RoboCupRescue 2018 Team Description Paper
Seowground Robot

Sanga Taechersai, Wiwat Puyati, Somsakkayapong Tansura, Prawit Saengsil

INFO

Team Name : Seowground Robot
Team Institution : Buriram Technical College
Team Leader : Sanga Taechersai
Team URL : http://sroewground.simdif.com/
Team Email Address : ausaram@gmail.com

Fig. 1 : Seowground Robot

ABSTRACT

"Seowground Robot" developed by Buriram Technical College is a state of art Robot for fire rescue operation using latest hardware and software. Incorporating artificial intelligence and simple algorithm, even though Seowground Robot was conceived as a low cost robot, with continuous upgratedation, it is very versatile and can be used in rugged terrain with gravels, sandy and sleeper conditions. Administration of initial first aid on site to the victims along with live video communication with ground crew to show the severity of every victim makes the "Seowground Robot" stands different compared other robots developed by others.

INTRODUCTION

The ministry of Education and the Office of Vocational Education Commission in Thailand under the guidance of her majesty Princess, started Rescue Robot Competition in the year 2009. As a vocational and technical education college under the ministry of Education, Buriram Technical College built a team of electrical, mechanical and software developers with greater ability to grasp latest available technology to develop our rescue robot. That paved the way for us to take part in competitions organized by the office of Vocational Education Commission in Thailand. Nurturing a team of inexperienced students came with many failures and disappointment. However with every passage of time, our team could grew stronger not only in terms of adopting new technology but also with a great strong desire to excel. Our team saw a ray of light at the end of tunnel in the year 2015 at Rescue Robot Competition organized by Office of Vocational Education Commission, though securing a lower end position. Encouraged by that achievement led in improving upon all lacuna, we redesigned and have been upgrading that has led us to receive laurels every year, including first prize twice at Rescue Robot Competition and third prize at the RoboCup Asia-Pacific 2017 competition which took place in Bangkok.

This rescue robot for this competition is designed based on proficiency robot. We designed it to motivate roaming around rough terrains mounted arm on our robot by using Caterpillar tracks Our team designed stable cameras mounted arm on our robot and on the body of the robot to help it identify the victims. We use the high-quality motors and effectively sensors. The full set of affordable sensors are put on the armrest to measure temperature, distance and CO2, moreover, we have 2D map to merge. We have two-way communication. Even we are new but in each competition we had, we improved our weakness technically, mechanically and electrically any time after the competition, as shown in fig. 1. Our goal of this competition is to have to opportunity to take part in the big competition like World RoboCup for educating our students and vocational organization. As a result of our big achievement, we were selected to designed and made the robots for the Defense Technology Institute on behalf of The Ministry of Defense to rescue the victims from the bombs in the south area of Thailand and we made a robot for the bomb rescue department in Buriram Province of Thailand to protect the family of the royal of Thailand when they visit this province.

The Ministry of Education and the Office of Vocational Education Commission in Thailand under the auspices

Fig. 2 : First Prize Rescue Robot Competive 2017

Fig. 3 : 3rd Prize RoboCup - Asia Pacific 2017

Fig. 4 : First Prize Rescue Robot Competive 2018

of the Princess, started Rescue Robot Competition 10 years ago, that is the year 2009. We as a vocational and technical Education college under the ministry of Education took it upon ourselves and came up with a team of both electrical, mechanical and a group of students who showed some great ability in technology to fabricate our own rescue robot so, we could be able to take part in competitions organized by the Office of Vocational Education Commission in Thailand.

Even though the Rescue Robot Competition in Thailand started in 2009, we had to wait until 2015 that we made our first appearance in the Rescue Robot Competition organized by Office of Vocational Education Commission in Thailand under the auspices of Her Majesty the Princess of Thailand. Despite being our first time in the competition, we were awarded the 7th position out of 62 competitors.

Encouraged by the position we were awarded on our first appearance; we came back and didn't give up. We had to do some amendments by strengthening our Rescue Robot on some areas of weakness. In the year 2016 we came back in the same competition, and this time around, we were handed the fourth place in the competition. In 2017, that is 3 years later, we were the champions of Recue Robot Competition of the Office of Vocational Education in Thailand under the auspices of Her Majesty the Princess of Thailand. In the same year, we also had a very good chance to participate in RoboCup Rescue Robot League of RoboCup Asia-Pacific 2017 in Bangkok. We were awarded the third place. Recently, in 2018, we were the champions of Recue Robot Competition of the Office of Vocational Education Commission in Thailand under the auspices of Her Majesty the Princess of Thailand, as shown in fig.2.

IMPROVEMENT OVER PREVIOUS CONTRIBUTIONS

Our first competition in 2015, the Seowground robot could mechanically move with front and rare chains with double frame. It could only check the temperature, the carbondioxide, and the movement of objects or victims. From the above, you will realize in 4 years that we have progressed from the 7th to the first. This is as a result of the fact that we had to make some important changes in the robot. We moved the robot from a double frame to a single frame which enabled it to move faster and rescue the victims and also made changes on a controller.

The first version as shown on Fig.1 was designed for the first competition. We fabricated it for rescue purposes. The robot could mechanically move on trends and overcome obstacles to reach the victims so that the robot can detect if there is still life in the victim because the robot is capable of checking the carbon dioxide, the victim's temperature and the sound but the rescue robot had 2 frames which coursed it to be heavy and slow in motion as a result, it couldn't easily reach the victims, so we were awarded the 7th position as earlier mention above.

For the second version of our rescue robot, we had to do some slide changes. The double frames which was used in the first version had some setbacks, as a result, we took the initiative to change it to one frame. This enable the rescue robot to cut across the surface easily. It could easily move to the victims. As a result of the fact that it was more light in weight compared to the previous one. We changed the warm gear that we made ourselves to meet the required standard, so that the robot could move smartly and flexible. For this reason, we were awarded the 4th position in the same competition in 2016.

For the third version, we changed the structure to enable the chains fit well in between the wheels so as to facilitate motion. The center was expanded to bind the front and the back wheels and to avoid any looseness around the timing chain. For this case, the robot was stronger so we were awarded the first position in 2017 in the same competition. After the competition, we had to improve the mechanical and technological ability of the robot by adding the one auto sensor which enabled the robot to interact with the controller and also to read and give feedback of the QR code, symbols, temperature and Co2. We had one more new thermal camera with 2D mapping to mark the location of the victims by reading movement, and symbol so the robot could detect the situation of the victims. As a result of this improvement, we were able to take part in the RoboCup Asia-Pacific in Bangkok, Thailand which ran from the 12th – 18th of December 2017. In the competition, we were awarded the third position out of 5 competitors.

II SYSTEM DESCRIPTION

A. HARDWARE

The robot is 48kg weigh, 116 cm long, 48 cm wide, 59.7cm high which included 145 cm fully stretched arm in doggy style. This robot has four flippers to give him balance to go through the all different kinds of obstacles. The flippers were manufactured to keep, pull, rotate the small things. It is equipped with 6 cameras, two at the base for looking to the victims in narrow, one at the front and one at the back, two one the arms as the main search cameras. It has three sensors, two in the front for detecting QR code, motion and symbols. It has one sensor for detection CO2. It also has thermal sensor to detect the victims. It has the map in front very near to flippers to map out the surrounding within 30 meters radius. It is equipped with flash light for navigation, microphone and speaker for interaction between the controller and the victims or the survivors.

1. Locomotion

The locomotion of our robot made of the conveyer belt system that we examined from different surface characteristics of the terrain. Many parts of the robot have improved in order to be strong for tough

surrounding, to be lighted for moving fast and easy to fix or maintenance as much as possible. We have 2 drive systems consisted of 2 motors. They are front and rear armrest motors with 40 mg and 200 watts. The camera and measuring systems can be quickly and easily adapted or replaced. The data can be transmitted by radio or fiber optic cable directly to the head of operators.

2. Batteries :

The robot consume the 4 lithium polymer batteries of 5300 m Ah 3SIP 11.1V 30C because they are light and have high power.

3. Electronics :

The electronics systems are low-level systems. The micro-controllers are used to interface with motor-driven system and data acquisition.

4. Manipulation :

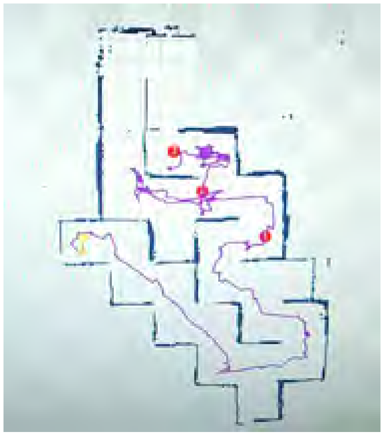
The tele-operative robot can extend its arm from the doggy style standing up to 145 cm to search the victims around the surrounding or disaster area. The checkable arm consist of temperature sensor, CO2 sensor. The arm of the robot can navigate itself by knowing the end-effector position in Cartesian coordinate system.

5. Sensor

The robot identifies the victims by analyzing the information from the different kinds of sensor which fixed at the robot surveying arm. The controller can check the status of the victims through CCTV camera and measure the victim temperature by utilizing temperature sensor. In condition of the disaster, we can know if the victim alive or not by the temperature sensor which will be interacted with the data from CO2 censor, and we can hear the voice or sound of the victims via microphone which will analyze the situation of the victims.

B. SOFTWARE

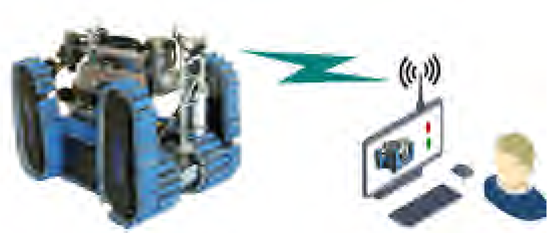
MAPPING AND PRINTING



The robot team wrote the program by Micro C that is the opened source. We installed the several kinds of sensors on each robot to gain the data to process and create an automatically 2-D map on the operator computer monitor. The map is generated by using the information from the distance of the robot movement from encoders, the inclination and direction of the robot sensed by Inertia Measurement Unit, and the distance between the robot and the obstacles from laser range finder. For these, when the robot moves on the different surfaces, we meet some slippery condition that we can avoid to face. Our team wrote the program ourselves for this competition.

C. COMMUNICATION

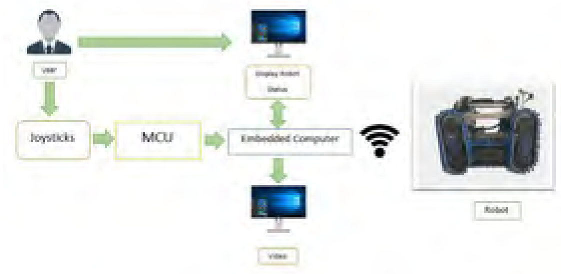
The robot is configured with wireless network with 802.11a/5.8GHz. We use high-power network bridge to communicate between (See Fig.2). Considering the reliability of wireless communication in practice, we reduce the dependence on wireless. When operating in



autonomous mode, our robot can run normally in drop-out in drop – out zone because of its fully on-board data process control. Switching to manual operation mode, our robot can work in reduced functionality mode.

CONTROL METHOD AND HUMAN-ROBOT INTERFACE

We use the joystick to control the robot from the notebook. The operator uses the controller which interacts with the robot through the monitor which is connected to the cameras attached to the robot. We educate our operators on high technological skill on how to operate machine using PCS and joysticks. The operators have specialized in repair should there be any break down in the robot. Our operators are also given sound knowledge on assembling a robot.



III APPLICATION

D. SET-UP AND BREAK DOWN

The set-up and break down time of the operation system of the robot can be started in 3 minutes to make sure that all actuators are in the initial positions including starting the mapping, autonomy and victims detection mode the robot The operator control includes a notebook, a joystick, an access point, an antenna, and a monitor. We use aluminum case as the station. When we need it, just open and turn on the switch.

E. MISSION STRATEGY

As this is our first time to challenge us to take part in the world Robocup, we are only a college in Thailand and we are not experienced in a competition out side the country, so we worry if we can pass the document step. We wish we can participate so that we can learn and experience more.

F. EXPERIMENT

As we participated in Robocup Asia-Pacific 2017 and Robot rescue Competition of the Office of Vocational Education Commission under the auspices of the Princess of Thailand, during the competitions we studied the criteria of the competitions and tried to do it as possible with in the time limit. We were abled to win those competitions due to the robot unsurprising ability to navigate through various terrain, camera, and Co2 sensors capabilities to locate and identify whether survivors are alive.

G. APPLICATION IN THE FIELD

We have no experience in real situations of disaster, but we considered that it is very important to make the practical application when we first designed the robot how to build it strongly with the knowledge of mechanism, electronics to help the victims from the disasters and from first we took part and till now, we are still improving and perfecting our robot. We will continue to improve by making it more comfortable to bring it to anywhere, we will make it lighter than this one, we will use higher power network bridge for communication, we will change some parts of our robot to fit and make it more stable. We will change the motor with high quality. We will make it to help the victims from real disaster effectively. The most important , we will do our best in the first our competition in the World RoboCup 2018.

CONCLUSION

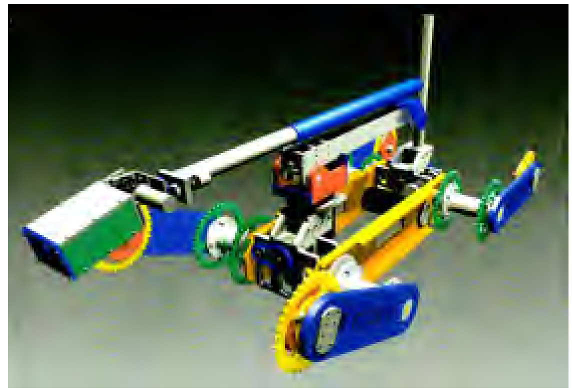
Our lesson were from the competitions we took participating in 4 years. From we first had competition, our robot was not so technologically and practically, but after that we improved more and more, because we learned and experienced for each competitions. In the second year, we still used the manual function, but the student who controlled the operator and the robot had more effectiveness in controlling the robot and helping the victims in time as to meet the criteria in the competitions. The third and the fourth year, we were awarded the first position of the competitions because we changed from double chains to the high competency single chain to make the robot lighter, so it can move faster and fit to the track without any, plus the motors we changed made it moved smoother and more stable and we had flippers and two-way communication, so we achieved the goal in the competitions. Our team gained much more experiences, even we were young, but we have a good team work, and we got support from the sponsors in Thailand to advanced our robot to fit in the World RoboCup 2018 in Canada.

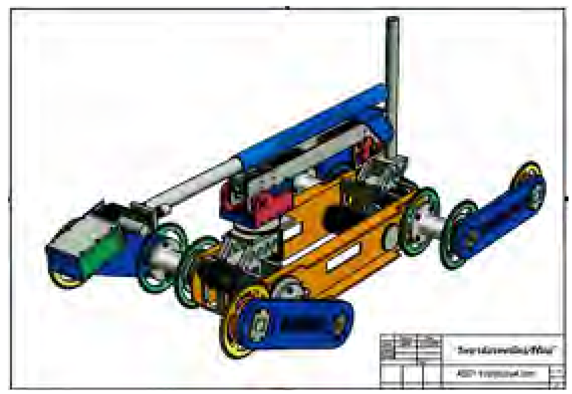
APENDIX A

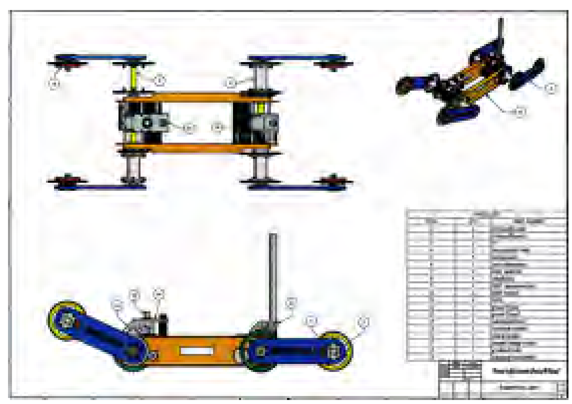
TEAM MEMBERS AND THEIR CONTRIBUTIONS

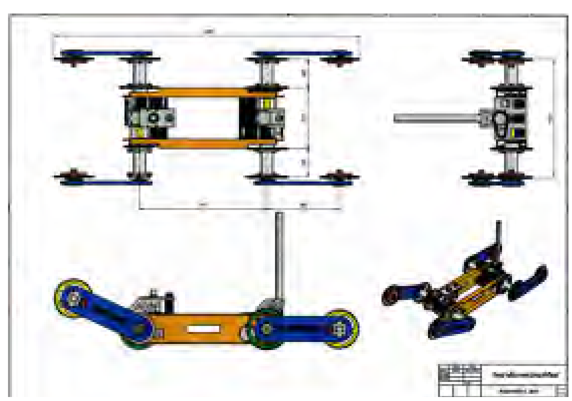
Sanga Taechersai	Team leader
Wiwat Puyati	Control system design
Somsakkayapong Tansura	Mechanical Component
Prawit Saengsi	Electrical design
Prachit Suwanakarn	Software and control
Karn Tangprasertwut	Operator
Nattaphat Bunlung	Battery Control
Chakrit Wattanapongpisan	Programming
Naree Inram	Coordinator

APENDIX C









APENDIX C

TABLE I
MANIPULATION SYSTEM

Attribute	Value
Name	Soewground Robot
Locomotion	Tracked
System weight	48 kg.
Weight including transportation case	68 kg.
Transportation size	0.7x1.0x0.7 m.
Typical operation size	0.6x1.0x0.6 m.
Unpack and assembly time	150 min
Startup time(off to full operation)	15 min
Power consumption (idle/typical/max)	ND
Battery endurance (idle/normal/heavy load)	ND
Maximum speed (flat/outdoor/rubble pile)	ND
Payload (typical, maximum)	5 kg.
Arm : maximum operation height	1.2 m.
Arm : payload at full extend	8 kg.
Support: set of bat. Chargers total weight	ND
Support: Set of bat. Chargers power	ND
Support: Charge time batteries (80%/100%)	ND
Support: Additional set of batteries weight	1.12 kg.
Any other interesting attribute	-
Cost	23,000USD

TABLE II
AERIAL VEHICLE

Attribute	Value
Name	Soewground Robot
Locomotion	quadcopter
System weight	3 kg.
Weight including transportation case	6 kg.
Transportation size	0.7x1.0x0.7 m.
Typical operation size	0.7x1.0x0.7 m.
Unpack and assembly time	10 min
Start up time(off to full operation)	3 min
Power consumption (idle/typical/max)	100/150/300 W
Battery endurance (idle/normal/heavy load)	20/15/10 min
Maximum speed	10 m/s
Payload	0.15 kg.
Any other interesting attribute	-
Cost	2,000 USD

TABLE III
OPERATOR STATION

Attribute	Value
Name	Sroewground Robot
System weight	20 kg
Weight including transportation case	30 kg
Transportation size	0.6x0.8x0.4 m
Typical operation size	0.6x0.9x0.4 m
Unpack and assembly time	30 min
Startup time(Off to full operation)	20 min
Power consumption (idle/typical/max)	ND
Battery endurance (idle/normal/heavy load)	ND
Any other interesting attribute	-
Cost	2,000 USD

APENDIX C

TABLE IV
HARDWARE COMPONENETS LIST

Part	Brand & Model	Unite Price	Num.
Structure Structure	Owned Structure	2,000 USD	2
Drive motors	Zheg	150 USD	2
Drive gears	Planetary Gearhead GP 62	150 USD	2
Drive encoder	Omron rotary	120 USD	2
Motor Drivers	ND	-	2
DC/DC	Rcgutator	-	1
Battery management	ND	-	1
Batteries	LIPO	-	1
Micro controller	Arduino, Pic	-	1
Computing unite	Nootbook, Embedded	-	1
WiFi Adapter	Access point outdoor UBIQUITI Bullet M5-HP) Wireless N150	101 USD	1
IMU	Xeens	320 USD	4
VDO Cameras	ND	320 USD	4
PTZ Camera	ND	-	1
Infrared Camera	ND	-	1
LRF	ND	-	2
CO2 Sensor	ND	125 USD	1
Temperature Sensor	ND	19.78 USD	1
Battery Chargers	ND	259 USD	4
Owned construct	ND	1,000 USD	1
Aerial Vehicle	ND	2,000 USD	1
Rugged Operator Laptop	ND	1,000 USD	1

TABLE V
SOFTWARE LIST

Name	Version	License	Usage
Ubuntu	14.04	Open	
ROS	Indigo	BSD	
OpenCV	2.4.8	BSD	Haar: Victim detection
OpenCV	2.4.8	BSD	LBP: Hazmat detection
Hector SLAM	0.3.4	BSD	2D SLAM
2D Mapping	-	Close source	2D Mapping
Owned construct	-	Close source	Operator Station

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