Original Research Paper

Disaster Sites Roaming Smart Car with Hand Gesture Controller

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Abstract: IoT is machine or device that can transfer data over a network without a connection between human-to-human or human-to-device interaction. One of the significant of IoT is the revolution of smart car. This research is a research about smart car that help civilian in distress that have been caught in a natural disaster like land slide or even an earthquake and traps in a collapsed building or it can be a smart car that can recon the site. This smart car can assist the rescue squad to detect that survivor by going through the small hole that been create by the collapsed building and give the rescue squad the where about of the survivor and provide information to the rescuer about the site. The smart car also have solar system to power the system and can run longer than powered only with battery. The smart can also have anti capsize that may make the smart car overturn in the disaster site while roaming in the disaster to detect the victims. This feature help the smart car easily to roam freely with the unstable environment. The smart car also provided with camera for the rescue squad to analyse the structure in the disaster and avoid to dig the rubble or disaster site and killed the victims and the user can gain the insight of the site and gain information more detailed. The smart car can be controlled with a globe type controller for easier the user to control the smart car in the unstable and fragile site.

Keywords: Hand Gesture Controller, Internet of Things, Natural Disaste, Smart Car.

1. Introduction

Natural disaster or collapsing building have been occur all this year, many victims that are unfortunately evolve by it. Every time disaster occurs such as collapsed building cause of earthquake, landslide or even aged building itself can victim traps under it with life threatening every each seconds. Rescuer have to race against time to rescue the victims by putting their life on the line to help the victims within the dangerous environment. The disaster sites can be unstable and can be dangerous to the victims and rescuer without proper understanding of the site environment. There is a chance that the site will be collapsed that can make the rescuer in a dangerous situation and may cause the victims underneath the site be crush before there a chance to be rescued.

Disaster sites may cause danger to the rescuer to roam and endanger the rescuer life itself and even to the victim's life. The disaster sites contain unexpected situation to the rescuer. Thus, the aim for this research is to help rescuer to roam the disadvantage environment safely with the smart car and gain information and insight of the environment.

This reserch is about an investigation the evolution and the uses of smart car that can be helpful to the user in a disadvantage environment to the user and gain a specific information. The smart car should help the user to gain specific information from an unwanted event occur such as landslide or collapsed building that may dangerous for the user to roam and collect the information by their self. So, the smart car can roam into the sites and recon for the user to collect data or information for the user. The data that have been collect will be automatically save into the database and user can check it to collect the information.

The smart car that provided with camera and sensor that is connected to the database to help to recon or roam a disaster site to gain information. It proposes a roaming and monitoring mechanism that takes video and information throughout its operation through each every sites. The aim is to design a controlled smart car that can be used in a disadvantage site that may can harm the user and can gain insight or information through the roaming operation.

2. Literatur Review
2.1. Internet of Things

Internet of Things (IoT) technologies nowadays have gain more interest within engineer and people around the world by developing all king of research whether for hobby or to help them to do some specific task. The growth and evolving IoT today are begin to shows within the years. Referring to Dachyar et al [1], the research area of the Internet of Things in recent years has experienced growth and development in an interdisciplinary manner. Various papers are written very massive, and reach various concepts and fields of knowledge ranging from technology, applied engineering, economics, business, strategy, industry, management, etc. By this statement we ensure that IoT growth have become positively increase around us.

Besides that, Udayakumar [2] stated, Iot is the internetworking of physical devices, vehicles, buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduce human investments. The function that are provide by IoT technologies nowadays can be used in variety of sector and suitable for this research that have to be use in disaster sites.

Referring to Gubbi et al., [3] Internet of Things can be realized in three paradigms internet-oriented (middleware), things oriented (sensors) and semantic oriented (knowledge). Although this type of delineation is required due to the interdisciplinary nature of the subject, the usefulness of IoT can be unleashed only in an application domain where the three paradigms intersect.

Internet of Things also have been state by Brous & Janssen [4], IoT is a technologies that can make connection between themselves and other internet-enabled devices over the internet. IoT allows us to monitor and control the physical world remotely. As such, adopting IoT may provide a wide variety of benefits for organization and the resulting big data offers the potential for organization to obtain valuable insights. The IoT smart car will be using this function by been controlled with hand gesture controller.

Nguyen et al., [5] research stated the digital transformation following the Industrial Revolution 4.0, especially the development of Internet of Things (IoT) is taking place strongly all over the world,

affecting various areas of life such as transportation, medical and healthcare, energy management, automated vehicles and so on.

The interaction can be divided into 3 categories which are short form, medium form, and long form. All the categories will be describe's and explained.

1. Short Form

   Short form interactions occur when a user is not satisfied with current physical conditions, such as occurred malfunction to the product. This is an immediate and urgent issue for the user and is one they are willing to spend time fixing. Since the user did not anticipate this need of interacting with the system, it is important to resolve the issue quickly since the user is likely already in a negative mental state and likely have not allotted mental time for interaction.

2. Medium Form

   Medium form interactions occur when a user consciously decides to interact with the application. There are two goals the user has when performing this type of interaction: planning for future events and changing the recurring scheduling. These interactions differ from short term interactions in that the user has consistent and ongoing action. On occasion, a user will want to make a temporary change to normal operation. For example is detecting that a room has not been occupied for a certain period of time. The system could then send the user a notification asking if they want to lower the temperature in that room as it does not appear to be occupied often. The primary goal of this system is to use sensor and short-form interactions to inform the user about the exact medium-form recurring system correction, without the user having to expend effort in deciding what they want changed and how to change it. It is also important to note that the intelligence system must never make corrective actions without the user's explicit approval.

3. Long Form

   Long form interactions should rarely, if ever, occur. These are actions that 30 seconds or more. Ideally, long form interactions are only performed by a user on initial setup of the system. This is when excitement in the product is still high and users are more willing to spend time configuring it to their unique preferences.

2.2. Smart Car

Smart car is one of Internet of Things (IoT) research with a flexible multipurpose function to adapt for all kind of specific task that have been programed by the user. Smart car also an evolving technologie's that adapting today smart environment with ever ending improvement of technologies and demanding human-computer interface in smart technologies in our current life.

Smart car also one of IoT product that have been develop nowadays and it keep involving with exceptional rates. Within this research, the smart car that going to be develop are remotely operated vehicles (ROV) type of smart car. Referring to Andre Chia and Cheslav Balash (2020) [6], mention the joystick or controller evolution that can be implemented with thruster scaling and vectoring that allowing vehicleto accelerate and turning.

Smart car can be describe's by referring to Jing & Li [7], the smart cars is a car that can be automatically operated according to the artificially set mode. The smart cars can not only achieve tracking and obstacle avoidance functions, but also operate in high-risk places to provide services for people.

This reserch is about developing a smart car or known as multipurpose robotic car that help user to roam a disaster site safely. The smart car will be develop's by using Arduino that can be describe by referring Udayakumar [2], Arduino is a microcontroller that completed with microprocessor system built on a single IC. Microcontrollers were developed to meet a need for microprocessors to be put into low cost products. Building a complete microprocessor system on a single chip substantially reduces the cost of building simple products, which use the microprocessor's power to implement their function, because the microprocessor is a natural way to implement many products.

The research by Zhen & Li [8], stated with the development of Internet technology, the development of wheeled robots has gradually matured. In the current situation, autonomous mobile wheeled robots are widely used in materials transportation, nuclear weapons, military environments and other fields. It is a kind of concentration that senses the surrounding environment, automatic planning and operation decisions, intelligent driving and so on.

2.3. Uses of Hand Gesture Controller

Hand gesture controlling or motion sensor today become trend or a kind of technology or function that have been dream off by developer and nowadays the function and system have been created to help user in varies way in their routine life. Today, all kind company have been using this method such as a smart phone company that using motion detector to snap a picture or a gaming console company that also using motion detector that detect user movement by playing the game and have exercise in a sametimes.

This statement have been describe by Nicol´o Bargellesi, and Mattia Carletti [9] in research by saying characterizing/sensing the human-in-the-loop has become a prominent topic in control system technologies, with applications in many fields, from gaming and spot [10] [11] to health care [12], from home automation [11] to industry 4.0 and robotics [13].

Within this research, the smart car going to be controlled by using hand gesture controller by using motion detector. Referring to S. Ahmed and V. Popov [14] gestures would allow human to interact freely with the robot by performing different control commands mapped to desired position of arms, legs, hands, etc. Such interface combined with autonomous control algorithms would change completely the understandings of human-robot interaction.

Besides that, the hand gesture controller also one kind of controller and controller can be describe by Ismail et al [15], controller provide control via two axes of motion: forward/backward and left/right. There are many iterations of the device, some with varied means of determining the stick position; however, the working principles are largely similar: the controller constantly reports the stick's position back to the controlling program, which then executes the relevant commands to trigger the desired response.

Referring a research from Shiji & Krishnan [16], the most regular thing that people do when frustrated with devices is perform hand gestures to try to demonstrate the device what they want it to do. A controller is unnatural and requires getting used to; body language and hand gesture, however, are instinctual. The gesture recognizing glove utilizes various sensors to capture those hand gestures and deduce them as inputs.

Shivamadhu et al. [17] research describe hand gesture is a sensor that analyzes the movement of the operator's hand is used. This sensor detects movement of the palm and fingers of the operator in real time. Based on the detection result, the movement of the robot corresponding to the movement of the operator is generated.

The hand gesture or motion gesture technology will be implemented in this research by creating a hand gesture controller. The controller will be design in a glove type of structure for the user to wear so they can control the smart car easier without any problem.

2.4. Natural Disaster

A natural disaster is a major adverse event resulting massive damage or changes from natural process of the Earth. Natural disaster is the occurrence of an extreme hazardous event that impacts on communities causing damage, disruption and casualties, and leaving the affected communities unable to function normally without outside assistance. A natural disaster can cause life and massive damage to variety of sector such as economy or industrial sector and take a lot of time and resource to recover from it.

There several type of natural disaster, such as:

1. Earthquake

    An earthquake is a natural phenomenon like rain. Earthquakes have occurred for billions of years. Descriptions as old as recorded history show the significant effects they have had on people's lives. In simple terms, earthquakes are caused by the constant motion of Earth's surface. This motion creates build up and releases energy stored in rocks at and near the Earth's surface. Earthquakes are the sudden, rapid shaking of the Earth as this energy is released.

2. Floods

    The significance of flood as a natural phenomenon appears only in the context of human perception. Flood is commonly defined as an overflow of water onto lands that are used or are usable by man, and are not normally covered by water. Floods have two essential characteristics: the inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river, stream, lake, or ocean.

3. Tsunami

Tsunami is a Japanese word, meaning 'harbour wave's. The term was introduced by the fishermen who on return to the port (after fishing) found the area surrounding the harbour devastated by sea waves. Tsunami occurs when there is a sudden and massive vertical displacement of ocean water because of tectonically induced deformation in the Ocean Crust. In spite of close association, there is no direct cause-and-effect relationship between earthquake and Tsunami.

4. Volcanic Eruption

A volcanic eruption is marked by the discharge (aerially explosive) of fragmentary eject, lava and gases from a volcanic vent. A volcano is an opening, or rupture in the earth's surface that allows hot magma, volcanic ash and gases to escape. They are generally found where tectonic plates come together or separate, although some occur in the middle of plates due to volcanic hotspots activity.

Today, we as human are obsess with mentality to build a futuristic environment or technologies and build a skyscraper without have any thought the condition of the environment. Uncontrolled evolving construction can cause over deforestation, global warming, unstable ground and even filthy environment that leads to all kind of disaster such as earthquakes, tsunami, floods, landslides, collapsed building and all kind of disaster whether from nature or unexpected even like exploded factory.

Deforestation can cause unstable slope or became a natural slope that leads to landslides and mudflow. Referring to Tsuchida & Kano [18] state natural slopes are considered to be susceptible to landslide and mudflow disasters. Natural slopes are made from residual sandy soils of heavily weathered granite, called "Masado". The occurrence of these failures is mainly due to the rise of the groundwater table in the slopes or the loss of the inbound shear strength of the Masado soils due to intense and continuous rainfall during a heavy rainy season [19].

Referring to Rossell & Becken [20], earthquakes, tsunamis, floods, bush fires, hurricanes, droughts and heat waves have always occurred. These events have formed part of the wider 'riskscape' that humans have learned to manage and live with. However, more recently the impacts of disasters have increased substantially, partly because of the exacerbating effects of climate change, but also due to the growing complexity of socio-ecological systems in a highly connected and globalized world.

The smart car will be roaming all kind of disadvantage terrain within the disaster site to collect information for the user. Disaster happens all around the world without any warning and can happen at any times. The environment become a high risk and dangerous to us, human to roam by ourselves but we can avoid the risk by using the IoT smart car.

2.5. Device of Internet of Things

Nowadays, there are a lot research or invention of inventor or developer to implemented IoT concept in their work. There are many device that have been developed today to help developer to build an IoT basedt. The main device that will be used is Arduino.

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino board are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

Arduino is a single-board microcontroller to make using electronics in multidisciplinary researchs more accessible. The hardware consists of a simple open source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM.

Arduino is a low-cost single-board microcontroller. Concerning R&D and Academia activities, Arduino constitutes a merging trend which has become a powerful tool to develop different applications in the fields of data acquisition, automation and engineering in general. It is widely known that programming and configuring Arduino hips is easy and versatile. However, visualizing its parameters and operation is not so easy, which constitutes a serious difficulty to overcome for advanced application. In other words, the integration of Arduino devices with proprietary Supervisory Control and Data Acquisition (SCADA) systems remains unsolved.

Arduino Uno is a microcontroller board based on the 8-bit ATmega328P. It has 14 digital input and output pins, 6 analog inputs, a 16 MHz ceramic resonator a USB connection, a power jack, an ICSP header and a reset button. It can be simply connected to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started [16].

Table 1. Comparison of Various Types of Arduino

Name	Image	Processor	CPU Speed	Flash (kB)	USB
Uno R3		ATmega328P	16 MHz	32	Regular
Gemma		ATtiny85	8 MHz	8	Micro
LilyPad		ATmega328P ATmega168P	8 MHz	16	-
Mega 2560		ATmega32U4	16 MHz	256	Regular
Pro		ATmega328P ATmega168	16 MHz 8 MHz	32 16	-
Leornado		ATmega32U4	16 MHz	32	Micro

Arduino is an open sources programmable circuit board that can be integrated into a wide variety of IoT researchs both simple and complex. This board contains a microcontroller which is able to be programmed to sense and control objects in the physical world. By responding to sensors and inputs, the Arduino is able to interact with a large array of outputs such as LEDs, motors and displays. Because of its flexibility and low cost, Arduino has become a very popular choice for developer and looking to create interactive hardware researchs.
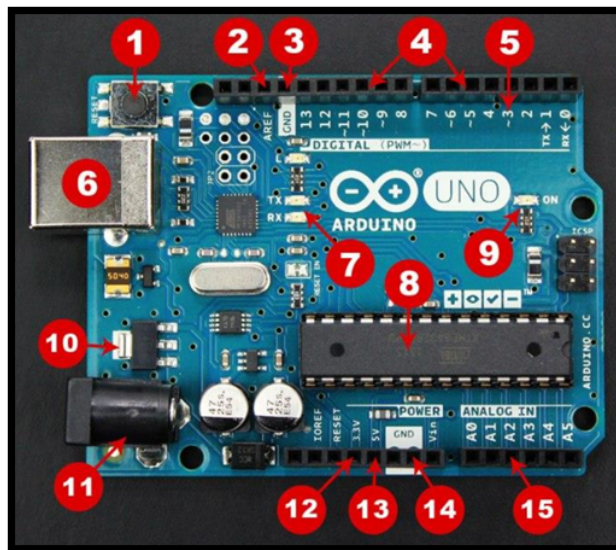

Figure 1. Arduino Uno R3 Circuit Board

Table 2. Arduino Uno R3 Board Breakdown

| No.	Name	Description
1.	Reset Button	This will restart any code that is loaded to the Arduino board.
2.	AREF	Stands for "Analog Reference" and is used to set an external reference voltage.
3.	Ground Pin	There are a few ground pins on the Arduino and they all work the same.
4.	Digital I/O	Pins 0-13 can be used for digital input or output.
5.	PMW	The pins marked with the (~) symbol can simulate analog output.
6.	USB Connection	Used for powering up your Arduino and uploading sketches.
7.	TX/RX	Transmit and receive data indication LEDs
8.	ATmega Microcontroller	This is the brains and is where the programs are stored.
9.	Power LED Indicator	This LED lights up anytime the board is plugged in a power source.
10.	Voltage Regulator	This controls the amount of voltage going into the Arduino board.
11.	DC Power Barrel Jack	This is used for powering your Arduino with a power supply.
12.	3.3V Pin	This pin supplies 3.3 volts of power to your researchs.
13.	5V Pin	This pin supplies 5 volts of power to your researchs.
14.	Ground Pins	There are a few ground pins on the Arduino and they all work the same.
15.	Analog Pins	These pins can read the signal from an analog sensor and convert it to digital.
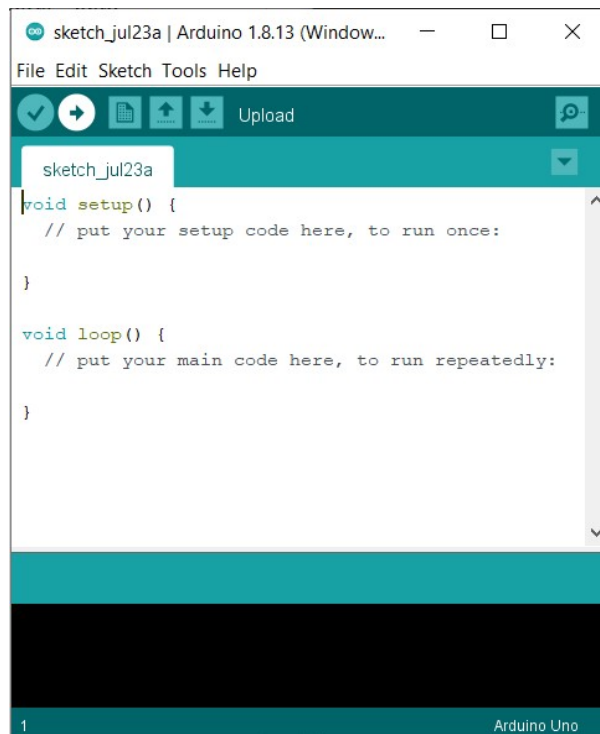
Figure 2. Screenshot of Arduino IDE

Arduino IDE is an open sources software that is mainly used for writing and compiling the code into the Arduino Module. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.

A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino micro and many more. Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.

The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

3. Methodology

Since the chosen methodology is rapid prototyping then there is certain information that needs to be understood about what is Prototyping. Prototype methodology is one form of Agile methodology that are more flexible research managing and require a lot of rapid development [21] [22]. Truth to be told, this research will have a lot of error fixing sequence to make this research successful. With the flexibility of the methodology, the error can be identified easier and be fix within the process without to wait until the research have been complete without knowing the error occur and where it come from. Within Prototype methodology, there are a few phase that are require such as requirement phase, quick design, build prototype, user evaluation, refining prototype and implement and maitain.

Prototyping methodology required developer to spontaneously build a prototype with minimum requirement that can be tested and reworked if needed until an acceptable prototype are acceptable to be the final product [23] [24] [25]. The improvement and modified to the product are based from the feedback or comment from the end user or client after the prototype have been evaluated. Based on the feedback given, developer can detect any error occur and make improvement to the product. This cycle will be repeat until product can be satisfied by the user or client without any error occur. Thus, the quality of the product can be maximise.

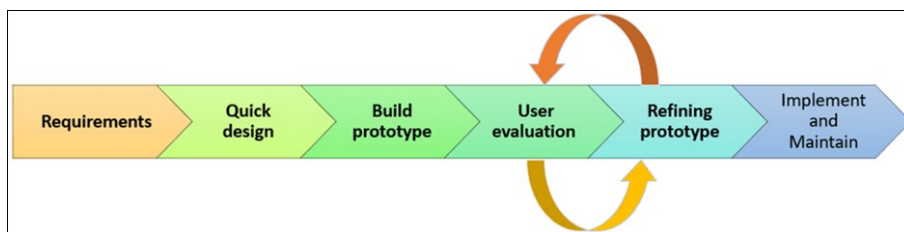Figure 3 shown the phases of the prototype methodology.

Figure 3. Prototype Methodology Diagram

Figure 4 shows schematic diagram of receiver while Figure 5 shows schematic diagram of transmitter.

4. Finding and Discussion

A testing have been made to see how the Disaster Site Roaming Smart Car with Hand Gesture Controller work by including:
1. Distance between the controller and the smart car.
2. Type of terrain that are suitable for the smart car to roam.
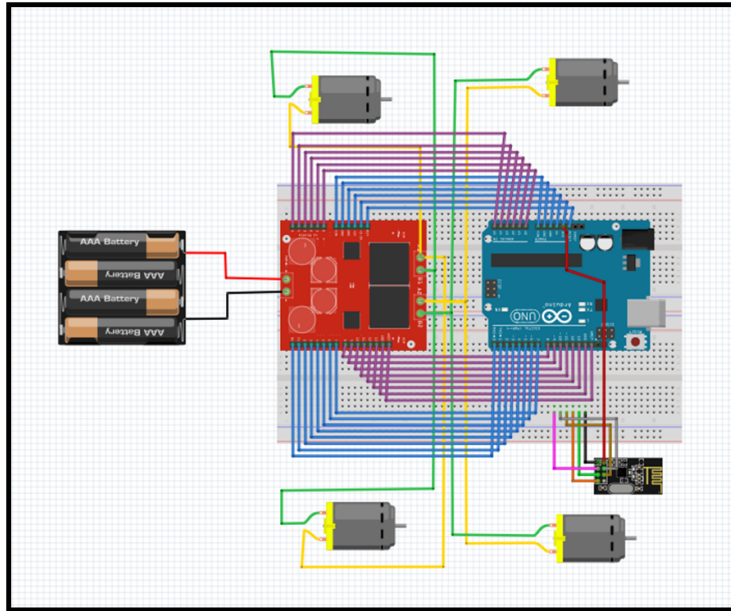3. User can see through the web cam in different environment.
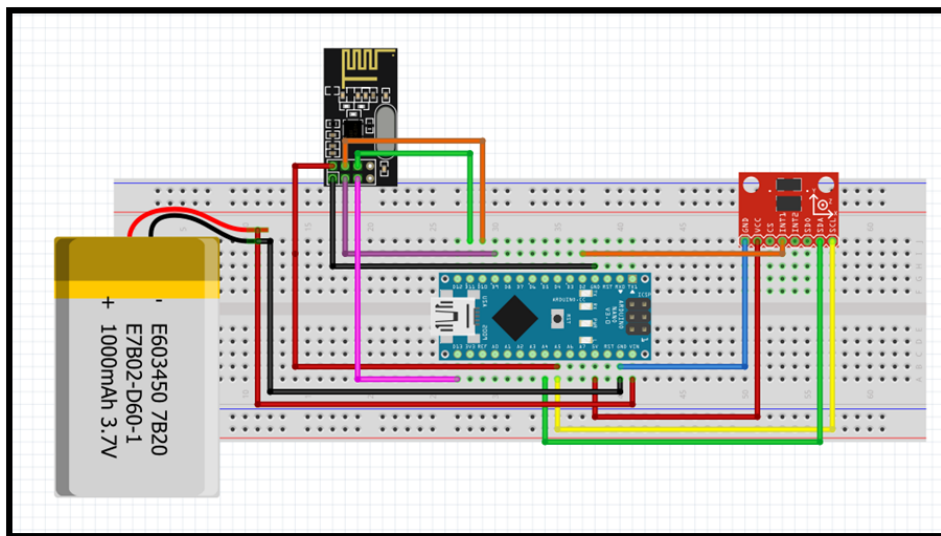
Figure 4. Schematic Diagram of Receiver

Figure 5. Schematic Diagram of Transmitter

4.1. Distance between the Controller and the Smart Car

For distance testing, Disaster Roaming Smart Car with Hand Gesture Controller been test at outside area and the distance between the controller and the smart car been become the variable which is start from 0, 10, 30, 50, 70, 100, and 150 meter.

Based on Table 3, the smart car had been test various distance to see how far the controller which is the hand gesture controller can be connect to the smart car. From the distance of 0 to 100 meter that been test, the transmission of the controller and the smart car seem fine and still able to be control. The transmission starts to lose on the meter of 150 as it had reached the limit of the coverage for user to control the smart car.

Table 3. Distance and Response

Distance (meter)	Response
0	Yes
10	Yes
30	Yes
50	Yes
70	Yes
100	Yes
150	No

4.2. Type of Terrain that are Suitable for the Smart Car to Roam

The smart car have been placed on a different type of terrain to test the capability for the smart car to move within the terrain. Type of terrain to test the smart car movement is normal road which is usually use by car or bike, grass terrain, dirt terrain and wet terrain.

Based on Table 4, the smart car have been tested on various type of terrain to test the suitable terrain for the smart car and the movement of the smart car in the terrain. When the smart car placed on the normal road, the smart car can move easily and stable. The movement of the smart became unstable when the smart car have been placed on the grass and dirt terrain but still can move easily. For the wet terrain is not suitable for the smart car because the smart car doesn't have any water resistance that may cause problem in the board.

Table 4. Distance and Response

Terrain	Movement
Normal Road	Easily
Grass	Easily but Unstable
Dirt	Easily but Unstable
Wet	Not Suitable

4.3. User Can See through the Web Cam in Different Environment

The smart car provided web cam function for the user to see from the smart car perspective. The web cam will be placed on a different environment to test the visibility of the web cam display such as normal environment which is in daylight, night environment and in the dark room.

Table 5. Environment and Visibility

Environment	Visibility
Normal	Clearly
Night	Blurry
Dark Room	Not Visible

Based on Table 5, the visibility of the webcam in a normal environment can be see clearly and become more blurry when the webcam placed in a night time environment. But the display of the webcam are not visible when it been placed on a dark room.

There are several problems that occur in prototype 1, such as:

1. The smart car move automatically

   For this problem, the change that have been made in prototype V2 is the component that have been used in prototype V1 is from Arduino Motor Shield to L298N Dual H-Bridge Motor. This change because L298N have more resource reference for beginner to develop a research. By using L298N, the command to move the smart car are simplify and easier from a beginner to understand. The problem the smart car move automatically are related to the transceiver are

communicate between the receiver and the transmitter. This problem will be explain in the next section.

2. The NRF24L01 are not communicate between transmitter and receiver
   There are two factor this problem occur in prototype V1. The first factor is in prototype V1, the NRF24L01 component are used by the receiver and transmitter are not the same. The transceiver that have used on transmitter are without antenna as the receiver used. By theory there are no problem for this two transceiver to communicate but the problem still occur. Thus the transceiver on transmitter change to the antenna type same as the transceiver on receiver. The second factor is the address pipe that have been used in prototype V1 are set with the same address. The change in prototype V2 are shownin Figure 6 and Figure 7.

```
//Create a pipe addresses for the communicate
const uint64_t pipe = 0xE8E8F0F0E1LL;
```

Figure 6. Address Pipes in Prototype V1

```
//Create a pipe addresses for the communicate
byte address[] [6] = {"pipe1", "pipe2"};
```

Figure 7. Address Pipes in Prototype V2

3. Battery are not enough to support all board
   In prototype V1, all board are powered by one battery. Thus, there are not enough power supply to power up all the board used. The solution that have been done in prototype V2 is to prepared 2 set of 7.2V battery to powering up L298N board and the DC motor and prepared a separate set of battery for Arduino and NRF24L01. Transceiver required a lot of power supply to transmit or receive any signal to communicate.

5. Conclusion
As the system for the research has been completed, the objectives of the research have been achieved. All the phases that involves are need in order to achieved the research aims and objectives will be describes in the next paragraph.

The first objective of this research is to investigate any smart car that have been develop and gather the requirement for the research. There are several activities that have been done to achieve the first objective. The activities are gathering the requirements, analyse the requirements and lastly document the requirement. All of the activities are done by interacting with distribute the questionnaire, observing the existing application and reviewing the existing documents resulting in delivering the deliverables for the first objective. Next, to develop an IoT smart car that help rescuer to roam the disaster site safely and gather the information of the site in development phase. After all requirements had been collected, it must be proceeded to design phase where the development team can have the guideline on how to build the research and meet the requirement. The next objective of this research is to test the IoT smart car to ensure the requirement are parallel and met. As the system is completed, the final objective is achieved. The research that have been made must be test to ensure the requirement that been gathered earlier had been reached to give full satisfaction to the user who use Disaster Site Roaming Smart Car with Hand Gesture Controller.

With the objectives have been achieved, the significance of this research can extend in the future. To the researcher who are interested in in continuing this system. There are several suggestions for this system that can be done:
1. Integrate with the GPS module.
2. The camera resolution are higher with a better camera.
3. The smart car are flexible in any environment.

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