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Emergency communication solution with GPS and morse coding during earthquake using microcontroller and radio frequencies

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ABSTRACT

This study discusses a modular and practical solution that enables secure communication during natural disasters with GPS signals of Morse code. It is an innovative solution that aims to effectively coordinate emergency services and aid teams by providing an alternative communication channel for the communication infrastructure damaged during natural disasters. In cases such as earthquakes, which are always on the agenda of our country and should be, the solution of emergency aid and communication infrastructure problems has become a focused topic. The aim of the study is to provide an alternative communication channel in cases where this communication is damaged. A specially designed radio transmitter circuit, GPS module and MORSE alphabet coding system constitute the basic components of our study. This solution will enable rapid intervention and coordination by transmitting real-time location information to local and international aid teams. The Arduino platform will allow us to adapt to different scenarios by providing flexibility and customizability. The radio transmitter circuit is designed for effective communication on the 2549Hz frequency, which is the UN SOS (United Nations Emergency Radio Frequency Line) line. The GPS data obtained with the help of sensors is encoded in the form of the MORSE alphabet with the help of a microcontroller and transmitted to the international helpline, and the location information is transmitted quickly and reliably. This system was tested for a short time in a laboratory environment and in an environment where communication was partially interrupted. Being accessible and applicable in terms of cost calculation increases the importance and effectiveness of the study in terms of appealing to every user. As a result, we aim to provide a vital alternative in cases where communication networks are inadequate, and to provide social benefit and scientific contribution.

1. Introduction

Our article aims to provide an alternative communication channel in case the communication infrastructure is damaged during natural disasters such as earthquakes, and aims to code the coordinates with Morse code and transmit them to help frequencies via radio waves. This alternative channel plays a life-saving role by ensuring that emergency services and relief teams are effectively coordinated and able to respond quickly. Our project offers an innovative solution that provides a tangible benefit to society by integrating social responsibility awareness with advanced technological knowledge and experience. By implementing technological developments in the field of disaster management that directly affects human life, our project aims to provide usefulness, benefit and convenience to society. In addition, it produces solutions to make life easier in technologically and economically disadvantaged regions and realizes these technologies with original and national resources [1-5]. The study has been meticulously evaluated and designed to be put into practice.

Considering the current literature studies, there are various studies on the subject, but our study is expected to provide a wider range of originality and applicability. When we look at these studies, it can be seen that communication issues are applied to a more limited area when needed. We aim to achieve success with this project in these years when our country is frequently on the agenda with natural disasters. At the same time, designing this project with an international communication code is expected to be beneficial not only for our country but also for our other neighbors, and this project will be used as a basis in future processes and

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years [1-5].

When we look at some studies on the structure; The increased use of smartphones has brought with it many innovations that provide convenience in human life. One of these conveniences is the global positioning system that is standard in smartphones. Thanks to this system, the person using the mobile device can find his location precisely, without allowing address confusion. In this study, it is tried to use this system to find the nearest taxi and communicate, as well as to find the location of another type of vehicle that is wanted to be followed and to track it on the map [2-6].

In another important study; A device that broadcasts information such as pulse and body temperature, which can be described as vital signals for people, with location data received from GPS satellites, on the amateur radio band with the APRS protocol, has been designed. The broadcasts can be received by portable PMR radios and amateur radio stations. It has also become possible to monitor radio broadcasts over the Internet via I-GATEs [3-7]. Finally, in another important study; An accident emergency call system has been designed to help treat the injured as quickly as possible by automatically informing the emergency team in case of accidents. The designed system uses the GPS module to send messages containing information such as the location of the vehicle, the deployed airbag number, vehicle model, age and license plate to the emergency team when the airbag of the accident vehicle is deployed [8]. In general, in such projects, Morse code provides communication between the receiver and the transmitter with a communication infrastructure. However, this study uses a more secure infrastructure such as GPS instead of transmitting Morse codes over the communication channel. Since communication infrastructures are damaged during natural disasters, communicating with the GPS module is of great importance in terms of both information security and time. This project creates great differences compared to other search and rescue modules due to its modular structure and especially in terms of cost.

As a result, reaching a target solution with an international aid code instead of just calling for local help in urgent and vital places and times highlights the effectiveness and awareness of our work.

2. Material and Method

2.1 Problem Analysis

• ***Fragility of Communication Infrastructure:*** Natural disasters or crisis situations such as earthquakes often cause damage to the communication infrastructure. This makes it difficult for emergency teams to coordinate effectively and prevents rescue operations from being directed in a timely and accurate manner.

• ***Lack of Alternative Communication Channels:*** When traditional communication systems often fail or are overloaded, alternative communication channels are needed for emergencies. However, the widespread and effective use of such alternative systems is limited.

• ***Social Media in the Maraş Earthquake:*** It is a known fact that news was received about many damaged and collapsed buildings in the Maraş earthquake thanks to social media. However, false/misshared information and locations have repeatedly caused teams to receive false reports. For this reason, unfortunately, many wrecks could not be found. It is extremely important to know which building was actually damaged during an earthquake. Failure to convey this information correctly to aid teams constitutes one of the main problems [6-8].

2.2 Problems Providing Possible Solutions

Our study shows that existing solutions are often dependent on GSM networks or internet connections and frequently become unusable during disasters. While solutions such as walkie-talkie devices or emergency message systems that offer limited information transfer provide short-distance communication, they are inadequate for long-distance and reliable information transfer. The study provides an innovative and effective alternative in this context, providing critical information transfer in disaster situations and accelerating emergency response processes. Thus, it aims to provide social benefit by filling an important gap in the field of disaster management and emergency services [14-16].

2.3. Solution

2.3.1 Problem Solving Mechanism

1.Detection: The gyroscope sensor detects the tremors that occur during an earthquake and triggers the system.

2.Data Collection: GPS module collects real-time location data.

3.Coding: The location data collected is encoded with Morse code.

4.Communication: The encoded data is transmitted to the international hotline at the frequency of 2549Hz through the special radio transmitter circuit.

5.Coordination: Emergency teams can make rapid response and coordination based on the location information received.

6. Independent Operation: It is aimed to create a product that can operate independently of the grid with the help of solar energy panels.

7. Cost Analysis: All parts used in the study were obtained from waste products and recycled materials. The total cost of electronic parts, components, GPS module and plastic parts varies between approximately 500-1000 TL. Especially being accessible will make a significant contribution to our country, which is an earthquake zone.

Our project aims to offer a sustainable communication solution that does not require maintenance, repair and renovation, unlike traditional communication systems. DAIS allows disaster victims and emergency services to communicate effectively and can thus play an important role in emergency communication. The project offers a vital alternative in cases where communication networks are inadequate and provides social benefit. They also provide significant contribution to disaster management, potentially saving lives.

2.4 Solution Proposal

• ***Specially Designed Radio Transmitter Circuit:*** The specially designed radio transmitter circuit to be used in the electronic circuit is designed to provide reliable communication in cases where the communication infrastructure collapses. This circuit offers the ability to communicate effectively on the BM SOS line frequency.

• ***GPS and Morse Code Integration:*** The GPS module and Morse code coding system aim to transmit real-time location information quickly and reliably in emergency situations. In this way, relief teams can quickly reach the scene and manage operations more efficiently [18-25].

• ***Using Arduino Platform:*** Arduino platform provides flexibility and customizability. In this way, you can adapt to different geographical and operational scenarios and adapt the system as needed.

• ***Hardware:*** Electrical connections of radio transmitter circuit and GPS module equipment

• ***Software:*** Ensuring communication by coding with Morse code

• ***Coordination:*** Patent studies and cooperation with Van YYÜ

Figure 2 shows the details of the designed Emergency Communication System (ECS). The gyroscope sensor, UART NEO-6M GPS module, RF radio transmitter card, voltage regulator and 868Mhz 3dBi SMA antenna are mounted on a perforated pertinax electronic circuit board connected to Arduino Uno R3, which we use as the microcontroller platform. If it is in a prototype box that is resistant to environmental conditions; Li-ion Battery with 3.7V-3200mAh protection circuit, Charge Control Regulator, 12W Perc Monocrystalline Solar Panel, LM2940 5V voltage regulator and cable components are installed. In addition, it is aimed to install the integrated structure with the prototype resistant to environmental conditions in a way that the windows can see the sun in apartments or detached houses. Even if the energy coming from the solar panel is not continuous, location data sharing can be provided uninterruptedly for approximately 2 years with a fully charged battery in the event of an earthquake. Since the energy needs will be met by using solar panels, the devices will be able to operate without being dependent on any electrical system. This feature provides a great advantage, especially in disaster areas, because the devices can operate as an uninterruptible power source even if the electrical infrastructure is damaged.

The planned prototype of our study is shown in Figure 2. In the waves seen on the oscilloscope screen, the period $f = 2548Hz$ is calculated as approximately $T = 392us$. The waves related to the measurement of these waves and the trial code are sent only to the Morse code: "." Frequency adjustments are made with the (dot emphasis) code. The oscilloscope screen shows a visual showing whether there is a phase shift between sending this frequency with the Arduino Uno and transmitting it with the radio circuit. The transmission of the Morse code encoded by the radio circuit to the receiver has been successfully completed. ECS contains a voltage regulator and battery charging circuits to adjust the operating voltage. In addition, the design was developed using a standard radio transmitter design and minimum circuit elements.

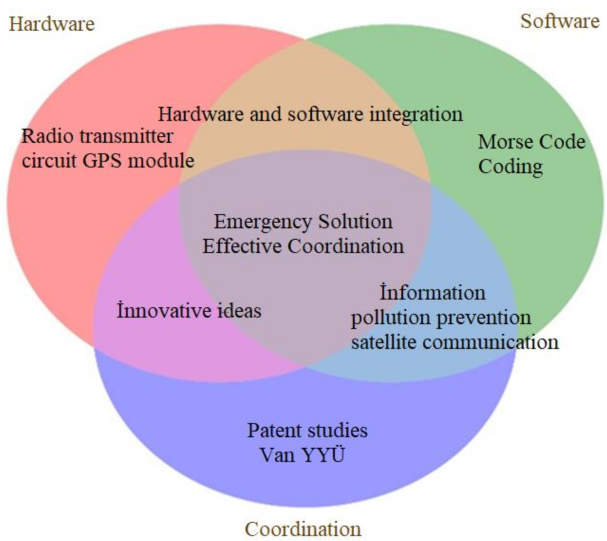

Figure 1. Schematic representation of the project realization process

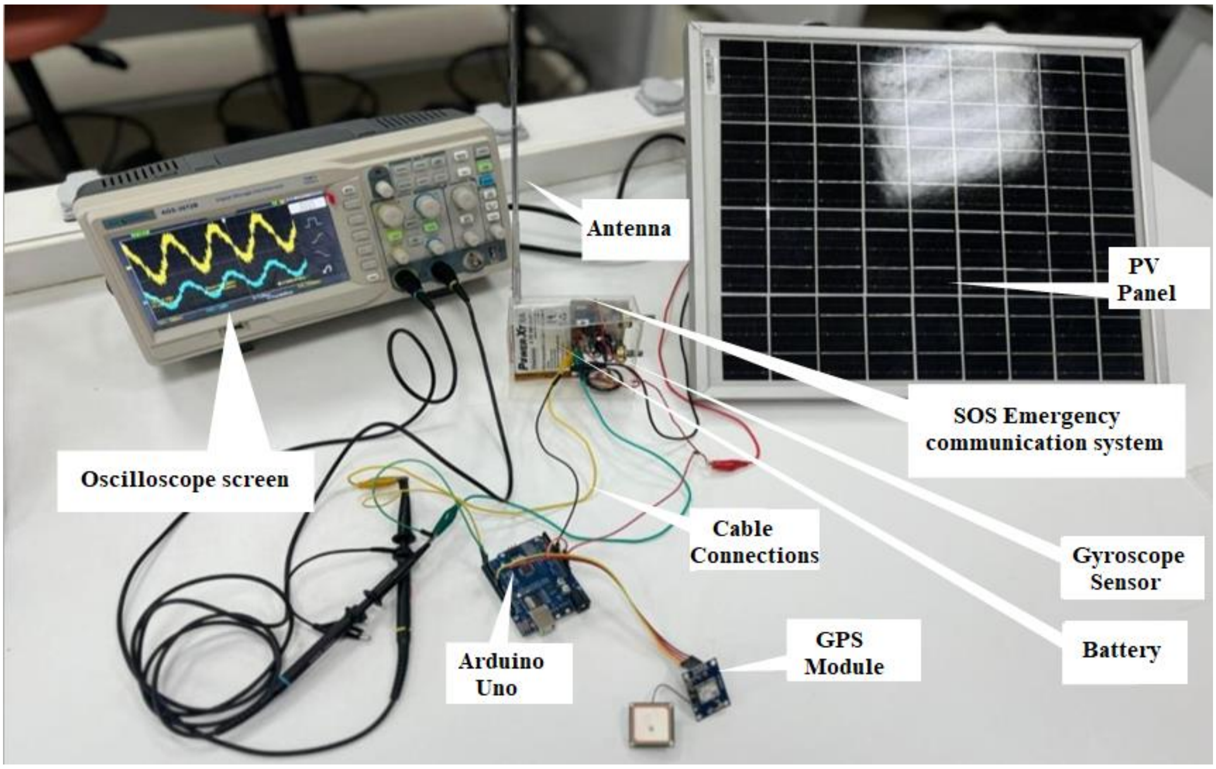

Figure 2. SOS emergency communication system prototype in-box test image

2.5 Writing SOS in Morse Code

The SOS text is expressed in Morse code as follows: "... --- ..." To transmit the SOS message in Morse code at a frequency of 2549 Hz, signals are sent by changing the frequency in a certain time period. Each short signal (dot) and long signal (dash) in Morse code is transmitted for a certain period of time, with gaps between these periods. Figure 3 shows the Morse code transmission circuit.

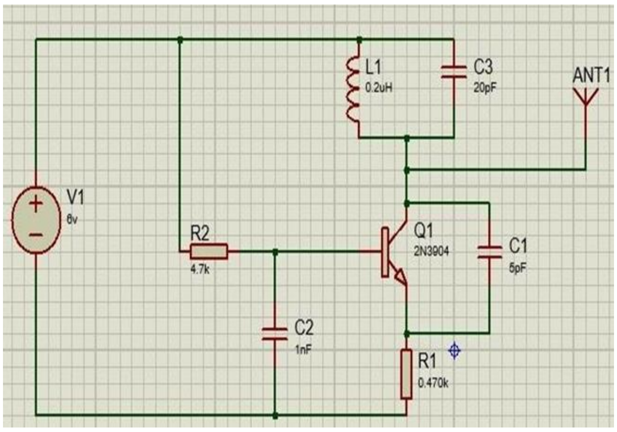

Figure 3. Radio transmitter circuit schematic representation

2.5.1 Timing Diagram of SOS Message

1. S: ...
Dot: 0.15 seconds
Space: 0.1 seconds
Dot: 0.15 seconds
Space: 0.1 seconds
Dot: 0.15 seconds
Space between letters: 1.2 seconds

2. O: ---
Dash: 1 second
Space: 0.1 seconds
Dash: 1 second
Space: 0.1 seconds
Space: 0.1 seconds
Dash: 1 second
Space between letters: 1.2 seconds

3. S: ...
Dot: 0.15 seconds
Space: 0.1 seconds
Dot: 0.15 seconds
Space: 0.1 seconds
Dot: 0.15 seconds

Space between words: 1.5 seconds (message may repeat when space between words ends)

Total Time

- S: 0.15 + 0.1 + 0.15 + 0.1 + 0.15 + 1.2= 1.85seconds
- O: 1 + 0.1 + 1 + 0.1 + 1 + 1.2 = 4.4 seconds
- S: 0.15 + 0.1 + 0.15 + 0.1 + 0.15 + 1.5 = 2.15seconds
- Total: 1.85 + 4.4 + 2.15 = 8.4 seconds

That is, the SOS message is transmitted at a frequency of 2549 Hz, repeated approximately every 3.4 seconds.

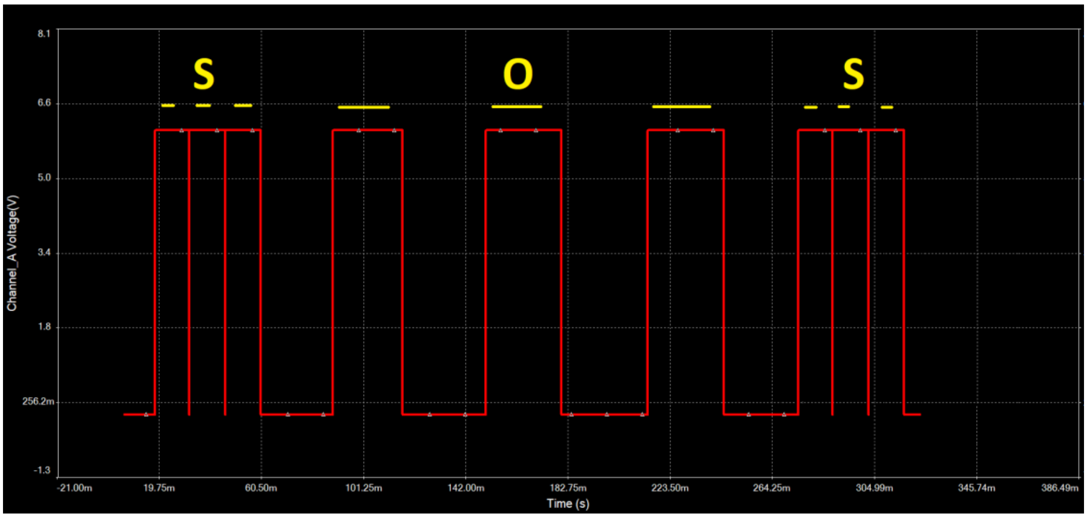

Figure 4. Voltage response of SOS signal (simulation)

Figure 4 shows the voltage response of the square signal in each signal of the SOS signal. These results were obtained in the Multisim circuit package program. The circuits in the application circuit and the Morse code signals are parallel. The source voltage selected in the simulation is 6V and the timing period is selected shorter. In the Multisim program, approximately 0.3 seconds was selected to shorten the simulation time.

3.Target Audience

Local and national emergency management teams that require effective intervention in natural disasters such as earthquakes, floods and fires, first responders such as fire brigade, medical personnel and police, non-governmental organizations such as Kızılay and AFAD that carry out aid and rescue work, disaster management and emergency planning municipalities and local governments, as well as military units that coordinate security and aid operations [11-13].

Our users are emergency management professionals, search and rescue teams, local government and municipality personnel who perform critical information transfer and coordination tasks in disaster situations, and employees of non-governmental organizations who organize aid and support activities [12]. This project is designed for individuals and communities experiencing communication problems and aims to save lives by providing reliable and fast communication during disasters.

4. SWOT Analysis

With this analysis, it is stated that the strengths and weaknesses of the system, as well as what potential it is open to, provide a holistic perspective to our study. Figure 5 shows the SWOT Analysis report.

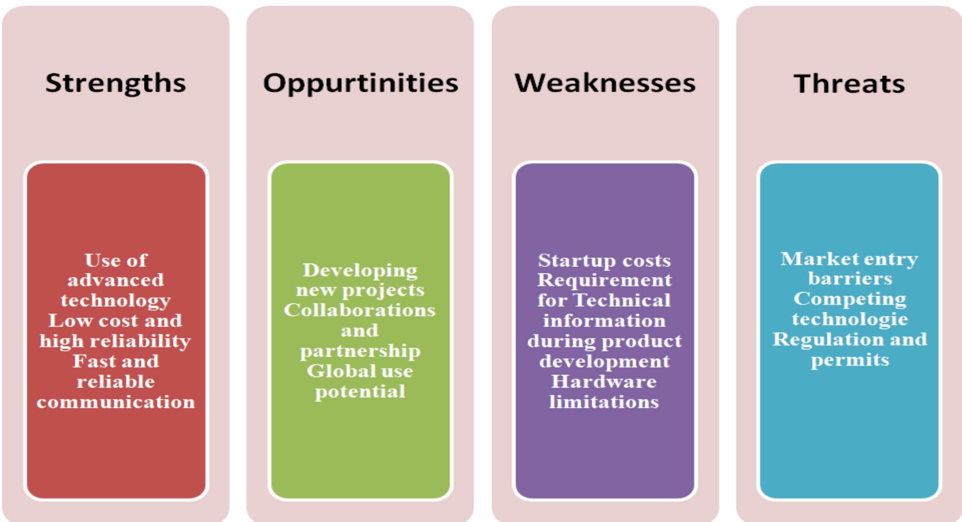

Figure 5. SWOT analysis report representation

Strengths: Our project provides an alternative communication channel in case the communication infrastructure is damaged during natural disasters, providing fast and reliable communication with low cost and high reliability through the use of advanced technology. The GPS module, radio transmitter circuit and Morse code coding system can reduce casualties and shorten response times by enabling the transfer of critical information in case of disaster.

Weaknesses: The initial costs of our project are high, and the implementation and integration processes may be complex due to the need for technical knowledge. Additionally, limitations of the hardware and software components used may affect the flexibility and extensibility of the project. These factors can create challenges for the sustainability and scalability of the project.

Opportunities: Our project offers opportunities to develop new projects and establish collaborations in the field of disaster management and emergency communication. Partnerships, especially with public institutions, non-governmental organizations and international aid organizations, can enable our project to reach wider audiences and be used on a global scale. Additionally, our project has the potential to increase its competitive advantage with technological developments and innovative solutions.

Threats: Market entry barriers are an important threat that our project may face during the commercialization process. The existence and rapid development of competing technologies may affect the competitiveness of our project. In addition, regulations and legal permissions in the field of disaster management and emergency communication may make it difficult to implement and expand our project. Strategic planning should be made to ensure the success and sustainability of our project by taking precautions against these threats.

5. Conclusions

This study aims to enable rapid response and provide social benefit by playing a critical role in disaster management with the support of specially designed hardware and software. Therefore, our project offers a vital communication channel during earthquakes and other natural disasters with its innovative approach and technological superiority. Existing solutions often depend on GSM networks or internet connectivity, and these infrastructures often become unusable during disasters. Our project offers an original study with long-distance and reliable information transfer using Morse code. The GPS module and Morse code coding system used distinguish it from existing solutions by providing fast and reliable communication in case of disaster. This innovative technology can reduce casualties and shorten response times by enabling the transfer of critical information in disaster situations. By using commercially available components, our product can be produced quickly and effectively with existing production infrastructures. Our prototype studies prove the feasibility and successful results of our product in real-world conditions, demonstrating its commercial viability.

Our project also offers ample opportunities for new projects and collaborations. It is envisaged that the impact area will be further increased with additional modules and software that will adapt to different scenarios in the field of disaster management and emergency communication. Collaborations with public institutions, non-governmental organizations and the private sector can also increase the impact of our product by enabling it to reach wider audiences. Therefore, our project provides both social benefit and has the potential to be commercially successful.

Declaration

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. The author(s) also declared that this article is original, was prepared in accordance with international publication and research ethics, and ethical committee permission or any special permission is not required.

Author Contributions

F. Author developed the methodology. S. Author performed the analysis. T. Author supervised and improved the study. F. Author and S. Author wrote the manuscript together. T. Author proofread the manuscript. …….. (This is an example. You must write all author contributions depending on your study period.)

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