectively [12] and transform the data into impulse with different width. By employing Ultrasonic intelligence software processing technology, there liability of measurement as well as the capability of ant jamming has improved. Sensor sends a brief chirp with its ultrasonic speaker and makes it possible for the BASICS tamp to measure the time it takes the echo to return to its ultrasonic microphone. The BASIC Stamp starts by sending the sonar sensor a pulse to start the measurement. Then, the sensor waits long enough for the BASIC Stamp program to start a PULSIN command. At the same time the sensor chirps its 40 kHz tone, it sends a high signal to the BASIC Stamp. When the sensor detects the echo with its ultrasonic microphone, it changes that high signal back to low. The BASIC Stamp's PULSIN command stores how long the high signal from the sensor lasted in a variable. The time measurement is how long it took sound to travel to the object and back. The duration of high level T3 will be ensured by the distance between the object and the telemeter. The host computes the distance though the impulse width input by the electronic eye module:

$$S= (V*T3)/2$$

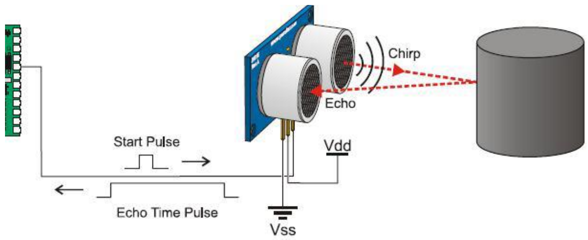

Fig.5: Distance Measuring Using Ultrasonic Sensor

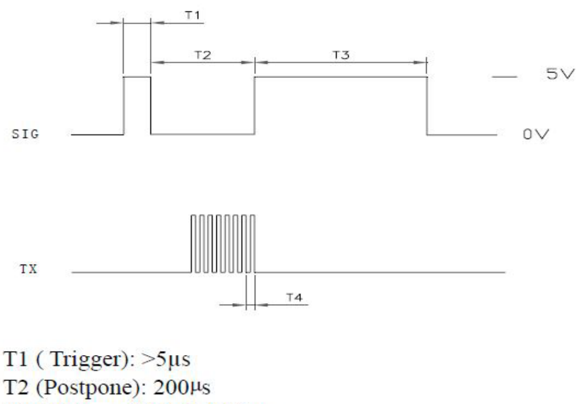

Fig.6: Signal Used in Distance Measurement

4.2 Servo Movement

Our system is manual controlled and our controller is joystick. When joystick moves in different direction then its output works as input signal. Controller converts this signal into resolution from 0-1023. This way signal control a servo signal by using mapping. After that signals mapped this value as 0 degree to 360 degree for arm movement. There is a minimum pulse, a maximum pulse, and a repetition rate. From Fig.7 servomotors can usually only turn 90 degrees in either direction for a total of 180 degree movement [11]. The servo motor expects to see a pulse every 20 milliseconds (ms). Here a1.5ms pulse will make the motor turn to the 90-degree position. Shorter than 1.5ms moves it to 0 degrees and any longer than 1.5ms will turn the servo to 180 degrees, as diagrammed below. This way arm moved in different position as per operation.

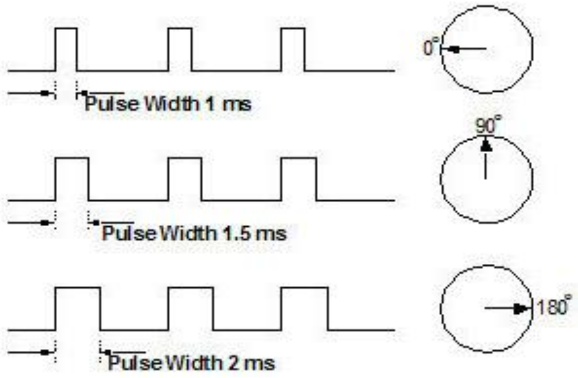

Fig.7: Rotation Process of Servo Motor

4.3 Networking

The XBees can operate either in a transparent data mode or in a packet-based application programming interface (API) mode. In the transparent mode, data coming into the Data IN (DIN) pin is directly transmitted over-the-air to the intended receiving radios without any modification. Incoming packets can either be directly addressed to one target (point-to-point). This mode is primarily used in instances where an existing protocol cannot tolerate changes to the data format. AT commands are used to control the radio's settings. In API mode the data is wrapped in a packet structure that allows for addressing, parameter setting and packet delivery feedback, including remote sensing and control of digital I/O and analog input pins. In this system point to point topology has been used.

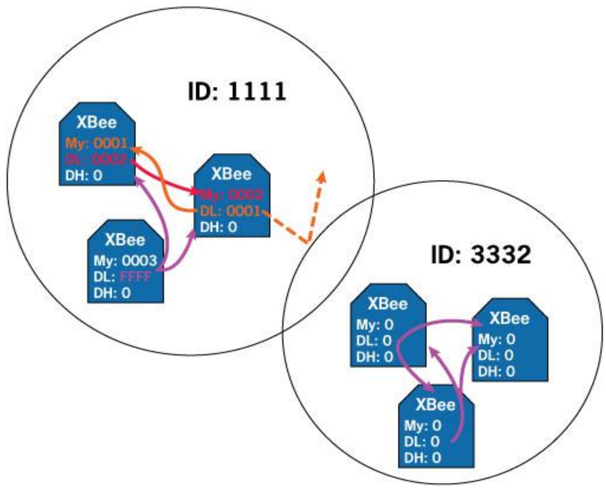

Fig.8: Xbee networking

4.4 Data Processing

For data processing high speed microcontroller has been used. In that case transmitter end microcontroller processes the instruction commands. And receiving end microcontroller receives the received data and performs operation of those instructions.

In transmitting end raw data filtered by kalman filter for first response, stability and accuracy. Then angle calculated by an artificial algorithm. This data has been mapped to make it synchronous for servo movement. Then data transmit over Xbee protocol as point to point communication. For robot movement also controlled by using some command, in that case no mapping required because user can observe its movement by using wireless camera module.

In receiving unit, data received by another xbee and hosted by processor. After that received data filter also and angle evaluation performed. Then this signal used to control the servo movement. This movement for arm control.

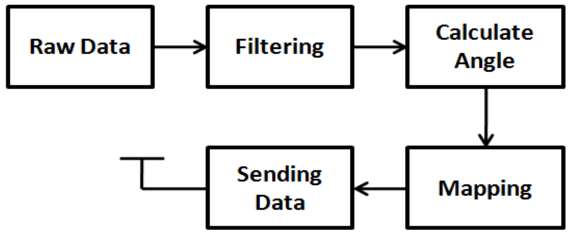

Fig. 9: Transmitting data process

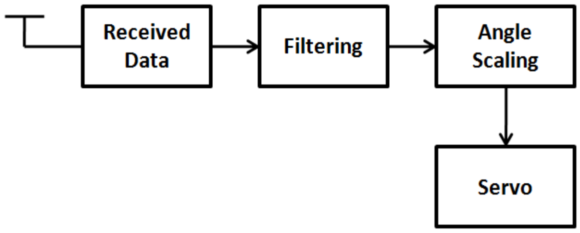

Fig.10: Receiving data process

5. ALGORITHM

Our total system divided into two parts. One section for pilot end and another section for robot end. In both case some special artificial algorithm and strategy has been used to make it more responsive and faster. Algorithms are given below.

6. RESULTS

During the robot in rescue operation, several parameters are inspected and then simulation performed by MATLAB tools. Here green line, blue line, red line indicates temperature, transmitter buffer time, receiver error respectively. Transmitting Buffer and Receiving Errors in fig. 13. Temperature shows in fig. 14. It's clear that processing unit operates in perfect condition i.e. temperature is remain constant with environment and does not exceeded safe level, buffer time is 100ms which not bad and receiver error or response error is zero. Arm synchronization moment is also responsive and fast, data shown in Table.1. So system is stable and first responsive.

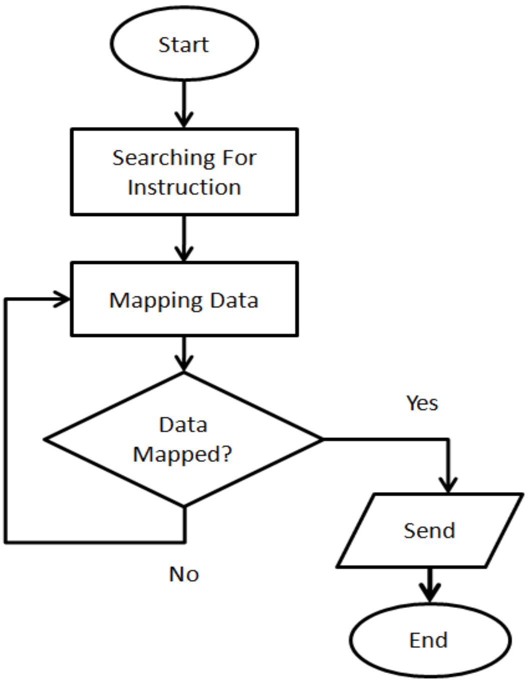

Fig.11: Algorithm of Transmitting Section

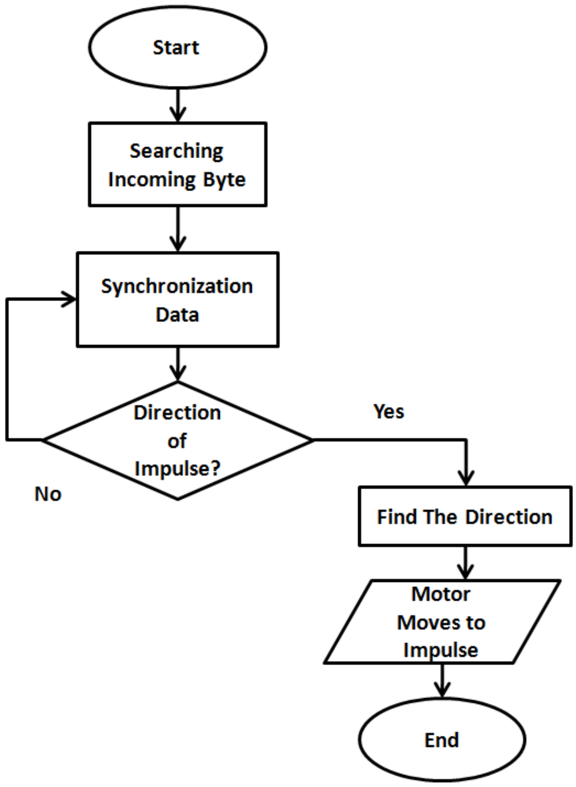

Fig.12: Algorithm of Receiving Section

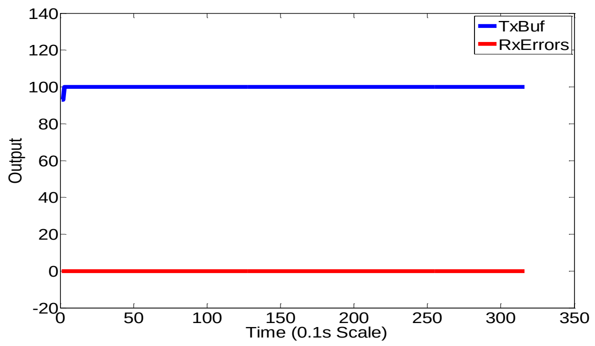

Fig.13: Performance curves

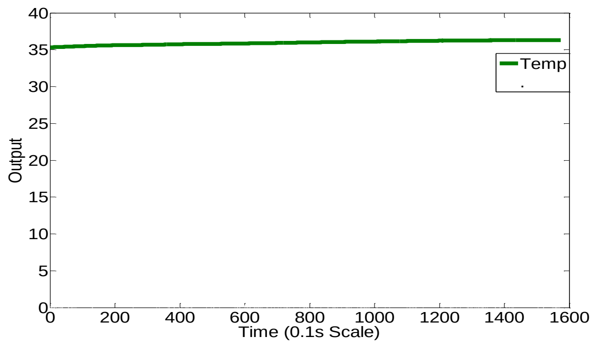

Fig.14: Temperature curve

Table 1: Arm Movement Data

Obs.	X-axis movement (deg.)		Y-axis movement (deg.)		Z-axis movement (deg.)	
	Joy-stick	Servo	Joy-stick	Servo	Joy-stick	Servo
1	30	31	25	23	51	49
2	54	56	60	59	80	80
3	90	92	85	84	75	74
4	120	180	70	68	110	112

7. CONCLUSION

After all from results and analysis, system is more stable, responsive and easiest process. To build a rescue robot is not so easy but this system ensures to avoid its complexity. User can control it from remote place and can observe places remotely. This system also measured obstacle and position of an article.

For further autonomous function GPS and Radar based technology also key point. By using this upgrade feature its may turn into a more powerful robot.

8. REFERENCES

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9. NOMENCLATURE

Symbol	Meaning	Unit
T	Time	(Sec.)
V	Velocity	(m/sec)
S	Distance	(m)