Acronym and Title

ROBOCON-OCU

Target

[X] This proposal can be announced to all student groups. It can be assigned to any student group.

Proposer Information

Names(s):	Teknolus Enerji Mühendislik Bilişim Danışmanlık San. ve Tic. Ltd. Şti., in collaboration with Prof. Dr. Uluç Saranlı
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Supervisor

[X] The project will be supervised by Prof. Dr. Uluç Saranlı

Project Description

General description:

The end product for this project is a standalone Operator Control Unit (OCU) that can be used by field operators controlling mobile robots in field scenarios. This OCU will be responsible from presenting a simple and effective control interface for legged and/or wheeled platforms, including navigational control inputs, and aids, display of robot state and health information, as well as views from one or more cameras. The end product is expected to provide the following functionalities:

- A portable, wi-fi capable OCU unit including joystick controls, an LCD display, tactile buttons and other inputs and outputs that may be necessary for particular robot platforms.
- A modular software architecture that allows robust and real-time communication with a robot platform to send/receive command and control signals as well as a soft real-time connection for transferring video from one or more cameras onboard the robot
- An operational example implementation with a simple, two-wheeled robot equipped with two cameras and a simple suite of sensors such as an IMU, GPS and encoders.

It is expected that some of these components will reuse/extend previous components and examples within RHexLib, which is a real-time control software that controls the RHex robot platform. The project scope, however, is expected to includes more modern extensions and approaches to several of the components

Technical Challenges:

Main technical challenges associated with this project can be summarized as follows:

- The selection of CPU and other components to enable real-time and robust implementation of a lightweight, portable OCU unit
- Implementation of robust technologies for transferring video over a possibly unreliable wi-fi connection
- Security features associated with OCU-robot communications that may interfere with the operational functionality in field settings
- General difficulties of working with physical robot platforms and embedded software

Tentative Plan

Major workpackages:

WP1: Choice, acquisition and integration of an embedded CPU that can interface with a high quality LCD, and stream video over the network in a real-time manner.
WP2: Design and implementation of the electromechanical components of the OCU, including a carrying case, CPU and LCD mounts, buttons and dials
WP3: Design and implementation of the software architecture for robot communications and I/O operations with digital, analog and other input/output components on the OCU
WP4: Design and implementation of a robust, real-time network communication software subsystem for communicating with the robot
WP5: Design and implementation of a soft real-time network communication system for transferring video streams from the robot to the OCU.
WP6: Overall system integration and scenario tests

Workloads:

WP1: 5 man-months
WP2: 5 man-months
WP3: 5 man-months
WP4: 6 man-months
WP5: 6 man-months
WP6: 5 man-months

Implementation order:

WP1 and WP2 will start in parallel, followed by WP3, WP4 and WP5. WP6 will follow, integrating most components together to conclude the project.

Similar Products/Projects

There are many robot control software architectures that have been used in the past. ROS (Robot Operating System) is perhaps among the most commonly used, but this framework is based on a network-transparent communication infrastructure and is hence quite inefficient for real-time control. The goal of this project is to implement a simpler, more efficient framework that is less universal but can be embedded into less capable CPU platforms.

http://www.ros.org/

RHexLib, the software library that runs the RHex robot platform that was designed and implemented by Prof. Uluç Saranlı provides a closer existing example to the goals for this project. In fact, components and design elements from RHexLib will be reused and modernized as part of this project.

http://rhex.sourceforge.net/

Contributions, Innovation and Originality Aspects of the Project

The originality and innovation for this project will come from its reusability and adaptability to multiple different robot platforms. It is expected that the design will allow different robot control methods to be implemented with low overhead, taking care of display and control functionalities through a simple and consistent API. There are numerous robot platforms that require robust operator control unit implementations. Every company with such remote controlled mobile robot products provide their own interfaces and they have limited inter-operability and modularity. This project is expected to address these issues.

Success Measures

The project should be considered successul if the following components are in place at the end of the project period:

- A self-contained, portable operator control unit with joystick and button inputs, informational LCD and other displays as well as one or more CPU units capable of real-time network communications and video display
- A modular library for interfacing with these input and output components in a real-time manner
- Libraries for robust and real-time network communications for command and control of a wheeled robot platform
- A modular library for soft real-time transfer of video information from the robot platform and displaying it on the OCU displays
- Successful demonstration of remote control of a two wheeled platform with two cameras, an IMU sensor and a GPS sensor as well as wheel encoders

Project Development Environment

It is expected that the following components, libraries and languages will be used throughout the project:

- Embedded single-board computer (SBC) boards such as the Digi ConnectCore 6 or BeagleBone
- Yocto-Linux as a real-time operating system
- An off-the-shelf 2 wheeled robot platform with two cameras, an IMU unit and a GPS sensor
- C++ language for embedded as well as high level software development

The general structure of the software will consist of two concurrent processes, one for command and control as well as I/O interfacing, and another for soft real-time video streaming. These component may either run on a single, more capable CPU, or two separate computers. Object-oriented software design methodologies will be heavily used throughout the project.

In terms of the hardware, solid design tools such as SolidWorks will be used. Basic manufacturing facilities such as laser-cutters, 3D printing and machining tools will be used to manufacture necessary components for the robot platform.

External Support

Hardware components such as CPU units, LCD displays, the 2 wheeled robot and other off-the-shelf components will be acquired and provided by Teknolus. In addition, manufacturing support for additional hardware components such as the OCU shell, mounting brackets and similar needs will also be met by Teknolus.

No external support other than the hardware and manufacturing support provided by Teknolus will be used. No data is needed for a successful completion of this project.

Intellectual Property Information

Intellectual rights for the end product will be jointly owned by the students, excluding any of the components that are derivatines of existing software architectures and libraries. Teknolus will reserve the right to use the technology in their own products.

Major Risks and Risk Plan

Among major risks are difficulties in the acquisition and interfacing of various hardware components. Fortunately, many of these components were previously acquired by Teknolus and Prof. Uluç Saranlı, so these risks are partially mitigated. Nevertheless, Teknolus has the necessary experience and infrastructure for rapid acquisition of components as well as facilities for mechanical manufacturing. As such, many of these risks should be easily addressable throughout the project.

References

Links and references were provided within the text.