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Tools to enable communication between sensor devices

Herramientas para habilitar la comunicación entre dispositivos sensores

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Abstract

This paper describes an analysis of applications to enable communication between systems such as: telemetry and sensors that interact in the RICB (Rescue In Collapsed Building) system that searches for victims in buildings collapsed by earthquakes, in which a decentralized communication platform is required. This platform needs to work independently from Internet such that people can integrate themselves with their devices such as: smartphones, tablets, laptops, and other mobile devices. An independent Internet collaboration tool is required, without a license, for which several were investigated, and an analysis and comparison of characteristics is presented. Tests showing which best adapts to the RICB system, chooses the one that is most flexible and versatile, especially when communicating between several different elements such as: people, applications, and sensor devices. For this investigation exhaustive research of applications was carried out; later their characteristics were tested, eliminating those that did not match the needs of the RICB system, resulting in two tools that were installed and tested. The contribution of this article is the search and choice of applications that maintain the connection between devices despite the lack of Internet.

Comparison, Systems, Analysis, Sensors, Telemetry

Resumen

Este artículo describe un análisis de aplicaciones para habilitar la comunicación entre dispositivos tales como telemetría y sensores que interactúan en el sistema RICB (Rescue in Collapsed Building) que busca victimas en edificios colapsados por sismos, en la cual se requiere una Plataforma de comunicación descentralizada. Esta plataforma debe funcionar temporalmente independiente de Internet para que las personas que interactúan puedan integrarse con sus dispositivos móviles como teléfonos inteligentes, tabletas y computadoras portátiles. Se requiere de una herramienta de colaboración independiente del Internet, sin licencia, para lo cual se investigaron varias, se presenta un análisis y comparación de características pruebas mostrando la que mejor se adapta al sistema RICB, eligiendo la que es más flexible y versátil especialmente cuando la comunicación viene entre varios elementos distintos tales como: personas, aplicaciones y dispositivos sensores. Para la investigación se realizó una búsqueda exhaustiva de aplicaciones, posteriormente se probaron sus características, eliminándose aquellas que no cumplieron con las necesidades del sistema RICB teniendo como resultado +dos herramientas que fueron instaladas y probadas. La aportación de este artículo es la búsqueda y elección de aplicaciones que permiten mantener la conexión entre dispositivos pese a la falta de Internet.

Comparación, Sistemas, Análisis, Sensores, Telemetría

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Introduction

A fundamental challenge in connection with human behavior in catastrophic situations is the image that the general perception of this topic has been shaped by decades of disaster films (Akhgar and Waddington 2017). In those films, the reactions of the civilian population to catastrophes are usually described as panic, shocked, passive, or paralyzed, with the aim of making the protagonists stand out through their readiness to act (Akhgar and Waddington 2017). However, this perspective does not correspond to reality, and leads to a fundamental misunderstanding among the population (McSeveny and Waddington 2017):

1. First of all, there is the myth of mass panic, which propagates those emotions such as: exaggerated, contagious and irrational fears, which inevitably overtake people in such an exceptional situation, lead to hasty and ill-considered flight behavior, which is not restricted by any social rules or conventions.

2. Another widespread, but equally false assumption, is the helplessness of people. That they react in a stunned or frozen manner and accordingly can no longer guarantee their safety and well-being in an appropriate manner.

3. The third and final falsified myth is the inevitable civil unrest that results from the idea that emergencies provide a context or excuse for people to behave antisocially or opportunistically (for example, through general rioting or looting).

Positively speaking: People in collective states of emergency generally act socially, rationally, and actively. (Smarter 2020). Therefore, communication and collaboration in crisis situations are considered as a special case, but still a case of everyday collaboration tasks. And thus, strives for the use of standard tools with the mere restriction of temporary non-availability or only little availability of resources like Internet and electricity access.

Development

The RICB (Cuevas-Rasgado et. al. 2022) is programed in a Raspberry pi zero, with a movement sensor, temperature and GPS Neo-6m connection. This Raspberry is inside a small transparent sphere made of resistant material to enter collapsed buildings. This entry is in accord with the strategy of rescuing people, mainly in places where the rescue squad suppose there are victims. Figure 1 shows the general diagram of RICB.

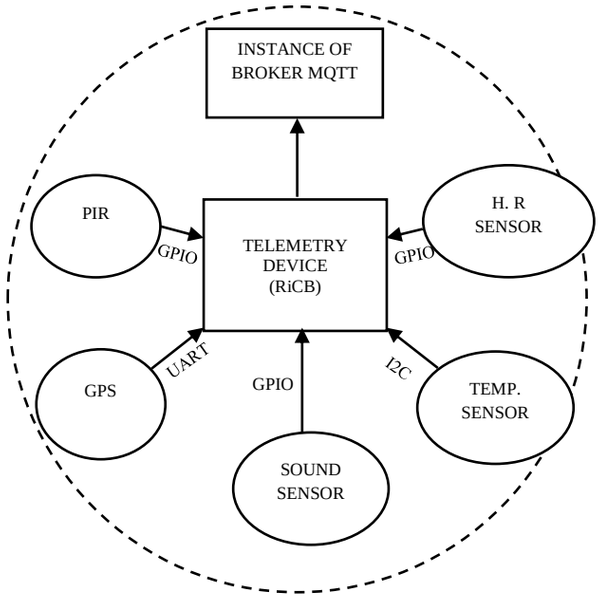

Figure 1 General diagram of RICB that describes the protocols of the sensors

Tools to enable communication among the RICB sensor devices

There are interesting works related to RICB, such as (Tumbaco 2022) that uses the MQTT protocol in the interaction of messages given by sensors in a security system, although in (Berbes et. al. 2022) an Application Programming Interface (API) that uses the FIWARE platform and the standards, generic components and Rest API services are presented. The plataforms's services are to facilitate the development of custom Internet of Things (IoT) applications. Others works such as (Cardona 2022) focus on people with hearing difficulties and provide better communication by translating some signs or voice into plain, natural text without excessively harming immersion, all through use of Virtual Reality (VR). With this technology, tools have been created that help any user with hearing problems to communicate naturally.

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For this Meta Quest is required to recognize the real hands of the user and project them in a VR; it also incorporates microphones and speakers. These works are all interesting due to the interactivity that exists between its components. However, all of them require an Internet connection. To manage the process of searching for live victims, and to enable communication among the RICB sensor devices, the Artificial Intelligence, and local rescue teams, a decentralized communication platform is required. That platform needs to work independently from Internet such that acting people can integrate themselves with their smartphones, and other mobile devices such as tablets and laptops.

Even though some of the market leaders such as Slack or Microsoft Teams offer a vast set of useful features for collaboration (Oracle 2020) these suffer decisive disadvantages. These products need permanent Internet access, and they need to be licensed. Here public domain software products seem to be more useful: They can be run on ad hoc networks, for example established on simple laptops serving as locally available access points. Furthermore, these access points can be set up independently using Docker images or images of a virtual machine (VirtualBox (Oracle 2020)) that can be distributed on storage devices such as memory sticks together with the RICB sensor devices.

Team collaboration tools

To obtain a license-free, Internet independent collaboration tool two publicly available tools were investigated. These were Mattermost (Mattermost 2020) and Matrix (Matrix 2020).

Mattermost

Mattermost is a communication service that enables direct communication between two or more actors in a direct communication space, as well as communication of several participants in corresponding "rooms". A room is a large team chat, which is dedicated to a defined topic or category and further subspaces can be contained here. A topic or category can be a group, for example, such as a rescue team, a common task, or a common interest.

Mattermost clients can be installed on all common operating systems, such as Android, Linux, IOS, and Windows. Alternatively, to the Mattermost proprietary client one can access Mattermost with any standard Internet browser and the appearance of the client does not change much.

Matrix and element app

Matrix is an open standard for decentralized, secure real-time communication over IP (Matrix Network 2020). The project is open source and maintained by the non-profit Matrix foundation. It is built to interoperate with other communication systems such as email, WhatsApp, Telegram or even IOT-devices. The standard is based on JSON and HTTP or HTTPS for data transmission and communication. In fact, any device that speaks HTTP can communicate via Matrix.

Matrix is designed from the ground up for decentralized operation. Each message that is sent in a chat room is synchronized to all other servers that participate in that room. If one server collapsed, all the other users in the room can still use the service and continue with their communication. When the server comes back online, the messages are synchronized again, and pending messages are transmitted. In contrast to the other group chat tools, the decentralized approach is therefore much more deeply anchored in the system.

The Element App (Element 2020) (formerly Riot.IM) is a client using the Matrix standard for communication. It offers features such as: chat rooms with thousands of users, file sharing, voice, and video calls, and all the other known features from group chat tools. Apps for iOS, Android, Webapp and desktop clients are available as well. The developers have used Matrix already to integrate a drone, control its flight and stream the image of its camera with a video call into an Element App chatroom.

The French government announced in April 2018 that it would introduce Matrix and Riot.IM as a strategic communication platform for its ministries and officials (Yates 2019). Since then, approximately 50% of the ministries have migrated to Matrix and Element App. This has given an enormous boost to the Matrix project. The existence and further development of the Matrix project seems to be more than secured with such an important customer.

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Comparison of Mattermost and Matrix

In order to compare the two tools their project-relevant features were determined and then the availability of these was checked. See Table 1.

Feature	Mattermost	Matrix (Riot)
Groups/Rooms	Yes	Yes
Send read markers	No	Yes
Sendings invites	No	Yes
Reply in threads	No	Yes
Attachments	Yes	Yes
Formatted messages	Yes	Yes
New user registration	No	Yes
Multiple accounts	No	Yes
Plugins	Yes	Yes
Intelligent notifications (e.g. if user is mentioned in message)	No	Yes
Bridge to other messengers	Yes	Yes
End to end encryption	Yes	Yes
Keyword notifications	Yes	No
Advanced permission controls	Yes	Yes
Server can be used in container	Yes	Yes
Already existent docker file for server	Yes	Yes
Large variety of messenger and servers based on original version	No	Yes
Easy to modify messenger and server applications	No	Yes

Table 1 Feature comparison

Here Matrix shows better suitability for the rescue process, especially due to the easy registration of new users, the large variety of supported clients, third party messenger apps, and server architectures. Also, the API of Matrix proved more open than Mattermost's. Therefore Matrix was favored as collaboration tool.

Rollout of collaboration tools

Matrix

Two variants were tested. Rollout via Docker (Docker 2020) or via a VirtualBox (Oracle 2020) Ubuntu-image. The latter variant proved to be easier to be rolled out, especially when it comes to installing several servers running in parallel. In our case, besides the Matrix/Synapse server an OpenStreetMap server for offline map services and an Apk server for the client's rollout is needed.

Matrix Clients

Depending on the rescue teams' needs Matrix clients described in (Matrix Client 2020) were investigated: The Element App and Pattle.

Element app

The Element App is available as web and various mobile versions. It integrates most of the features available through the Matrix SDK – the mobile version is nearly the same as the desktop version, but text formatting editor and multiple accounts feature are omitted. Both offer a few integrated plugins, among these Jitsi for video and telephone conferences, a plugin for shared use of documents and tables, and a Google Calendar plugin for sharing events. Furthermore, different possibilities to integrate bots are offered, what opens an easy way to bridge external sensor devices and KI algorithms' results. It has an easy usable User Interface (UI) in most parts of the Element App. It is available on Google Play Store and the App Store.

Pattle

Pattle offers a very simple and clear UI but only supports text messaging and photo attachments. There are no plugins and no formatting available.

It is available on the Google Play Store and on TestFlight for public iOS Beta Testing.

As a result of this comparison, the Element App for mobile usage was applied. Both (Element App and Pattle) can be used in parallel but only Element App supports all the features needed (plugins, formatting, joining groups). The Element App is also the official service of the Matrix foundation that is the main contributor to the Matrix service. Because of this, it is the most promising for a long support and lifetime. See Figure 2.

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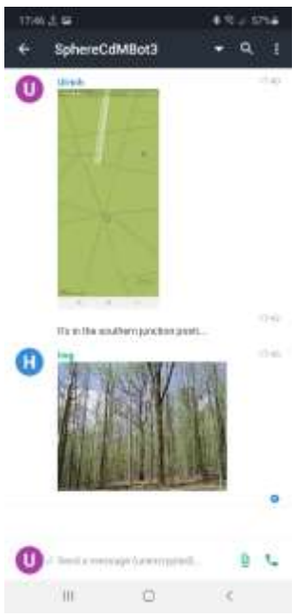

Figure 2 Test Use Case (UC) in Smartphone using the element App

Openstreetmap (OSM) integration

OpenStreetMap (OpenStreetMap 2020) was used in the past, and is still used for many humanitarian projects, in the case of natural disasters and epidemics. As a result, there are many different parallel developments of projects with OpenStreetMap in this context. During our research work many examples were found, but most of them were isolated solutions that addressed a specific problem and were inadequate elsewhere. By researching the working practices and reports of humanitarian projects that have used OSM in the past, it was eventually decided for POSM (American Red Cross 2020) since POSM allows bringing the standard toolset along for the ride when there isn't access to cheap and fast Internet connectivity.

For the sake of simplicity, the POSM server was integrated into the VirtualBox server image used for Matrix and Apk delivery too.

Conclusion and future works

The Element App has proven very flexible and versatile for most UCs especially when it comes to communication among many different parties (rescue teams, bots, and artificial intelligence). Moreover, its effectiveness and efficiency may be enhanced somewhat by dedicated apps for the most common UCs. Hence, currently the following UCs are designed, and the designs are tested for their usability:

UC1 and 2: Onboarding, creating a helper profile, see Figure 3.

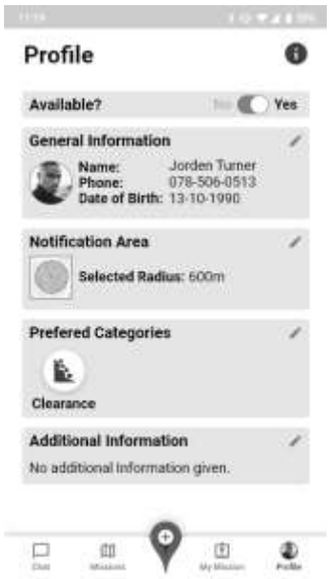

Figure 3 UC2 Design of Helper Profile Entry

UC3: Receiving and accepting a personalized call for help

UC4: Selection of a call for help on a map

UC5: (As a central manager, bot, or AI) send a call for help (See Figure 4)

UC6: Processing and completing a call for help.

Figure 4 UC5 Design of Mission Creation

Acknowledgements

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