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DEVELOPMENT OF REDUNDANT COMMUNICATION METHODS FOR ROBOTS IN NUCLEAR APPLICATIONS

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Abstract - *Generally the parallel communication between master control system and its sub-modules like analog front end, data acquisition unit or final control elements will require a large number of wires. This project minimizes the cables by serializing the independent digital and analog lines, thus providing a better noise immunity to the system. To improve the data security, data encryption/decryption methods are used. For redundancy, alternate communication methods are implemented, thus ensuring flawless data transfer even in case of failure of one communication stream. Power line communication and optical fiber communication methods are complementing each other along with RS-485 communication, providing a secure and redundant data transfer between the sub-modules in a control system.*

***Key Words*: Serial communication, RS 485, optical fiber communication, power line communication, printed circuit board, Arduino ~~board~~**

Introduction:

The data communication is necessary part of transmission of value from control room to robots in the nuclear field. To make the robot work more efficiently with reduced number of cables, we introduce this redundant technique for communication.

Redundant techniques in communication will generally involve more methods of data transferring. By doing this if any communication link fails also the alternate method will help in communication link fails also alternate methods will help in communication.

This will improve the availability of the robot. Here power line communication and optical fiber communication methods are complementing each other along with RS-485 communication, providing a secure and redundant data transfer between the sub-modules in a control system.

1.1 Communication:

The communication links, across which computers (or parts of computers) talk to one another, may be either serial or parallel. A parallel link transmits one bit of data through one channel whereas, a serial link transmits serialized stream of data will be send through one channel[1]. Hence the number of wire used for communication with the help of serial communication is less when compared with the parallel communication.

1.2 Channels for redundancy:

The redundant communication is made possible by transmitting the data over multiple modes of communication. Each communication mode can be considered as a module. In this project we use three modules:

- RS-485
- Optical fiber communication
- Power line communication

These features make it more important for the channel to be selected rather than any other channels.

As this project is mainly applied in the nuclear reactor it should see to that the number of wires used should be minimum. This is because when the number of wires used increases there is a possibility that the radiation leakage may occur.

Hence this idea will reduce the number of wires used for communication also.

1.2.1. RS-485:

RS-485 is connected with the help of MAX 488 that is more efficient and provides a full duplex. Hence communication can occur in both the directions.

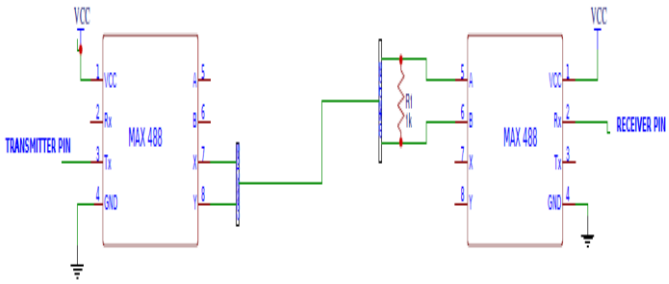

Fig:1.circuit connection for RS-485

1.2.2. OPTICAL FIBER COMMUNICATION:

Fiber optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information. By this project we can send pulses of light through an optical fiber[2,3,4].

Fig:2.circuit connection for optical communication system

1.2.3. POWER LINE COMMUNICATION:

Power line communication (PLC) is the use of existing electrical cables to transport data, and it has been around for a very long time. This basically means any technology that enables data transfer at narrow or broad band speeds through power line by using advanced modulation technology.

This is done with the help of KQ 330F modules. The advantage of using this module is that all the components are widely available, and the range of devices that are available provide a variety of applications that can be achieved using simple plug-in or wire-in modules[5,6]

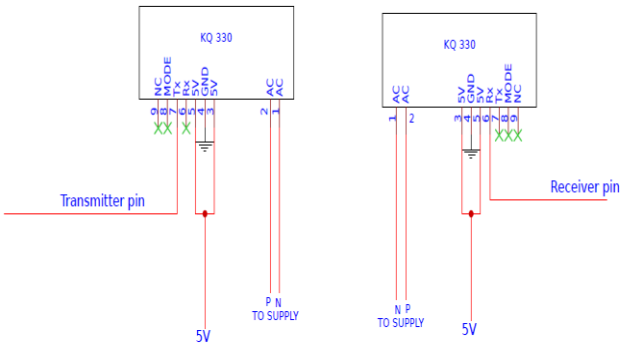

fig:3.circuit connection for power line communication system

Table -1: merits and demerits of each system

Module	RS-485	Optical fiber communication	Power Line communication
Merits:	Lower signal level interface	Resistance to Electromagnetic Interference	Reduction in the number of wiring used.
Demerits:	Not suitable to transfer large amount of data	Cost Is Higher Than Copper Cable	Data attenuation

2. Concept:

In this paper, the multiple communication modules are established between two micro controllers and a joystick based motor speed control of robotic arm with stepper motor as prime mover is implemented to verify the communication link. The joystick is an analog joystick with two channels. The data from the joystick is digitized and send by the transmitter micro-controller (Arduino mega 2560) to the receiving side micro-controller (Arduino mega 2560) using the three communication modules explained in 1.2. The data is displayed in a character LCD in both transmitting side and the receiving side to verify the data integrity. The data received in the receiving end microcontroller is used for controlling the motion of two stepper motors, in either direction and variable speeds, according to the position of the joystick lever. The stepper motors drives the robotic arm through suitable reduction gears.

A custom shield for MEGA2560 with all required electronics and connectors is designed and PCB is manufactured. All three modules are soldered and tested on the PCB. Programs for the Arduino boards are written in Arduino IDE.

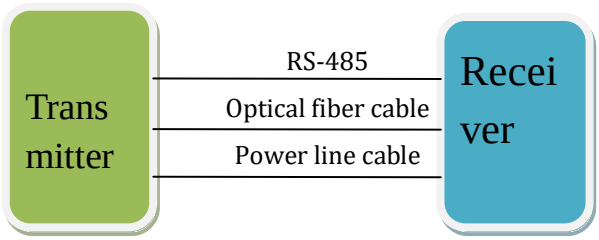

Fig:4. Model of transmission

3. Transmitter side:

In the transmitter side there is a controller (i.e., joystick) whose values are used to control the robotic arm. It also consists of the LCD display that helps in displaying the obtained value. Then the various communication transmitters are connected to the system in this side.

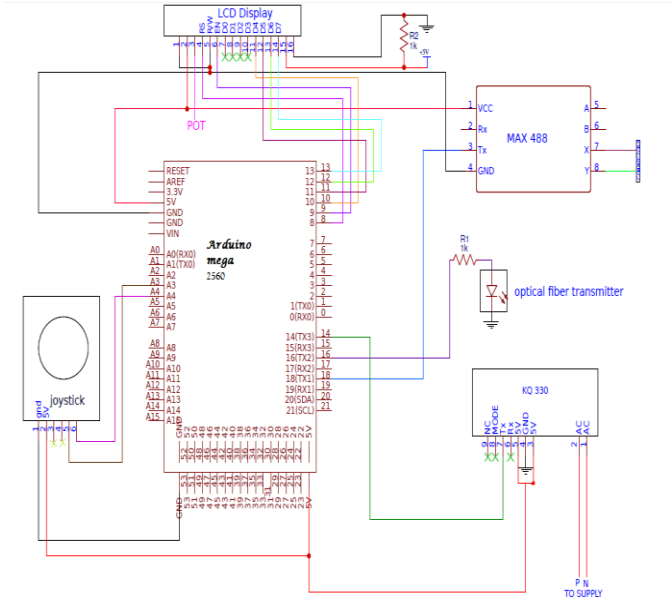

Fig:5. Circuit connection for transmitter side.

3. Receiver side:

The receiver side will have very similar connection that is in the transmitter side. The receiver side will have receiving end connection for each system.

The receiver system will also have the LCD display that will display the received values from the communication channel.

In addition to it , the receiver system is connected to the stepper motor that drives the robotic arm. The stepper motor is connected and controlled with the stepping drive. The stepping drive consists of two digital inputs, one for pulse and the other for direction of rotation. These two inputs are given to the digital pins of the microprocessor.

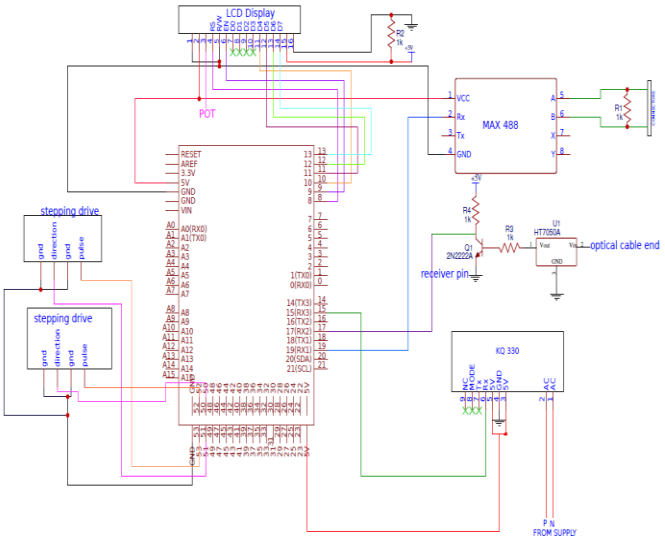

Fig:5. Circuit connection for receiver side.

Results & Conclusion:

System has been assembled and tested and communication was established through all the three channels. The transmission and reception are done simultaneously and if any failure occurs in any of the channels, the system will work efficiently with one communication link. Redundancy is verified by removing one/two channels in random, the communication was found flawless and robotic arm is tested successfully.

This project will help in providing redundant communication with the systems that are far apart. It also reduces the noise that is present in the system and very useful in communication system that cannot be regularly verified. It can be further implemented in automobiles too, so that the efficiency of the system control is in the hands.

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