DATA ACQUISITION MODULE STUDY (DAMS) AT MDRS

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ABSTRACT

The Data Acquisition Module Study (DAMS) is a research project developed by members of Crew 126 – Team Peru at The Mars Society's Mars Desert Research Station. The main objective of this project was to assess the effectiveness of a modular system for early data acquisition and personnel positioning on a Mars-like environment. DAMS provides a method to acquire weather data and determine the exact position of crewmembers on a planetary surface. A GPS system will be ideal for positioning, but it will take time to develop and deploy an operational system on another planet. DAMS is intended to provide a fast, inexpensive and portable system of positioning and weather acquisition by using a modular structure to share and fetch data, ideal for early planetary surface expeditions. This project is still on the beginning phases of design; in this regard, the testing during MDRS Crew 126 focused on the overall networking communication approach. This paper summarizes the DAMS research performed during MDRS Crew 126, describes the design approach, and provides recommendations for follow up research.

KEYWORDS

data acquisition; network; personnel positioning; early Mars exploration; low cost;

INTRODUCTION

It is a given that space exploration will become affordable in the future. For that purpose, there are many different fields which need to be developed. Two of them are data acquisition (i.e. weather information, health status, etc.) and human positioning. Several devices exist that can collect weather data but there is only a few of them which can locate a human in a defined space. Of course, while a Global Positioning System would be ideal, it is hard and expensive to deploy such system for early planetary explorations. This paper presents a concept of a network capable of fulfilling the aforementioned necessities.

HARDWARE

The proposed system consists of three devices which work in unison to accomplish the desired results: a Master Device, a Slave Device and a Portable Gadget.

Master Device

A small electronic box composed of a transreceiver, a microcontroller (Atmel's Atmega8 [1]) and a USB Serial adapter which collects all the information sent by the Slave Devices per request of the Master Device. This device is connected to a PC that processes the collected data into useful information for the crew and manage all communications done within the network.

Slave Device

Consists of many small boxes made with dust resistant materials and a transreceiver, a microcontroller, sensors and a power source. This box will acquired environmental data when required by the Master Device and act as a repeater for the network system as explained in the appendix 1.

Portable Gadget

This gadget is composed of a transreceiver, a microcontroller and a power source and acts as a beacon which is carried by the crewmember during an EVA.

SOFTWARE

The main program was coded in Visual Studio 2010 C++ and displays a user graphic interface embedded with a map with MDRS geography that shows the position of each Slave Device and their current climatological readings as seen in figure 1. This program also keeps a CSV (comma separated values) file with a history of the information for further analysis.

COMMUNICATION

The communication between all devices and the main PC is done with UART Serial communication with a data structure called package consisting of three parts: a route, a body and an outro. The data is transmitted using Manchester Encoding [2] to avoid noise during radio frequency communication.

Protocol

A reliable means of transferring data over wireless communication is needed. In system such as communication networks, a structured data stream, usually with a unique address for each device is required.

To fulfil this condition, a common protocol was developed for the communication between all devices of the network.

Main Server

The PC used to process the acquired data and manage the communications is in charge of computing the optimal route for a package to travel. Before sending any information, it is required to input the geographical coordinates of the Slave Devices deployed in the desired area of study into this PC. After this, the shortest distance between the Master Device and the targeted Slave Device is calculated and introduced at the ***route*** part of the ***package***.

Then, the ***body*** of the ***package*** is filled with request codes that the Slave Device will take in order to retrieve data. (A more detailed information about request codes can be found in appendix 1)

Finally, the ***outro*** of the ***package*** contains the returning path the package must travel with the purpose of going from the Slave Device to the Master Device.

Every time a package is sent, it is expected to receive an acknowledge response from the targeted device. If there is no response for a period of time, then the targeted device is rendered as a failure and will be ignored for future path calculation. Then, a new route is computed. (Refer to figure 2)

Each part of the package is divided by separating bytes as explained in detail in appendix 1.

Repeaters

The Slave Devices deployed in the network have dual functions: data fetcher and repeater. As a data fetcher, its only purpose is to provide the information acquired by the sensors embedded in the device. As a repeater, it will broadcast any package received that matches its address. By doing this, the range of the network is greatly increased.

Beacon Signal

The Portable Gadget carried by the crewmembers repeatedly broadcasted a beacon signal which was received by the Slave Devices. Whenever the main server requested a crewmember location, the Slave Devices within range of the beacon signal would activate, and the position of the astronaut would be computed as the intersection of the range of each activated Slave Device. (Refer to figure 3)

FIELD TESTING

The network was tested at the MDRS during the rotation of crew 126. Several Slave Devices were deployed around 50m of the base. A laptop inside the base acted as the ***main server*** attached to the Master Device. Due to high static noise at the desert, radio frequency was prone to high noise rates. For that reason, it was necessary to change RF communication with Bluetooth communication. Although the range was smaller, it was possible to try out the network.

RESULTS

In spite of having almost no wireless communication near the base, the static field generated at the desert induced noise in the system. After some adjustments, the network worked as expected. The system was capable of sending reliable data and detecting a crewmember within the network’s range.

However, strong desert winds moved some of the deployed Slave Devices, making them unusable for locating a crewmember since they were no longer in the right place.

CONCLUSION AND FUTURE WORK

The main objective of this research was to test the system network. For that reason, some optimization was omitted, such as power source selection. Since this network came to be successful, it is possible to make more efficient devices for the system. In this regards, it is suggested to develop small movable robots with a built in Slave Device to produce a flexible network. Furthermore, other types of communications, such as Wi-Fi, can be used to increase the compatibility with already developed systems.

ACKNOWLEDGEMENT

The authors would like to thank the Mars Society's Mars Desert Research Station for providing the research area, the Pontifical Catholic University of Peru for providing the necessary funding for the completion of the project and Alejandro R. Diaz for the initiative of forming a Peruvian crew.

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[2] Atmel, "Manchester Coding Basics," September 2009. [Online]. Available: http://www.atmel.com/images/doc9164.pdf.

APPENDICES

Appendix 1:

Proyecto Barsoom's Communication Protocol

Figure 1:

Screenshot of the software

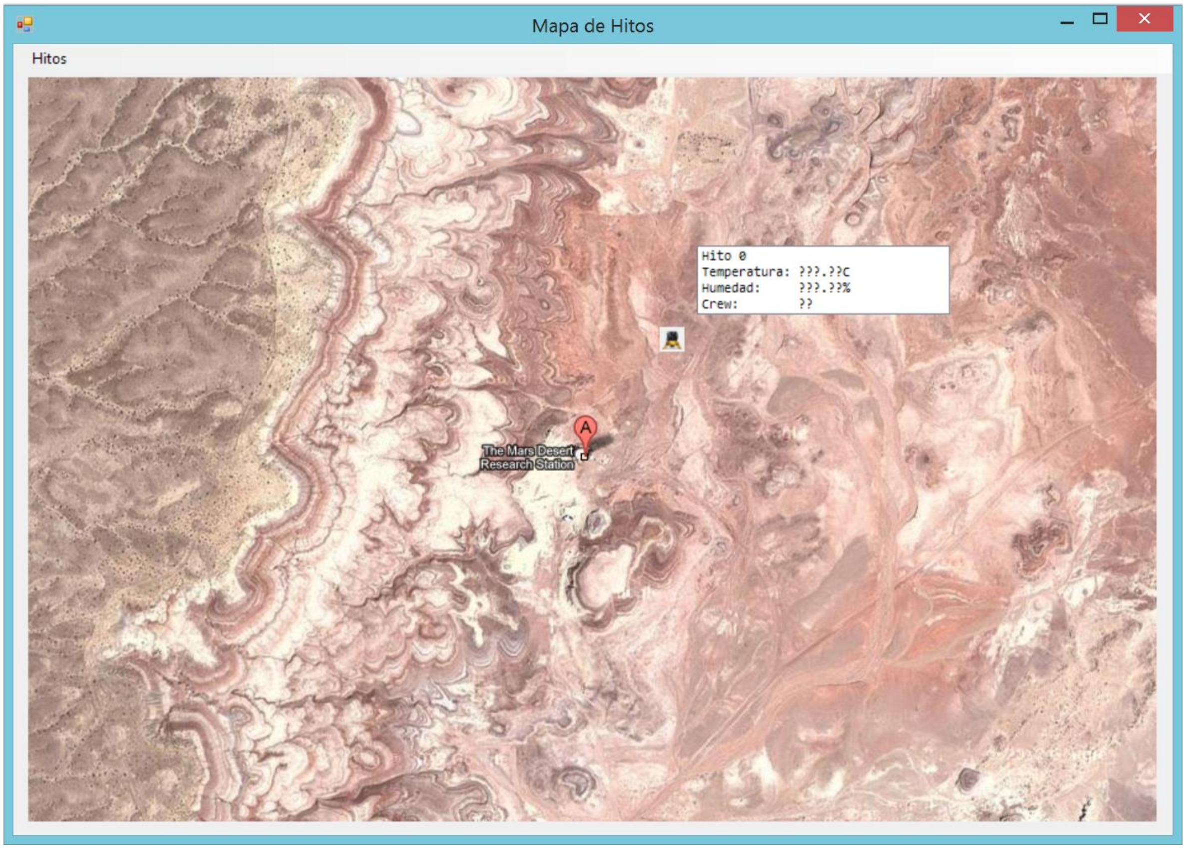

Figure 2:

Path calculation

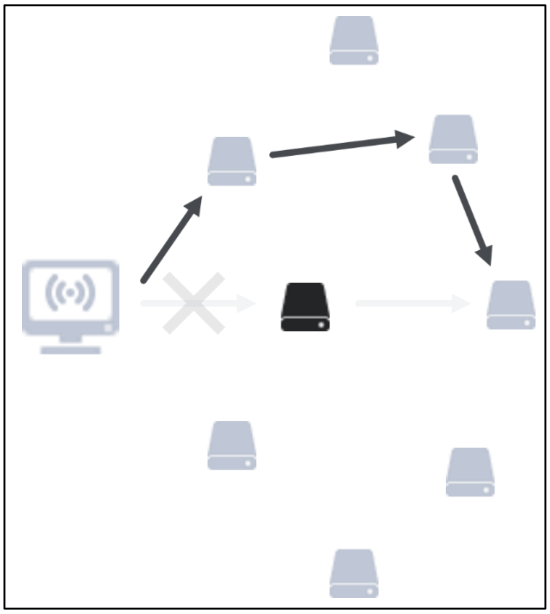

Figure 3:

Crewmember location