RoboCup Rescue 2019 Team Description Paper XFinder team

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Information

Team name: XFinder team
Institution: IFRobotics
Team leader: Martin Omar Vazquez Reyes

Summary - This construction work describes, installation and operating accessories of our XFinder robot, in order to participate in the TMR (regional tournament in which we are champions twice during 2015-2016 and 2nd place in 2018 you could take a look of competition results on these links http://femexrobotica.org/tmr2015/resultados.php our team name was “UTEZ UNO”, https://www.femexrobotica.org/tmr2016/resultados our team name was “MECANAO”, https://www.femexrobotica.org/tmr2018/ganadores/ our team name was “UTEZ-EXFINDER”).

Thanks to this competition, we finally got a place Competition in the RoboCup Rescue League.

Our project is a four-wheeled robotic system tele-operated suitable for indoor and outdoor used with high tensile strength, simultaneous localization and mapping (SLAM), visual detection of victims, recognition of QR codes and CO2 reading. The objective of this system is to recognize victims in any soil or land, creating a useful map for human rescue teams.

Index terms -RoboCup Rescue Team Description Paper, Tele-operated rescue robot, SLAM, 3D Mapping.

INTRODUCTION

The XFinder project originally began as an "integrative task" or final course project developed by four graduate students. Months later, it seems potential on this project due to many disasters in the nearby city of Cuernavaca.

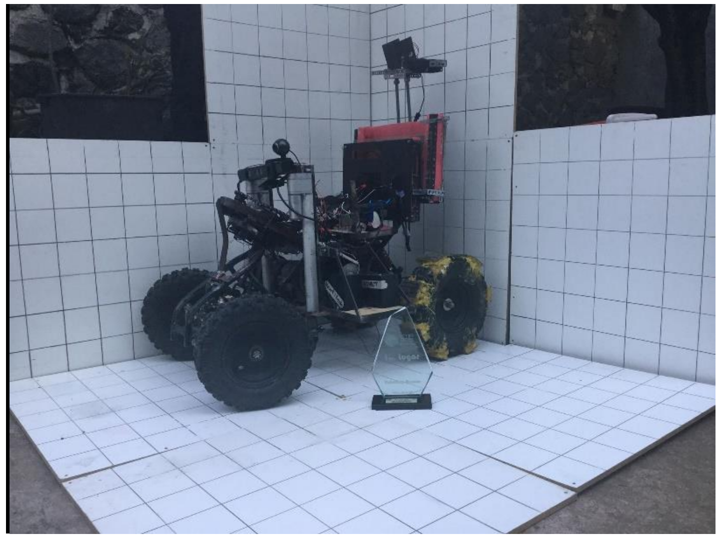


Fig. 1. TELEOPERATED XFinder robot.

During. many national competitions, the XFinder project has taken many forms refering to the teams which they´ve worked with, ending in our current version, shown in the picture above. Our main goal is to create a robot reliable and be able to provide real-time information, during disaster when conditions threaten, human intervention exploration.

After many field tests, several broken mechanical parts and burned circuits, it is proven that this robot is ready for the toughest conditions.

A. Improvements over previous contributions

The current XFinder project has received major software upgrades than field mechanics. We are focused on the application of 3D mapping, object recognition, navigation system giving us a better location and acquisition information. We are also improving our control systems for good, clearer

interaction between the operator interface and the action what robot will do.
You could see the new features in this link https://youtu.be/fxdpKCiMQUM

II. SYSTEM DESCRIPTION

A. Hardware

1) XFinder dimensions are 55 kg,
1 m long, 70 cm wide, 70 cm.

2) Many local competitions gave us a clear vision about implementing a system with suspension and wheels, in accordance to them we attempt to improve resistance to impact when the robot goes on uneven terrain from the ground floor or first floor whether or not there is an existence of a

ramp.

Fig. 2. SUSPENSION

3) Our Wheels design make it possible to slect between the speed or torque, depending on the conditions of the field, which adds a multiple transmission chain.

Fig. 3. transmission chain.

4) The XFinder has mounted cameras, rexsponsible for recognition of objects in order to avoid collision and tracking management to streaming video in real time and see any possible obstacles when it goes backwards.

Fig. 4. Cameras that are implemented in the XFinder

5) To enable 3D feature mapping, we have mounted on the front of XFinder, a Kinect for Xbox 360,where also plays a role as a front camera, working with other cameras for full view from, surroundings, getting a clear map , and better location with real-time view, in addition to 3D map.

Fig. 5. Kinect sensor. (3D Map)

6) XFinder uses Lipo Battery as:

- LiPo battery (22,2 V 10 000 mA) provides power to the traction engine XFinder, distributing more weight in the rear for more torque passing through the obstacles more easily.
- LiPo battery (11.1 V, 5.2 A) supplies power to the motor manager address

Lipo battery (7.4 V, 0.5 A) powers the device Kinect

Fig.6 LiPo's used in the project.

7) Engine control were designed and created circuits capable of handling them, such circuits are operated by the board Arduino UNO program which is encoded using Labview software, in turn, it works with the protocol TCP / IP communication to send and receive information (such as signals movements) from server

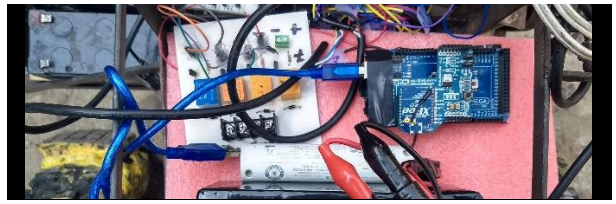


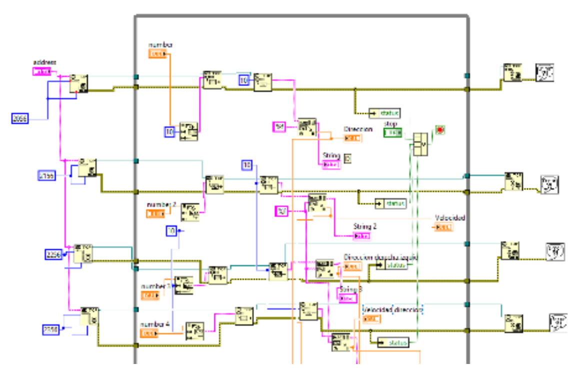
Fig. 7. The circuits mounted on plates box half.

B. Software

1) control signals movement is performed by the Xbox One, therefore signals are sent to the costumer

Fig. 8. Control Xbox

2) The internal code made in LabVIEW interface, help us a lot to separate actions, making fewer errors or making our code less dependent on the above conditions.



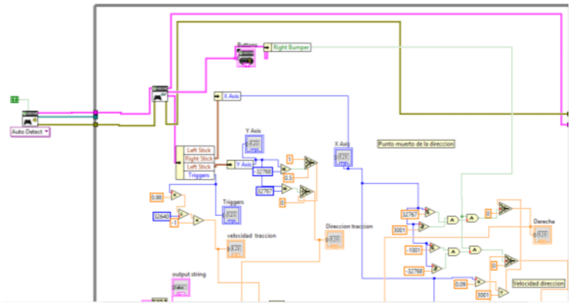


Fig. 10. Capture code Labview

3) Our SLAM is performed by an open source program called RTABMap using Kinect 360 sensor to measure and create real-time map to locate and navigate,in addition, front camera of Kinect has the front view, so it makes easier to operator interface. We are in process of adding object recognition for a better map useful reference points.

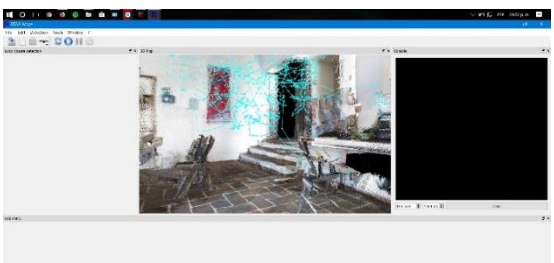
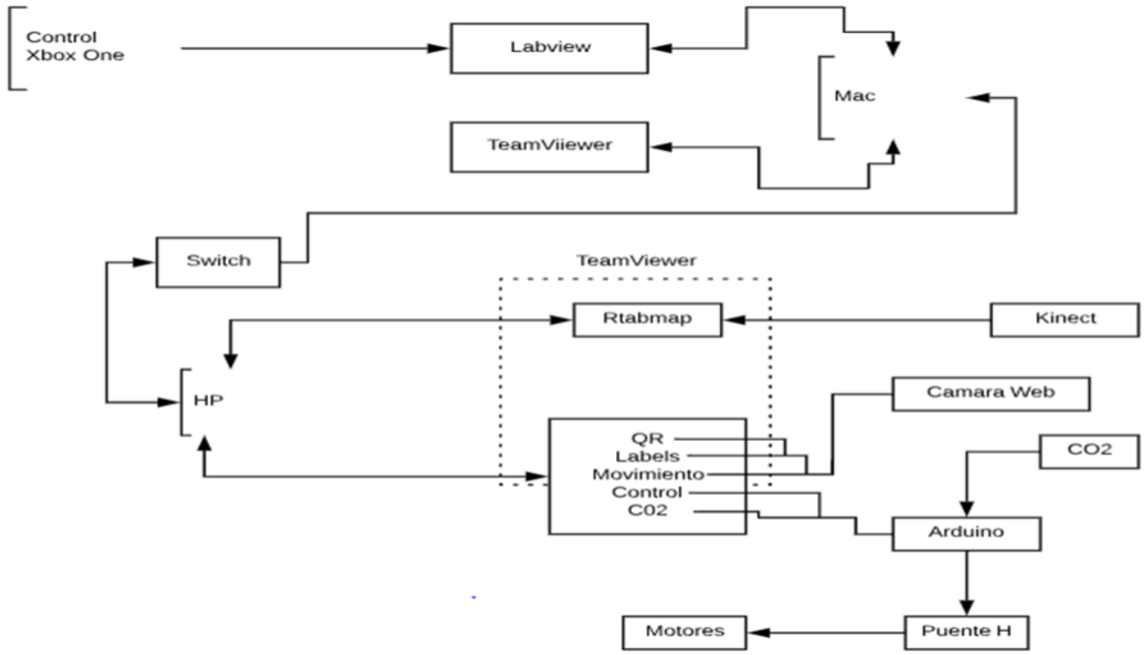


Fig. 12. Map 3D using RTABMap.

C. Communication

The communication is performed through the TCP / IP protocol which is responsible for connecting a server and a client that sends and receives data simultaneously in real time, said connection is made by a switch to assign the corresponding IP's
(2.4 g),

Fig.13 current operator station, going from left to right are: SLAM and 3D map, streaming video camera and robot control.



D. Human-Robot Interface

1. Communication Control

Communication TCP / IP is made by LabView. There are 2 codes depend on each other. certain code runs as a server which control signals Xbox One are acquired and according to set up parameters , numerical data will be written to send them to another code, the other computer is used as a client receiving the information command and this in turn is sent through the Arduino to control motors, However, it should be noted that the information is sent by different remote ports and to be specified in the server IP client where is going to be connected

III. REQUEST

A. Setup and breakdown

We are aware the speed of adjustment and the process of breakdown of each task is very crucial.

Our team includes XFinder robot, a laptop computer going inside the robot to send data at our station. All equipment is transported to operator station on a transport trolley.

B. Strategy Mission

In our simulations we have created two teams, one team is for the flow of vision and navigation; and the other one for 3D mapping and location. Let's deploy XFinder in the operating field and complete all possible targets in a planned routine regarding on the coordination of two teams, based on the distance and objectives of the way.

C. Experiment

Experiments have been mainly mechanical due simulation uneven terrain, debris and various types of materials like stones and sand. We expect the anatomy of XFinder in respect of all these simulations at different terrains allow us to complete the yellow or red areas of the operating field. In thesoftware area we are still linking the different programs and applications (QR mapping, object detection, motion, CO_2 detection) to enrich this way, the 3D mapping and be able to send the most complete information.

Fig. 15. XFinder 6 version goes up.

D. application in the field

Places near from our work area are industrialized size, because of this, it is expected that the XFinder project could be useful in exploring these areas in case of disaster or pollution implying harm in human. Sending data in real time to a parallel rescue action team and avoid human losses

1) The strength of the robot is based on the movement of pulling , its size and durability to sort the obstacles, therefore, the XFinder is suitable for real-world scenarios.

2) Weakness: No robotic arm.

3) Get a robotic arm.

IV. CONCLUSION

The XFinder project was born from scrap, reuse parts, sometimes money itself, but as a team we are ready to participate and demonstrate the product of our hard work.

APPENDIX A

Team and contributions

The XFinder robot has 7 members. Their names and responsibilities of each member are as follows:

1) Martin Omar Vazquez Reyes
   .-Team captain .
2) Chavarria Santiago Luis Ashmed.
   . - Mechanical Development.
3) Diaz Francisco Javier Altamirano
   . - System control / scan.
4) Claudio Pachecano Victor Abraham
   . - mechanical development.
5) Garrido Garrido Maria de Lourdes
   .-Electronic design
6) José María García Sotelo
   . - Object recognition
7) Jonathan Cruz Nava
   . - Development controller.

THANKS

We thank the small sponsors who have supported us to get resources and materials for the project financing, as well as our families have provide us full support in situations of adversity, lack of free time and financial support for the project and travel competences.

References

Because of our lack of support by experts in three different areas (mechanical, electrical and programming) and the origins of XFinder we don´t have many references, only a few books that have taken many ideas.

1) M. F. Labbe and Michaud, "Global Online detection loop close graphic based SLAM Multi-scale meets" in Proceedings IEEE International Conference / RSJ Intelligent Robotics and Systems, 2014. (From here took our main source to make our SLAM)

2) J. Craig, Introduction to Mechanics and robotic control. Pearson Prentice Hall; third edition, 2005.

3) M. Rashid, Power Electronics: Circuits, devices and applications. Pearson Prentice Hall; Third Edition, 2004.

APPENDIX B
SCHEDULES

A. Systems List

There are 3 main systems:

• Handling System in the table I
• The operator station in the table II.
• The list of hardware components on the table III.
• The list of software on the table IV.

TABLE I.
Handling system

Attribute	Value
Name	XFinder
Locomotion	Wheeled
System weight	85 kg
Weight including transportation case	90 kg
Transportation size	1.0 x 0.6 x 0.66 m
Typical operation size	1.0 x 0.6 x 0.78 m
Unpack and assembly time	210 min
Startup time (off to full operation)	5 min
Power consumption (idle/ typical/ max)	60 / 560 / 1000 W
Battery endurance (idle/ normal/ heavy load)	60 / 40 / 20 min
Maximum speed (flat/ outdoor/ rubble pile)	0.8 / 0.6 / 0.3 m/s
Payload (typical, maximum)	NE
Arm: maximum operation height	NE
Arm: payload at full extend	NE
Support: set of bat. Chargers total weight	2.5 kg
Support: set of bat. Chargers power	1,200W (100-240V AC
Support: Charge time batteries (80% / 100%)	40 min / 60 min
Support: Additional set of batteries weight	3 kg
Any other interesting attribute	2 electrical Pistons
Cost	4000 USD

TABLE II
Operator Station

Attribute	Value
Name	XFinder station
Weight system	15 kg
Weight including transport size	30 kg
transport size	0.8 x 1 x 0.4 m
size typical operation	0.8 x 1 x 0.4 m
Unpacking and assembly time	15 minutes
start time (out of full operation)	5 minutes
Power consumption (standby / standard / max)	NE
the resistance of the battery (idle load / normal / heavy)	NE
Any other interesting attribute	-
Cost	500 USD

TABLE III

HARDWARE COMPONENTS

Part	Brand model	Unit price	Num.
structure of the robot	-	2000 USD	one
drive motors	-	500 USD	two
drive gears	-	-	-
encoder unit	-	-	-
motor controllers	-	-	-
DC / DC	Regulator	-	one
Battery Management	Nebraska	-	-
battery	lipo,	750 USD	3
microcontroller	Atmel	50 USD	one
Computer unit	Laptops dual mount	-	two
IMU	-	-	-
VDO cameras	-	-	-
PTZ	-	-	-
Infrared camera	-	-	-
LFR	-	-	-
CO2 sensor	-	100 USD	one
Battery Chargers	-	200 USD	two
Robotic arm	-	-	-
air vehicle	-	-	-
Operator rugged laptop	-	2000 USD	one

TABLE IV.
SOFTWARE

SOFTWARE	VERSION	LICENSE	USE
Start Windows 10.	1607	closed source.	OS workstation.
RTABMap project.	0.11.14	open source.	3D mapping.
TeamViewer.	12.0.72365.	open source.	Streaming between laptops in the XFinder browser.
NI LabVIEW.	15.0.	closed source.	XFinder algorithm browser.
OBS study.	17.0.2.	open source.	Current cameras installed in the XFinder.
Kinect for Windows Drivers.	1.8.0.595	open source.	required for 3D mapping sensor controllers.
Kinect for Windows SDK.	1.8.0.595	open source.	an additional driver for 3D mapping sensor.
Kinect for Windows at runtime.	1.8.0.595	open source.	RGB camera controller integrated in the sensor 3D map.

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Otorgan el presente

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a

Martin Omar Vázquez Reyes

Por haber obtenido el
Primer Lugar

en la categoría de

"RoboCup Major Rescue"

En el 7° Torneo Mexicano de Robótica

Celebrado del 23 al 25 de abril del 2015

Santa Cruz Acatlán, Naucalpan de Juárez, Estado de México, Abril de 2015

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Otorgan el presente

Diploma

a:

MARTIN OMAR VÁZQUEZ REYES

Por haber obtenido el **1er LUGAR**, con el equipo

MECANAO

en la categoría

RoboCupRescue

en el **Torneo Mexicano de Robótica 2016**

celebrado del 15 al 17 de marzo de 2016, en Cd. Victoria, Tamaulipas.

Dr. Héctor Simón Vargas Martínez
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Federación Mexicana de Robótica, A.C.

Mtra. Sonia Maricela Sánchez Moreno
Rectora
Universidad Politécnica de Victoria

Cd. Victoria, Tamaulipas, a 17 marzo de 2016.

TODOS POR TAMAULIPAS

TMR 2018
MONTERREY

El Comité Organizador del X Torneo Mexicano de Robótica

otorga el presente reconocimiento al equipo:

UTEZ-EXFINDER

por haber obtenido el **2do Lugar**

en la categoría **RoboCup Rescue Robot**

MC Erick Sánchez Flores
Presidente de la Fundación
ProRobótica de N.L. A.C.

Dr. Enrique Sucar Succar
Presidente de la Federación Mexicana
de Robótica A.C.

Monterrey N.L., a marzo 24 de 2018