The Disaster Rescue Robot Design and Implementation Using Open Source

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Abstract. There are many disaster happened around the world. In addition there are unknown space or environment require human seek out it. Especially when disaster could move space for different between in before and after. People don't know any information can assist them make a right policy decision. Also human's perceptions don't very sensitivity, such as optical illusion. The nose can't smell and identify harmful gases, or ear can't identify source of sound. People are need sensors and algorithms to assist them in that scenario. This research presents a method an easily design prototype robot. And robot equipped multiplex sensor used open source hardware. This robot has variety functions. Those functions come from design idea and application. This robot has equipped compass sensor aka M-sensor. The robot equipped Accelerometer, aka M-sensor. Robot equipped other sensors and algorithm could provide navigation and so on function.

Keywords: Robot, Navigation, firmware, human interface software, hardware device driver software, Arduino Mega, Accelerometer, G-sensor, Compass sensor, M-sensor, Spherical trigonometry, Grate circle distance, color space, image processing, canvas, 3D space, optical illusion.

1 Introduction

Nowadays the microcontrollers are powerful usage for several atmospheres, such as wireless sensor network (WSN) [21-24], autonomous system, automation system, robotics [25-27, 31], smart home control, and even can used on hobby, art, education and Medical. Those system components can class to control chip part, sensor part, specific logic part and power energy. Normally the Logic part is hybrid software which is firmware. There are varieties of hardware embedded different microcontroller chip module you can select on your work. Such NI, TI, Silicon and more. Microcontrollers are tiny, signal ship, but there are also expensive. In recent years, Arduino [1] is one of less budget, low cost, common hardware, good for research and open source hardware, mostly easy to used, ability to operator and work with difference Operation Systems such as Windows, Mac OS, Linux, and UNIX-like.

While there are many news, papers, thesis, journals, technology report, and researches to describe the robot, such robot for a life be smart and autonomy. It is beautiful dreams, but the problem is how to design and implement it. Robot has many details in its design. In recent years, NASA in Mars science mission has proposes their building robot, which is "Curiosity". It is a car-sized robot. It is equipped multi sensor, those sensor let she have power function to face and assist finished her mission. Many papers to describe such as live life or dreams, but normally is only to describe a concept, and without how to implement. Further when student, novice, new researcher would designs and builds their project, problem has be coming and need face it. So that, when we usually design those systems, we widely survey many news, papers, journals, technology report, technology document, and researches papers, which is widely data. However, they are almost describes concept expect to implement that.

We will show you more details of our design, which is include how consider in circuit design of hardware, how software of hardware drive design, aka firmware. Finally we design software of control client, aka User Interface software. Perhaps, in the future we can portable from this system to any platform as soon as possible.

Table 1. End Products compare

Item	Budget	Extern available	Note
Lego NXT [10]	High	None, Black Box	
NAO [9]	High	Fixed	
TraxBot [12]	Middle	Restrict / Limit	
Bioloid [21]	High	Limit	
Arduino MCU	Low	Highly flexible	Our select

Table 2. Develop software compare

Item	Budget	Extern available	Note
LabView [11]	High	Yes, but maybe wait for engineering update	
NI vision Assistant	High	Yes, but maybe wait for engineering update	Need Labview
Matlab	High	Yes, but maybe wait for engineering update	
Visual studio Express edition	Free	Yes.	Our select.
Arduino IDE	Free	Yes.	Our select

Table 3. Equipment and Goods compare

Company	NI	Lego	Arduino
Item price	High	High	Mid
Software	LabView	Library and NXT	Any
Software price	NTD 70000+	NTD 10000+	Freeware
Troubleshooting	wait for engineering update	Wait for engineering update	Yourselfer

2 Methods, System Design

We omit large and heavy related works for readers. Instead of that we list some references [9, 10, 12, 25-27, 31] for readers when they are interest and improvement their research. Table 1, 2, 3 are we compare some robots function, ability and its budgets.

In this method for our design in Hardware side, we consider cheaper, low budget, cost down, and more over we can control chips, device driver, firmware, software by our self. This is means we don't want to at station is what happened and we need wait for some thirty parity to troubleshoot. We can control and handle we self.

We consider our Robot fundament functions include Compass, GPS, Accelerometer, Stand alone Power supply in principle. That we design some circuit with component [3], and use Arduino shield. That means we consider and calculate how many Digital Pins, Communication channel, Analog Pins and so on we need.

We select Arduino Broad, Mega 2560 are we selected. Moreover we need draw out our imagine prototype vision, make the dream be true. And this can help us more clearly to know our goal. Imagine that, using Compass because if we are in unknown and less information environment, compass can guide us direction information. If we can moreover to combine maps, then we could more clearly to know all of information. If we have GPS, then we can more easily to know what position we are, and Robot too. Accelerometer can help the robots to know its attitude, controller can easily to know robot are stand right.

2.1 Platform

Arduino Mega 2560 [1, 2] is a microcontroller production by Atmel, based on ATmega2560 chip. According to datasheet of ATmega2560, this signal chip is very powerful function that let Arduino Mega 2560 have strong application. Arduino Mega 2560 board, work on 5 Voltage, it has 54 digital Input/Output pins, 16 analog pins , 4 UARTs (serial ports) at 0, 1, 19, 18, 17, 16, 15, 14. TTL serial data are 0, 1, which is also used to connected to FTDI USB to TTL. USB connection which is connection to PC, provides ISP and work energy. Power jack which is can connection stand alone power supply or battery to provide more energy, and analog pins are inside A/D convert. Also in digital pins provide 15 PWM pins (2 to 13 and 44, 45, 46). 128kb Flash memory, work on 16MHz crystal oscillator (clock). Moreover it has SPI

communication which is 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). Also, TWI pins are Inter-Integrated Circuit (IIC, I2C) communication which is 20 serial data line (SDA), and 21 serial clock line (SCL). One LED (13) on board.

Arduino provide UART communication, which is serial port to communication to PC and Devices. The Arduino Mega 2560 have 4 UARTs that us more flexible to design.

Despite Arduino have its inside DC provide, 3.3V and 5V. But sometimes you may need difference Power supply or stand alone power energy, DC to DC convert solution this is. That allow you design the battery pools, and then used DC to DC Convert to supply you wanted Voltage power is go solution to device need, suggest 7.2V, 12V and so on, respectively. Shield module can provide 3~36Voltage DC, and if battery recharge or change, don't need to warring provide DC energy supply. DC to DC convert allow you to rise up or decline, go down Voltage. LM2596 provide step down voltage, its input 4.5~35 Voltage and output 1.25 ~ 26 Voltage at 2A. LM2577 provide step up voltage, its input 3~34 Voltage and output 4~60 Voltage at 2A. Only one need care is heat processing, use thermal grease, heat sink and cool fins to treatment this is.
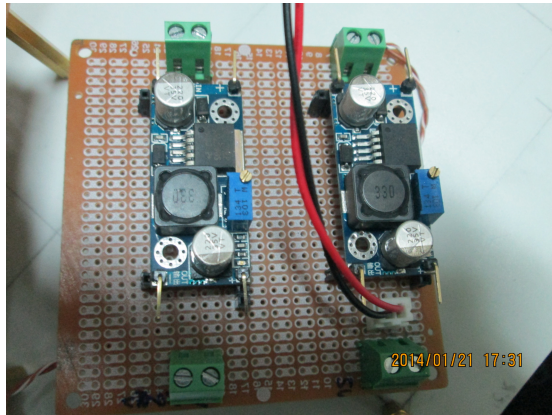
Fig. 1. DC to DC convert our design circuit 1

Battery always was power energy source provide everything of electronics goods to work, thus stand alone power are need careful to consider, include costing of cycle life. Each battery have its reference and normally current/voltage power energy provide [15] to work times dependent how goods used.

2.2   Software Template

This system requires algorithm to process and calculate our method. Here, we used Microsoft Visual Studio Express [5] to design our system application software. Microsoft announce Visual Studio Express for free and student program [4]. This announcement helps engineer, researcher, artists, hobbyist and novice to fulfill their dreams. About its principle datasheet, technology report of how to encode and more detail function, reader can visit Microsoft Developer Network (MSDN) [6].

Microsoft Visual studio has provided C++, C#, Basic and more program language. C# language have Command line mode, Windows Form Application mode (WinForm), Windows Presentation Foundation (WPF) mode, Active Server Pages (APS) .Net Mode. Each mode has its features and templates. Those various program language and mode means that it's difficult for programmer to study and specialize on it. In this study we are using used C# language, and coding on WinForm mode and WFP mode.

On the Earth, geomagnetic field are covered [28-30]. This Axiom is exist and support man to guide direction in the world. Compass is dependent on those axiom and provide the message for us. Digital Compass is more novel technology.

2.3   Sensors

Compass sensor GY 26[12], aka. device on HMC1022 compass chip [12], operating on 3~5 Voltage DC, -20 to 85 degree C, current 15mA in 5V or 8mA in 3V, provide 0 to 360 degrees and 0.1 degree resolution, 1 degree measuring precision, 9600 Baud rate, provide IIC or RS232 which is Tx, Rx Communication. Navigation are normally application. Include help or assistant Telescope position, hand guide, Guide system, GPS guide, Antenna position, Robot position and guide orientation. Airspace and aerospace model position also are important. We used compass to improve us more information to help decision.

Accelerometer sensor, aka G-Sensor, is provided a vector of moving change. Its operating on 5 Voltage

Now we have to know many sensors and it used, we may compile it into table. The follow table shows how we design in this project consider power energy, allocate and pins methods.

2.4   Implementation

We describe to implement our system in this session. The system composes hardware, software and algorithm. Now we have to know many sensors and it used on wide field, we may compile it into table. The table shows how we design in this project consider power energy, allocate and pins methods.

Firmware design is to design to control circuit, motors, get and send message. Normally send out control pins signals or reading single from IC message.

Design Arduino firmware is not to hard too. Arduino provide it IDE to develop, named Arduino sketch. This is develop can provide ISP function, plug c library of Arduino, also Arduino already provide some Open Source function on there. The robot firmware principle function is forward, backward, turn-left, turn-right and stop. Those design need consider into main loop. Arduino firmware have 2 necessary function, setup and loop. Setup like to Visual studio c# as WinForm, it is run once in start, beginning. Loop was running until to close Arduino. So that to design need consider with you add sensor. Firmware follow are very important in here. When we add M-sensor as GY-26, or G-sensor as MMA7455, subscript function was import into loop. All system photos we show on Figure 3.
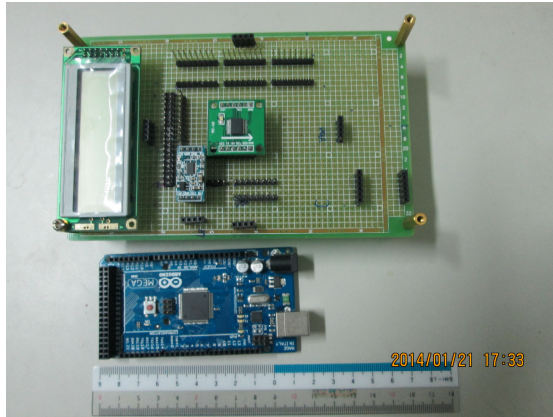
Fig. 2. Arduino Mega 2560 and our design circuit 2
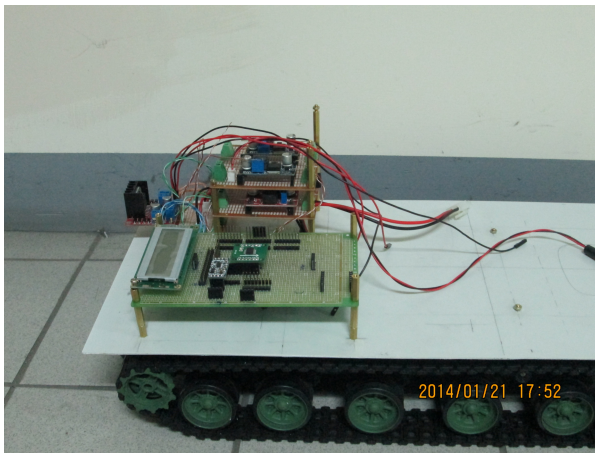
Fig. 3. Our system photo

3   Future Work

This project idea come with author's pass experience on his duty service on military, Taiwan, ROC. He has experience on many Operation mission. Dependent on his experience, he never see one of machine can support enough information to help decision, than after his research, he knows difficult on each part need redesign and he want solution it. After this project, in the future all of this project should need more functional be design. Such as we did not consider work on cool weather because this situation is very harsh environment, need to consider ESD, EMP. ESD and EMP would destroy or burn circuit, chips, and so on. Currently we design on warm weather can work. Future we select more high level chips those can work on cool weather and on more disaster environment.

Secondary, the battery, power pools consumption are very important, how to supervisor Battery furl gauges and send message feedback to controller, user how the robotics still have action time, works time and even provide automatic robots to re-charge its battery is very important. We can design this in future.

Transport message is hardly work, dependent how large data bytes need sends and receives. Video data such as Webcam or Kinect data sender and review. Bluetooth has it limit can not quickly send Video message. Large data transport via wireless is one of important issue. Especially in simultaneous localization and mapping (SLAM) via wireless communication to User Interface need wide band capacity. Finally, dependent on our limit resource, we select and abort some good idea.   All of those ides can improve this system performance.

4   Conclusion

We brief our design and improvement, our considering functional robot, we describe way to how to easily modify and true to build invention your own robotics. Perhaps this study can help the readers easily to build there own robotics. This robot functions have compass can navigation you way. It has sensors can detector environment situations. Optical sensor can provide video and depth image. Depth image can measurement distance. Mick array we design algorithm can tracking voice. Accelerator with our algorithm can provide the robot's attitudes. Gases sensors whit our algorithm can identify and provide people what air composition in there.

We wanted this can be interesting more people join and enjoy in science or development, invention. Our robotics provides hardware, logic, software, compass to navigate and prevent loss in new space after disaster. This project is work in progress. We would like this project can help or interesting more people. We would happy to response and troubleshoot when who have question.

NOTE: Because the regular of this conference, the paper length only 8 pages we should follow it and this limit us to cart our paper. Therefore our paper seems not enough. Please, readers can contact us if they have questions.

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