

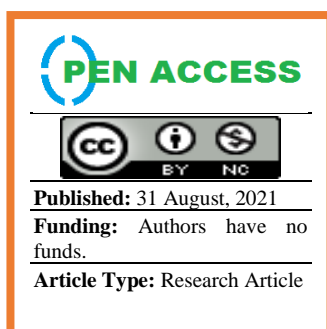
CONTROL ALARMS BY USING NRF 24101 RADIO MODULE

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ABSTRACT



Due to the development of microelectronics technology and high-speed digital signal processing technologies, wireless communication is undoubtedly a convenient, fast and effective method. It has been used widely in industrial production and people's life; especially it has enabled new advanced methods of data acquisition and transmission for complicated terrain conditions, hostile environmental conditions and other places that are inconvenient to reach for humans. Here, we design a scheme of wireless communication system that has small size, low cost and can collect environmental factors such as temperature data remotely and in real time. The core of the system control module ATMEGA328 microcontroller is a high-performance single chip microcomputer with a wide voltage, low power consumption, high integration, strong anti-interference and strong portability characteristics. The core of Arduino UNO processor is ATmega328. It has 14 pins for digital input/output (six pins can be used as a PWM output), 6 analog input pins, 32 KB Flash Memory and 1 KB EEPROM. The sensor has anti-interference ability, high integration, high precision, low power consumption, small size and low price. Software is based on the Arduino exploitation environment. Arduino has its own exploitation environment which is based on Eclipse IDE development environment, similar to the JAVA and C/C++, the UI is user friendly and program compilation and flashing of software with Arduino IDE is simple. NRF24L01 through configuration registers, define all the configuration characteristics. The configuration register can be set-up through SPI. SPI (Serial Peripheral interface) is a synchronous serial communication interface. It has 10 Mbps maximum transmission rate and Twelve instructions are associated with SPI.

Keywords: IoT; sensors; signal processing; power consumption; wireless communication;

1. INTRODUCTION

Technologies in industry have been expanding sharply in the last two decades. As glowing day after day, more and more advanced electronic products are more advanced than the old day [1] [2]. At the same time, the wireless industry is demand and desire to produce a device capable of catching up with technologies, while producing more and more wireless devices that are useful to the public, especially for the task of remote-control work. Because the technologies are getting higher, development fees also increase with them. Thus, the machines that are produced that are equipped with high technologies are increasing in price. In this project, NRF24L01 wireless designed to transfer signal of temperature the task will be discussed [3]. However, to produce of this device, it should be low price in development fee and with high technologies integrated. If it is consider as manufactured for one time purpose or one time use, then it should be as low cost in production fee as well. However, currently commercialize robotics are very expensive and consumers are unaffordable to buy a single of it.

Currently, marketing devices are mainly for a safe task that does not include in any crisis of destruction and may not bring damage to users that can be considered not to be designed for being destroyed [1]. We may need to think of a good job is always bring the product has been used only once. So that we using NRF24L01 wireless in building system which watching temperature degree. However, currently the cost of producing a device that is intentionally designed for the task of transmitting the signal via wireless, therefore, it is not appropriate to consider the use of only one time. In addition, the project must be designed According to the requirements of life, due to the large number of devices used in the present, the focus is on the transmission and remote control devices in a time sensitive manner, which means that it should be more accurate in time to do a task and must be a specific task [4]. As a result, there is a very high demand in producing such a device which is low production cost and perform a good task in a timely manner in a sensitive manner so we used NRF24L01 wireless [5].

In this project, the objective is to design, implement and build a low cost substation using NRF24L01 wireless. There are several sub-objectives need to accomplish in order to successfully achieve our target which are as below:

1. Define, design and construct the structure of the substation control units.
2. Define a parts that using to building the control units.
3. Define the working of the system to control the substation.
4. Construct the NRF24L01 remote controlling for the substation.

By the end of this project, a substation is developed and it can be control by NRF24L01 wirelessly. The substation control unit is able to sending alarm when any problems happened in the substation to make us able to solve these problems before it become large.

2. BACKGROUND

Through weather monitoring system we can collect the information about temperature and according to current and previous data we can produce the results in graphical manner in the system. After reviewing many articles, there are presently no papers that mention monitoring the combination of temperature by using NRF24L01 wireless in one integrated system and have actuators to modify these settings. In addition to this, there is one research paper that has discussed monitoring these environmental conditions; however, there has been no mention about having actuators to modify. So our main idea was to coin a system that can sense the main component that formulates the weather with using wireless and can be able to forecast the weather without human error. Ancient weather forecasting methods usually relied on observed patterns of events, also termed pattern recognition. For example, it might be observed that if the sunset was particularly red, the following day often brought fair weather. This experience accumulated over the generations to produce weather lore. However, not all of these predictions prove reliable, and many of them have since been found not to stand up to rigorous statistical testing. The simplest method of forecasting the weather, persistence, relies upon today's conditions to forecast the conditions tomorrow. This can be a valid way of forecasting the weather when it is in a steady state, such as during the summer season in the tropics. This method of forecasting strongly depends upon the presence of a stagnant weather pattern [6] [7] [8].

It can be useful in both short range forecasts and long range forecasts. Measurements of barometric pressure and the pressure tendency (the change of pressure over time) have been used in forecasting since the late 19th century.

Monitoring and controlling of substations are essential task for supplying healthy power to the consumers in this automated era. Depending on the voltage levels and end users, there are transmission or distribution substations those supply electrical power to various loads. Remote monitoring and control make these substations to be operated through wireless communication technologies like NRF24L01, GSM, GPRS, Ethernet, etc. Substations consist of various equipment like transformers, circuit breakers, relays, APFC panels, etc., and these equipment ought to be operated in such a way that the loads must be delivered safely with specified parameters. These parameters include voltage, current, frequency, power factor, temperature, and so on [9] [10] [11].

This system acquires a remote substation's parameters like voltage, current, frequency, etc., via network using NRF24L01 wireless. It allows the remote operator to operate relays, circuit breakers and buzzers, and facilitates the display of various parameters in the LCD that is interfaced to the microcontroller (Figure 1).

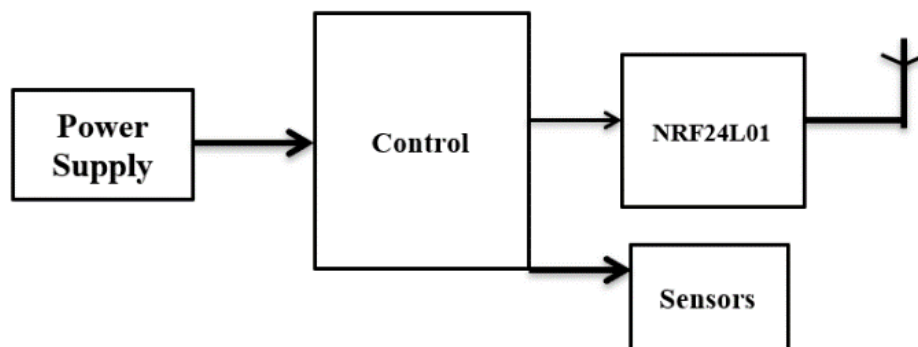


Figure. 1 Diagram system for TX wireless

3. PROPOSED SYSTEM

There are a lot of high-end systems available these days for round the clock weather monitoring. But these systems are implemented on a very large scale, for monitoring real time weather for a whole city or state.

Implementing such system for a small area is not feasible, since they are not designed for it and the overhead for maintaining such systems for a small area is very high.

Our proposed system makes use of 3 sensors to measure the weather/environment factors such as temperature, humidity, light intensity, dew point and heat index. The values read from the sensors are processed by the Arduino micro-controller and stored in a text file which can be processed upon to derive analysis. The readings are also displayed on an on board LCD for quick viewing. All these readings can be analyzed to get the weather characteristics of a particular area and record the weather pattern. These recorded parameters are essential and vary from places to places. All these requirements are fed into the database and these values are essentials and recorded over time. Using these values as input we can plot a weather chart of a particular area over time. Based on the present weather factors and preset values the set actions are done. The set action can include turning on the heating system when the temperature is colder than the set value and turning on the cooling system when the temperature is hot or humid beyond the set values.

The serial output from the Arduino micro-controller which are the values read from the sensors can also be stored in a database. The database can be used as a source for data if we want to display values through a website or a standalone application.

The modules that make up the weather monitoring system have been carefully and well thought of, to make sure that the sensors used are giving the most accurate reading and are compatible with the Arduino micro-controller. The modules used for the weather monitoring system can be summarized as follows (Figure 2):

Temperature sensor: This sensor is used for reading the temperature and also to calculate dew point and heat index.

PIR sensor: PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

IR photodiode: The IR transmitter is a particular LED that emits radiation in the frequency range of infrared, invisible to the naked eye. An infrared LED just works as a simple LED with a voltage of 3V DC and a current consumption of about 20mA. The IR receiver, such as a photodiode or a phototransistor, is capable of detect infrared radiation emitted from the IR transmitter. Aesthetically it is similar to a LED but the external capsule can be wrapped by a dark color film.

LCD: 16x2 LCD display is used to display the readings in real time manner. This is also human interface to the system.

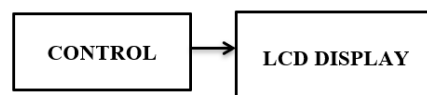


Figure. 2 Diagram for LCD display

4. THE MATERIALS

A wireless sensor network is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions [3].

In researching on this project, it reveals that monitoring using wireless sensor network technologies have been developing rapidly throughout the years. Many applications use this technology. These technologies have been employed, for example, to monitor heart beat rate [12], weather (SECTION 8 [1], in agriculture [13] [14] and many other situations. The advantage of these systems/technologies is obvious as it has significantly reduced the cost and extra work of wiring, and also allows configurations that permit data communication over longer distances. In addition, terminals can easily be moved and devices use less power. Many of these, however, have been built using old type analog sensors that used the microcontroller analog pins [1] for example), thus limiting the number of sensors that can be used for monitoring. The digital 1-Wire sensors were used in this project as already mentioned. Recent developments of wireless sensor networks shows a new direction of developments in open source hardware/software. This paper takes advantage of the Arduino open-source hardware platform and the nRF24L01+ radio module to present a developed dynamic wireless sensor network system. This is a low cost design, easy to maintain as compared to earlier wired and/or other radio standard designed networks. Environmental disasters, such as heavy storms pulling off roofs or trees are good example cause of failure to wired networks, making it difficult to maintain especially when implemented over longer distances.

Therefore, some of the major obstacles for a sensor networks to become transformable in engineering, commercial, and scientific application in the past, had being in its lack of flexibility, scalability, reliability, lasting

operation and maintenance. Some of these challenges may be handled by the network system implemented in this project. This system leaves room for future automatic addition or detection of more designed sensor nodes that comply with the system. are good example cause of failure to wired networks, making it difficult to maintain especially when implemented over longer distances.

4.1 Scope of the research

A Dynamic Wireless Sensor Network System based on the Arduino platform will be implemented. The system will consist of a Base station that will communicate wirelessly with a number of sensor nodes for environmental monitoring. 1-Wire sensors will be used. The sensor nodes will be battery powered. The base station will be responsible for the user interface where administration of sensors will take place. It will automatically detect new sensor devices that are in range, establish a connection, evaluate the sensor type and decide what type of data this sensor devices will send and what entities they measure, and then add the sensor to the user interface. The system will also update frequency, detect error, and will report these to the user interface. When a sensor is out of range or a battery is going bad this will be detected and shown in the user interface. A solution will be provided to keep the sensor nodes small and power efficient [15] [16].

4.2 Outline of the research

First, the topic, the problem, and the overall system architecture are introduced. The scope is then presented. Once a general idea of what the thesis is all about is known, we started building concepts to develop the sections that followed. This will include a presentation of the system hardware and the system design. The system design will be presented as a design for long-ranger nodes and the base node where the hardware design and software design will be included and explained in detail. The system will be tested and some sample data collection will be presented, all to demonstrate the usefulness of this equipment. Finally, we will present the problems faced and conclude with a summary and conclusion of the research.

4.3 Security Implementation

Wireless part networks are highly vulnerable to security attacks when compared to a wired or infrastructure-based network [17]. Thus, the nodes must have an effective yet low overhead security module. The information from the leaf node does not reach directly to coordinator or root node. The message is passed by various sensor nodes. The number of hops taken for the message to reach the root node is known by the sender. For this reason, an Onion protocol can be implemented. In this method, the sender will encrypt the data in layers according to the number of hops. For example, if it takes 3 hops to reach the root node, the sender will encrypt the data 3 times successively and then send the data to the root node. When the data is received by a node, it will remove one layer of encryption as shown in Figure 3.

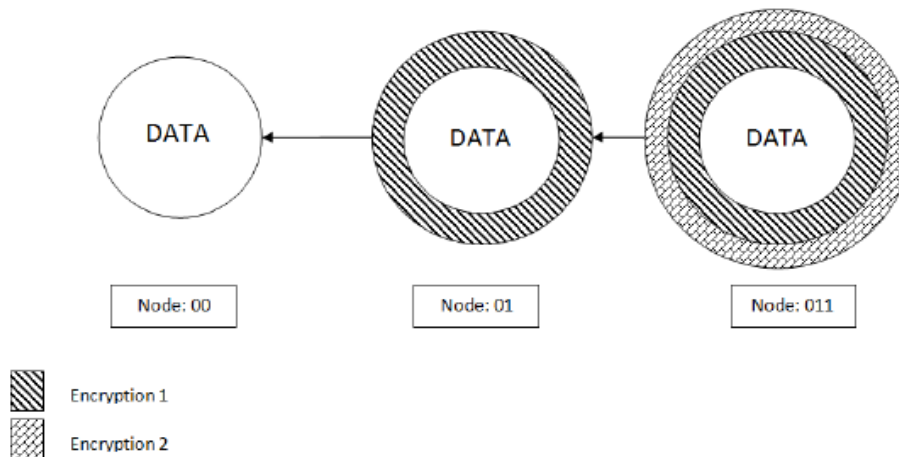


Figure. 3 Onion encryption

4.4 Application of wireless

The wireless sensor network attained with the implementation of RF transceivers and Arduino has many applications:

I. Home automation: Home automation is the use and control of home appliances remotely or automatically. The overall wired setup of home automation system can be costly and complex. By implementing wireless sensor network, we can overcome the cost problem while attaining a flexible and scalable system (Figure 4).

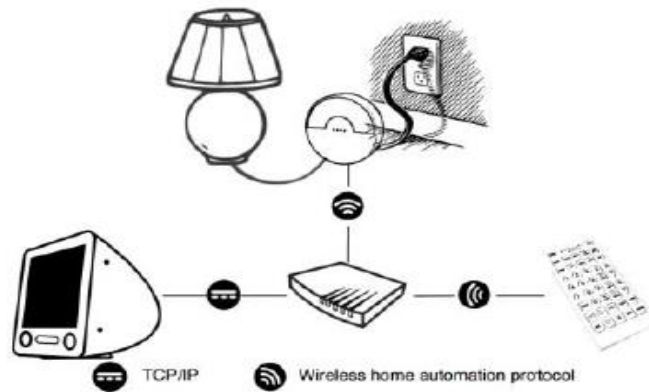


Figure. 4 Home automation

II. Wireless body sensor network: In a hospital healthcare monitoring system it is necessary to constantly monitor a patient’s physiological parameters. The monitoring system has a coordinator node attached on a patient’s body that collects all information from wireless sensors and sends them to the base station to be evaluated. These attached sensors on the patient’s body forms a wireless sensor network (Figure 5).

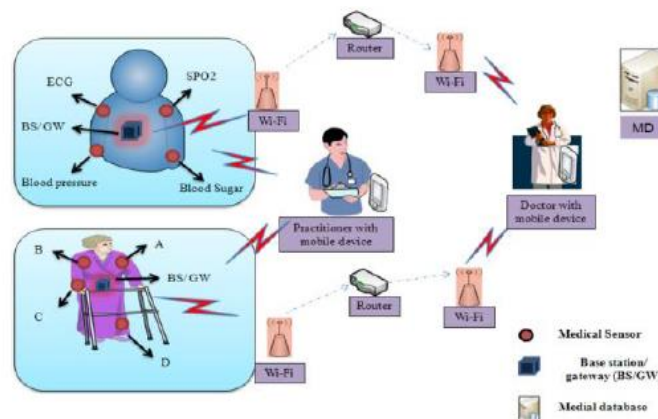


Figure. 5 Hospital body monitoring system

III. Factory Monitoring System: For factory automation, devices and machines consume a lot of space and make it a crowded place. As the pipelining space is limited, the labors working in the environment become more accident prone [13]. The combination of embedded systems on wireless technology has an enhanced quality of industrial safety.

IV. Internet of Things (IoT): Today smart grid, smart home, smart water network as well as intelligent transportation are infrastructure systems that connect our world. The common vision of search system is associated with one single concept i.e. IoT, where through the use of sensors the entire physical infrastructure is closely coupled with information in communication technology [3]. The wireless sensor networks are the key technology IoT(Figure 6).

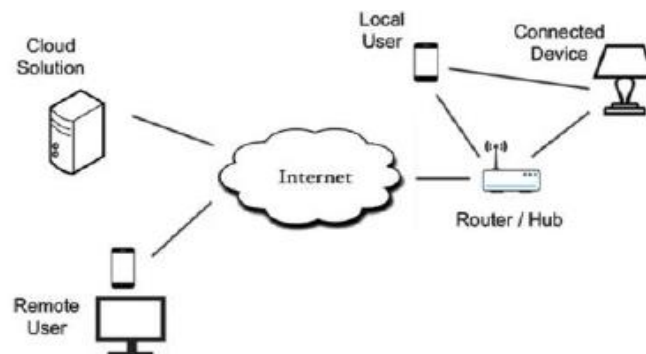


Figure. 6 An overview of the Internet of Things (IoT)

4.5 Wireless NRF24L01

The nRF24L01+(nRF24L01p) is a single chip 2.4GHz transceiver with an embedded baseband protocol engine (Enhanced ShockBurst™), suitable for ultra-low power wireless applications. The nRF24L01+ is designed for operation in the world wide ISM frequency band at 2.400 - 2.4835GHz.

To design a radio system with the nRF24L01+, you simply need an MCU (microcontroller) and a few external passive components. The high air data rates combined with two power saving modes make the nRF24L01+ very suitable for ultra-low power designs. NRF24L01+ is drop-in compatible with nRF24L01 and on-air compatible with nRF2401A, nRF2402, nRF24E1 and nRF24E2. Intermodulation and wideband blocking values in nRF24L01+ are much improved in comparison to the nRF24L01 and the addition of internal filtering to nRF24L01+ has improved the margins for meeting RF regulatory standards (Figure 7).

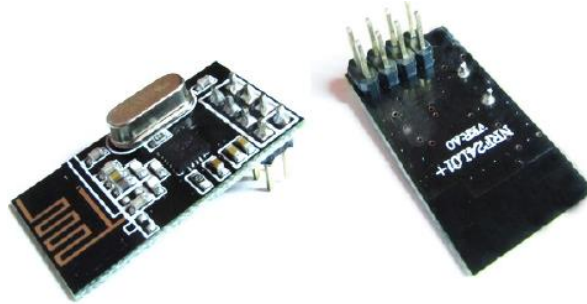


Figure. 7 NRF24L01

4.6 Mechanic Dimensions

1- Enhanced ShockBurst™ : The Enhanced ShockBurst™ features enable significant improvements of power efficiency for bi-directional and uni-directional systems, without adding complexity on the host controller side. In Enhanced ShockBurst™ it is possible to configure parameters such as the maximum number of retransmits and the delay from one transmission to the next retransmission. All automatic handling is done without the involvement of the MCU. It could be for wireless mouse wireless keyboard (Figure 8).

2-ShockBurst™ : ShockBurst™ makes it possible to use the high data rate offered by nRF24L01 without the need of a costly, high-speed microcontroller

(MCU) for data processing/clock recovery. In ShockBurst™ TX, nRF24L01 automatically generates preamble and CRC, it compatible with nRF2401A, nRF24E1, nRF2402 and nRF24E2 communication.

If you want use 6 data pipe MultiCeiver™ for 2.7-a star networks, selection Enhanced ShockBurst™

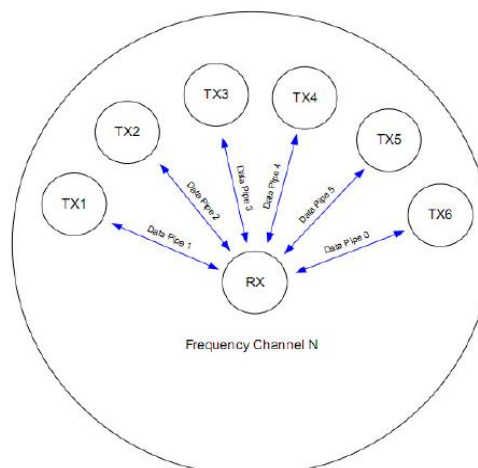


Figure. 8 Star networks

4.7 NRF24L01 in a star network configuration

An nRF24L01 configured as primary RX (PRX) will be able to receive data through 6 different data pipes, see Figure 4. A data pipe will have a unique address but share the same frequency channel. This means that up to 6 different nRF24L01 configured as primary TX (PTX) can communicate with one nRF24L01 configured as PRX, and the nRF24L01 configured as PRX will be able to distinguish between them.

acquisition system consists of ATMEGA328 MCU based on Arduino platform, LM35 temperature & voltage sensors and wireless transceiver module nRF24L01. Control system is through single-chip microcomputer ATMEGA328 which controls the wireless transceiver module nRF24L01 and then displays the received information on LCD12864 in real-time. The control part also provides the flexibility of setting the upper and lower limits of temperature data at any time. The received data is checked for the upper and lower limits, if the received values are not within the original data range, the buzzer will sounded for alarming the people's attention, to make a timely dispose. Adapter power supply 230V AC to 5V DC charger can be used for powering Arduino boards and LCD. NRF24L01 requires a +3.3V for power requirement (Figure 11).

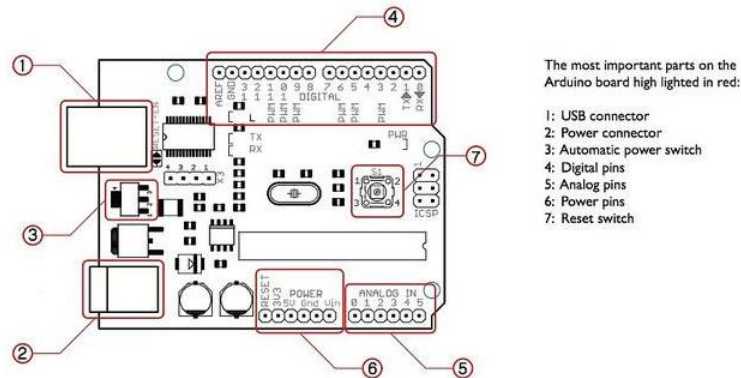


Figure. 11 Diagram arduino UNO

6. CONCLUSION

In this study, a design concept of wireless sensor network is obtained using low-cost transceivers and open-source microcontroller, Arduino. The system is well suited for environmental monitoring. For our requirements, the sensor nodes are made as small as possible. The proposed system is secure; each node has its own data buffer identified by a 64-bit address along with Onion protocol which enhances the data encryption among nodes. For future works, we have two works: 1) Development this project by add GSM to show alarms through text message, and 2) we can control this system by using Ethernet with Arduino.

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	<p>in contrast sensors to find a path or in counting sensors to count objects.</p>
<p style="text-align: center;">LCD</p> 	<p>An LCD display is composed of pixels made up of liquid crystals. Liquid crystals exist in a state that's between a solid and a liquid. At any time liquid crystals can be in a variety of phases, most notably the nematic phase or the smectic phase. In the nematic phase the crystals act more like a liquid, allowing the molecules of the crystals to rearrange themselves while remaining oriented in a uniform direction. In an LCD, a liquid crystal pixel lies between two glass filters, one behind it and another in front at 90 degrees. When electricity is applied to the liquid crystals the twisted structures that have naturally formed are straightened out. This rotates any light passing through 90 degrees, thus allowing it to pass through the two glass filters.</p>
<p style="text-align: center;">I2C LCD</p> 	<p>The I2C 1602 LCD module is a 4 line by 20 character display interfaced to an I2C daughter board. The I2C interface only requires 2 data connections, +5 VDC and GND to operate.</p>

The pseudo code of Arduino software is of concern:

The pseudo code of Arduino software:

- 1: RF24 radio(CE_PIN, CSN_PIN)
- 2: Serial.begin(9600)
- 3: radio.begin()
- 4: radio.openWritingPipe(pipe)
- 5: pinMode(3,0), pinMode(5,0)

The pseudo code of Rx wireless is of concern:

The pseudo code of Rx wireless:

- 1: RF24 radio(CE_PIN, CSN_PIN)
- 2: void setup()
- 3: pinMode(5,OUTPUT), pinMode(6,OUTPUT)
- 4: pinMode(7,OUTPUT), pinMode(4,OUTPUT)
- 5: Serial.begin(9600)
- 6: radio.begin()
- 7: radio.openReadingPipe(1,pipe)
- 8: radio.startListening()