Urban Search and Rescue Robotics

Tele-Operated Robot

The Competition | RoboRescue League
Location | Nijmegen, Germany
Date | 28th March to 1st April 2012
- Robots demonstrate their capabilities in a number of fields such as mobility, sensory perception, mapping, and practical operator interfaces in a simulated earthquake disaster zone [1]

The Team
- Kyle Blanch | Project Manager
- Joe Tomita | CAD Lead
- Tobias Burgess | Secretary
- Sam Johnston | Fixasa Officer
- Tim Bradley | Sponsorship Officer
- Simon Young | SIS Officer

Outreach
Visits | Local Schools & Science Museum, London
- Our work has been showcased to school children of multiple ages, highlighting the application of career paths in Engineering
- The 2012 WMR Outreach programme has seen us visit numerous schools within the local area and partake in the Science Museum’s Antenna Live Exhibition during the half term school holidays

Mechanical Arm
- Functionality and reliability increased by improving weight distribution and reducing backlash in the joints
- 5 revolute joints (as shown) move the sensory elements and gripper into positions that will allow victims to be identified and supported

Supported Ball Bearing and Thrust Spigot Housing
- Full support at both ends of the worm gear prevents bending of the motor shaft [2]

Inverse Kinematics
- The position of the end effector can be controlled directly through inverse kinematics which output individual joint angles to satisfy the complete motion of the arm
- For flexibility, independent joint control is also possible with the implemented configuration

Flippers
- Chain slack has been reduced by re-pinning the internal shaft to the outer shaft
- A bearing system (as shown) has been devised to transfer most of the force from the motor shaft to the chassis
- Constraining the motor at both ends prevents bending of the motor shaft and housing caused by cyclical loading

Head
- The head contains sensors used for victim identification
- Redesigned to reduce overall size and weight
- The base frame consists of laser cut Aluminium sheet and the hood cover has been rapidly prototyped

References

3D Mapping
-一款 stationary current-carrying conductor generates an output voltage which varies in response to a rotating magnetic field. This provides an absolute position of the flippers which is useful for the visual interface

Hall Effect Encoders
- The device is connected to each individual cell
- The buzzer will sound when any cell drops below the pre-determined level, even though other cells may have higher voltages
- This prevents over-discharging which permanently damages the battery

Robot Representation | Interface
- The Arm and Flippers are visually displayed in 3D using absolute positional data obtained from encoders
- Limb centre of gravity and joint angles combine with accelerometer and gyrometer data to calculate robot tilt
- A visual guide of overall robot centre of gravity warns the operator of the robot toppling

Battery Warning Sensor
- The current system to deliver a greater level of performance in terms of functionality and reliability
- To successfully compete in the 2012 German RoboCup Rescue competition
- Design and build a new Mechanical Robotic Arm
- Integrates the system to be fully Tele-Operational
- Receive the issues causing Flippers slack

Robot Battery Discharge
- Battery Warning Sensor
- Battery Discharge
- Battery Warning Level

Conclusions
- Appropriate manufacturing techniques and capabilities have been considered throughout the design process
- Information from mapping and encoders now allows the operator to be fully aware of the robot’s own position and environment
- All of our design changes were determined level, even though other cells may have higher voltages
- The torque requirements for the shoulder joint motor have been halved by reducing overall weight and using a larger diameter worm wheel gear

QR Codes
- Finding, identifying and reading Quick Response Codes is a new requirement for the competition
- Live feed from the Web Camera outputs decoded results in real-time using Java programming code

Free Mapping in Unstructured Environments
- A visual guide of overall robot centre of gravity warns the operator of the robot toppling

40
45
50
55
60
65
70
75
80
85
90
95
100
Discharge Capacity (%)
Voltage (V)
Robot Battery Discharge

HRM: Mobile Robotics [12]
WWW: MobileRobotics.warwick.ac.uk