Mobile Robot Knowledge Base

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ABSTRACT

Robotic technology is developing at a rapid rate for both commercial and Department of Defense (DOD) applications. As a result, the task of managing both technology and experience information is growing. In the not-to-distant past, tracking development efforts of robotic platforms, subsystems and components was not too difficult, expensive, or time consuming. To do the same today is a significant undertaking.

The Mobile Robot Knowledge Base (MRKB) provides the robotics community with a web-accessible, centralized resource for sharing information, experience, and technology to more efficiently and effectively meet the needs of the robotic system user. The resource includes searchable information on robotic components, subsystems, mission payloads, platforms, and DOD robotics programs. In addition, the MRKB website provides a forum for technology and information transfer within the DOD robotics community and an interface for the Robotic Systems Pool (RSP). The RSP manages a collection of small teleoperated and semi-autonomous robotic platforms, available for loan to DOD and other qualified entities. The objective is to put robots in the hands of users and use the test data and fielding experience to improve robotic systems.

Keywords: Robot, Relational Database, Collaboration Tools, Website, Joint Robotics Program

1. OVERVIEW

The MRKB is a component of the Joint Robotics Program (JRP) Web Center. The JRP Web Center is an Office of the Secretary of Defense (OSD) sponsored program mandated to serve the DOD robotics community. The JRP Web Center encompasses several resources:

- JRP Home
- Mobile Robot Knowledge Base (MRKB) (Technology Database, Robotic Systems Pool Support, Technology Transfer Forum)
- National Unmanned Systems Experimentation Environment (NUSE2)
- Business and Collaboration Tools for JRP Managers, Committees, and Teams
- Joint Architecture for Unmanned Systems (JAUS) (to be incorporated in 2005)

1.1 Background

The MRKB effort has been increased in scope to meet the expanding requirements of the growing customer base. In April of 1999, SPAWAR Systems Center, San Diego (SSC San Diego) launched the Small Robot Technology Database website. It offered users online data on several small ground robot platforms and a few categories of components. The use of common metrics enabled quick and impartial analysis of available systems. The need for this type of information rapidly outpaced the Small Robot Technology Database scope and funding.

A new effort was initiated in 2001. The database was expanded in scope to include platform, subsystem, and component technologies related to mobile robot development. The task began as an in-house effort to streamline the costly and labor-intensive market-research phase of system development. SSC San Diego is currently involved with more than fifteen different autonomous or unmanned system projects. Significant resources are

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necessarily invested in finding, analyzing, and tracking emerging technologies and players; to amortize the cost, the information needed to be quickly and efficiently shared across projects.

The Mobile Robot Knowledge Base (MRKB) website was launched in January 2002; it served as the publicly available, online interface for the expanding collection of robot technology information. In short order, the MRKB grew into a robotics community resource and became an asset to not only developers but program managers, sponsors, and system end-users.

In 2004, the scope of the web resource was again expanded to include NUSE2 Collaborative Data Management and basic collaboration tools for geographically-diverse JRP committee members. The next logical step, to host all JRP web resources under one JRP Web Center umbrella, is currently being implemented.

2. MOBILE ROBOT KNOWLEDGE BASE

The MRKB is logically divided into three technology resource sections and one support section. The resource sections are dedicated to meeting specific user needs; they include the Technology Database, the Robotic Systems Pool Support, and the Technology Transfer Forum, each with a similar appearance and navigation menu. The fourth section, called the iWeb, is a secure, password-protected site used for MRKB data and information management and secure-access administration.

Figure 1. MRKB Technology Database GPS high-level information summary table.

2.1 Technology Database

The Technology Database affords access to searchable robotic component, subsystem, and platform specifications. The user can specify search criteria or browse an entire subject database; specifying data order based on his or her interest. Technology information is organized in categories, such as Platforms, Communication, Obstacle Avoidance, or Mission Payloads, and then broken into logical sub-categories, for example, Ground, Air, Underwater, and Water Surface Platforms. High-level information is presented in a table format for easy comparison (Figure 1). Further detailed technical specifications are available in a common format for each entry in the table (Figure 2). Information for the database is solicited from government, commercial, and academic sectors; vendors and others are encouraged to submit product information online. All data management is accomplished via the iWeb secure site.

Technology Database users generally fall into three groups-technology developers and integrators, program managers and sponsors, and system users. Developers can use the MRKB to quickly research, identify, and compare components or subsystems that will meet their project requirements. Program managers can employ the available data to compose budgets and analyze the feasibility of project requirements given the state of current technology. When technology vendors call, managers can rapidly make comparisons and informed decisions on the offered product. System end-users can access the MRKB to obtain an understanding of the performance capability and cost of available mission payloads. This information will allow them to balance needs and desires with available funding when drafting system requirements documents.

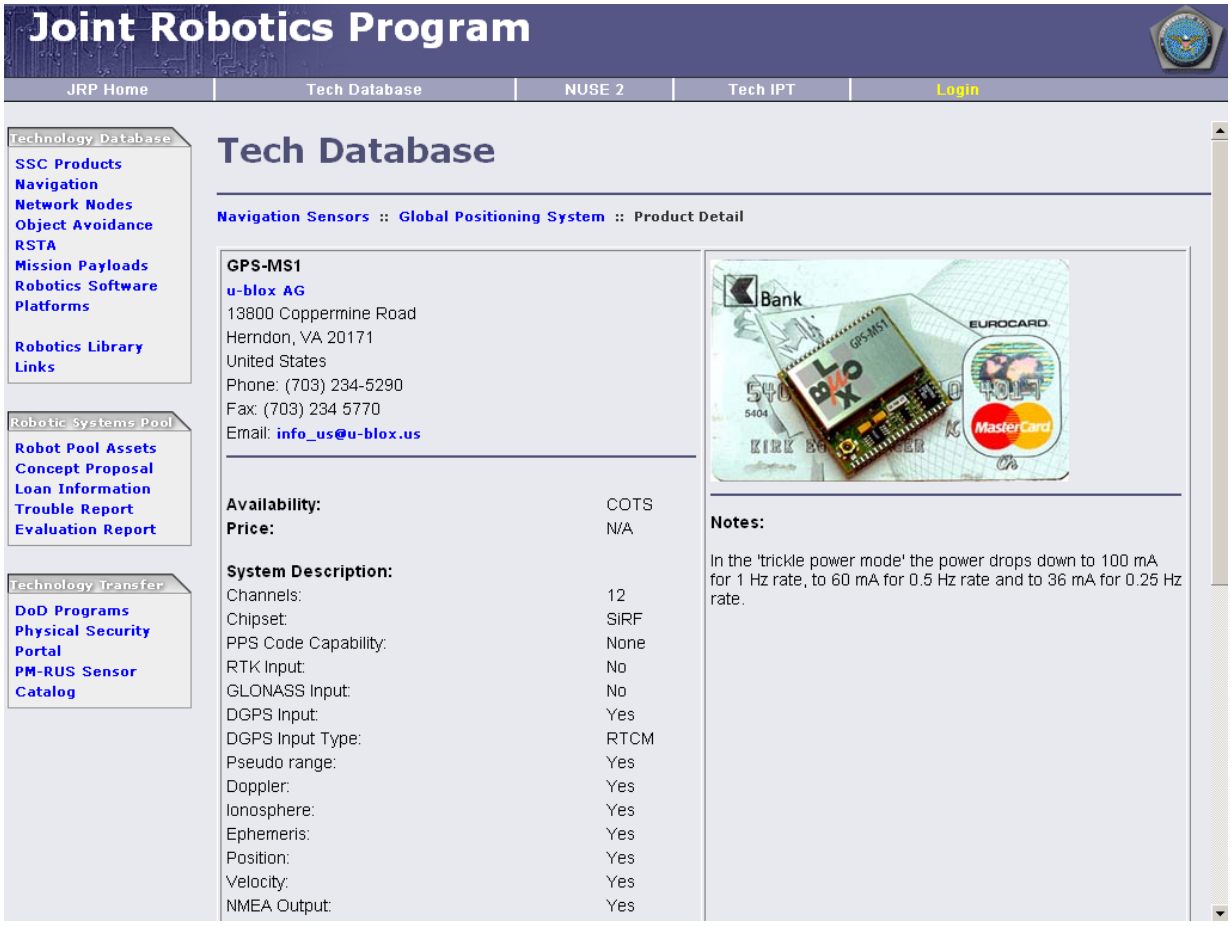

Figure 2. MRKB Technology Database GPS detailed product specifications.

The Technology Database section is continually being updated, modified, and expanded to provide current information, an easy-to-use interface, and more classes of technical information.

2.2 Robotic Systems Pool Support

This section provides an interface to the JRP RSP robot loan program managed at SSC San Diego. It includes an asset database with supporting information, publications, and specifications, Figure 3. Also available are loan policy information, sample bailment agreements, concept proposal forms, and trouble report and evaluation submission forms. The iWeb site plays a major role for the RSP Support section. It facilitates online distribution of the robot experiment/exercise Evaluation Reports to authorized personnel. In addition, it provides RSP management with real-time administration of each robot asset through a password-protected Report Database resource accessible from any internet-capable computer.

Figure 3. MRKB Robotic Systems Pool Assets table.

The RSP serves as a user-feedback mechanism for robotic system development. It puts small robots in the hands of users to perform experiments or exercises. The robots can be equipped with various sensor packages and mission payloads. At the end of the loan period, the user submits an evaluation report. This information is fed back to the development community to facilitate advances in robot technology, tactics, techniques, or procedures that will meet the requirements of the user. To date, platform navigation and control efforts have been greatly aided by the comments received from users. Lessons learned and technology developed from RSP loan program will be placed in the Technology Transfer Forum to be utilized in the next iteration of unmanned development.

2.3 Technology Transfer Forum

The Technology Transfer Forum hosts the DOD Robotic Programs Database, Figure 4, and links to related technology resources hosted at various organizations. In the near future, it will also host the Technologies for Transition Database and a Technology Transfer Forum that will provide a secure forum for discussions and lessons learned, a community events calendar, and document exchange.

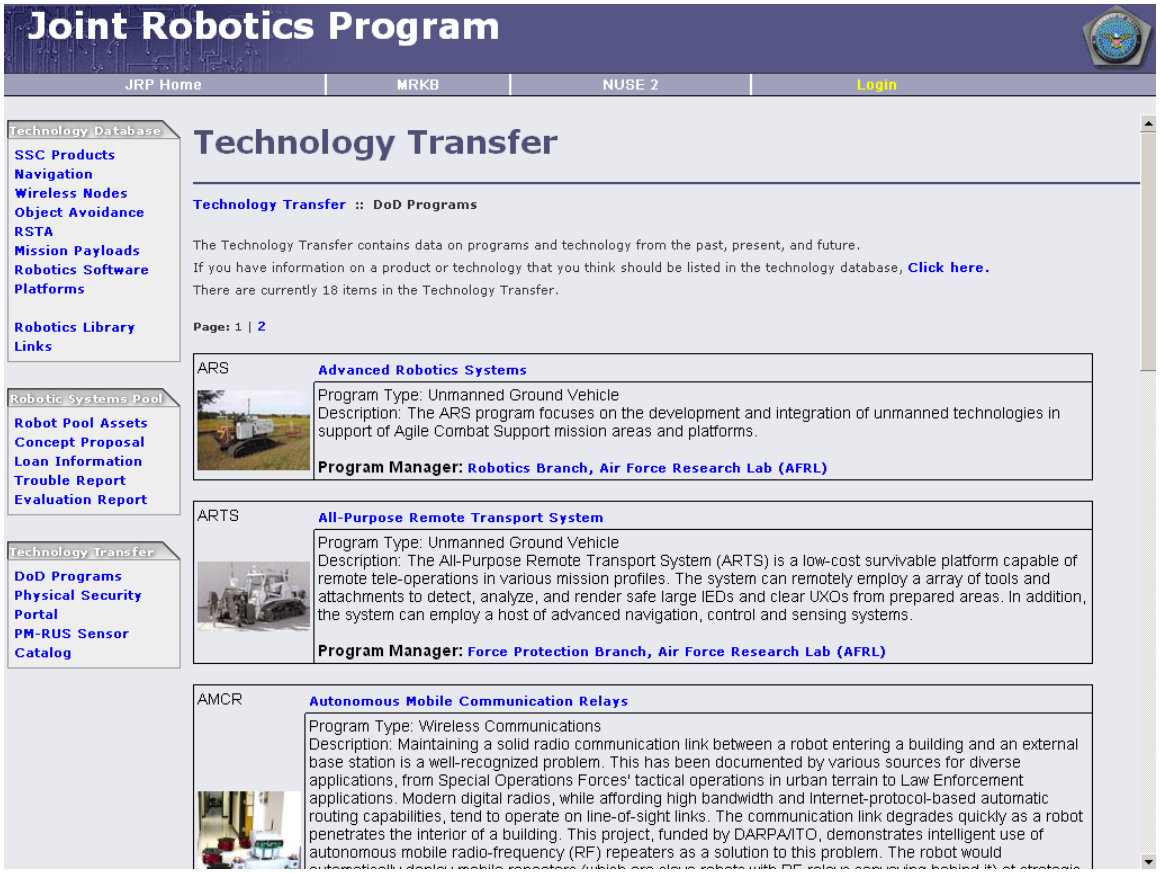

Figure 4. Technology Transfer Forum Robotic Programs Database.

2.4 iWeb

The iWeb provides a secure online capability to manage the large amount of data for product specifications, technical documents, and program information contained in the MRKB in real-time and in a distributed manner. The iWeb supports multiple user levels, as well as various segments to which each user may be granted or denied access. For example, registered users, such as vendors, developers, and key players, can submit new entries to the database or update previous entries to which they have modification privileges, Figure 5. These changes are marked for review by site administrators before being posted on the site. The entire process takes minutes, and every step is done directly through the iWeb. Unregistered users will also be able to submit data on new products and programs.

In addition, the iWeb provides secure online tools for behind-the-scenes information management on the RSP effort and for MRKB-wide user account administration.

The key to the success of the Mobile Robot Knowledge Base is meaningful content. Supporting this end, the iWeb serves a vital purpose of making the MRKB not just the collected knowledge of a few individuals, but of the robotics community as a whole.

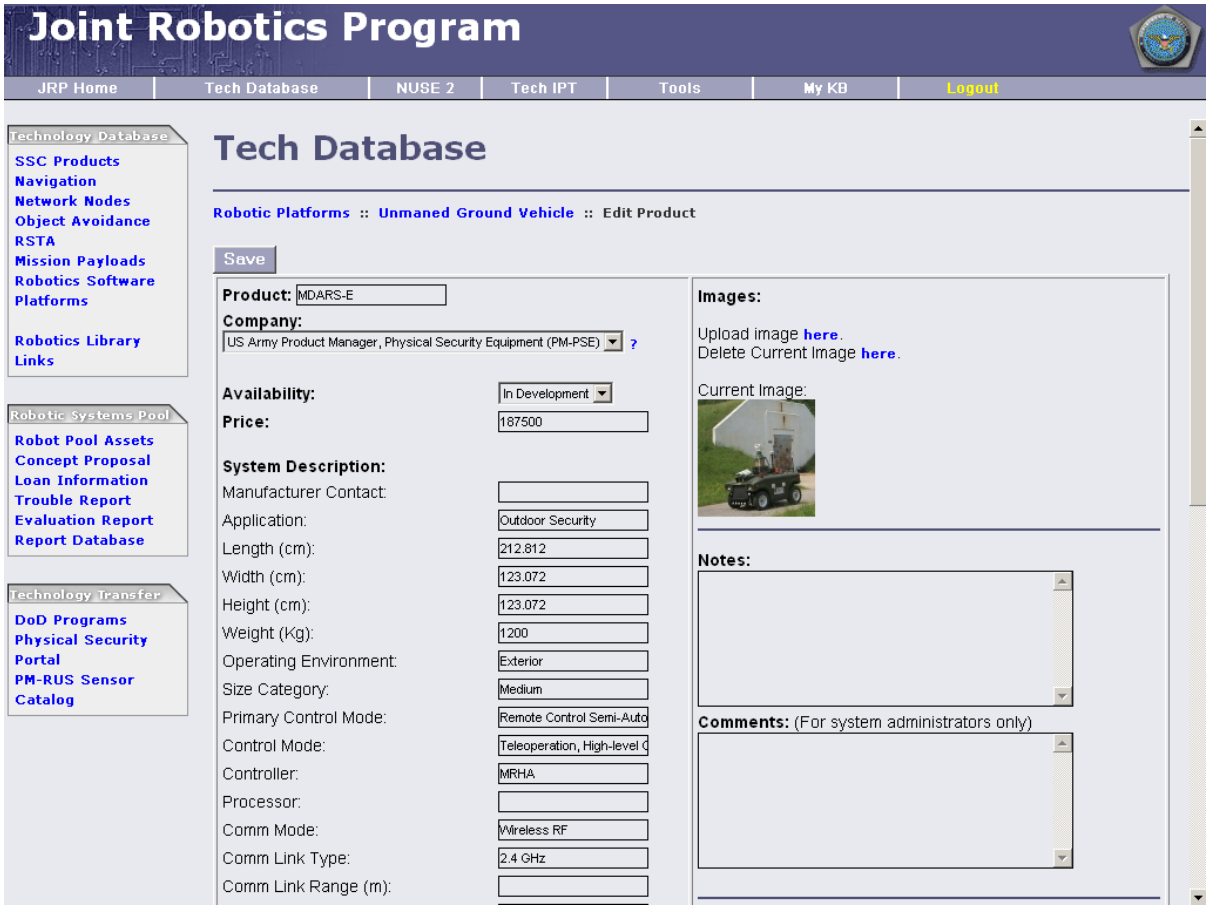

Figure 5. The iWeb provides MRKB System and Database Administration Tool, including data input forms for the Technology Database.

3. APPLICATION DESIGN

The MRKB interface design utilizes multiple computer languages and technologies to best meet the needs of today's robotics community. The interface uses proven cross-browser technologies such as Microsoft's Active Server Pages (ASP), VBScript, and Javascript to interconnect users with robot system data. The ASP/VBScript section of the interface is used for the behind the scenes functionality that makes this application a user friendly, end-to-end solution. The Javascript section of the interface handles browser events and client-side error handling. Together ASP, VBScript, and Javascript allow the MRKB to be a user-friendly tool for the robotics community.

3.1 Distributed User Administration

The MRKB contains both publicly available information and password-protected sections. This design created questions of user administration: Who is going to have access to each section?; What levels of access is each user going to have?; etc. In a monolithic site, these questions may be trivial, but when applied to the multiple sections of the MRKB, each having its own authentication and authorization requirements, the answers to these questions became necessarily complex. The only way to truly handle all of the administration issues that come from a multiple-branch multiple-application site would be *distributed user administration*. From the users' point of view, each section would appear to be developed specifically for their organization and tailored to their needs.

Distributed user administration allows each section of the MRKB to function independently yet permits scalability across the multiple server/multiple user environments. In short, distributed user administration allows each application (section) to appear to be used exclusively by each user or group of users.

For example: Company A has ten engineers that all need accounts on the Technology Database section of the MRKB. Using the distributed user administration model, an MRKB administrator would give one account to the Company A representative. From that account the representative could administer all of the accounts for Company A. When user(s) from Company A, perform administrative functions, such as viewing the Technology Database user accounts, they would only see accounts from their own company. It would appear to them that the system was only being used by Company A and they would have full control over the authentication and authorization of the users within their company.

Distributed user administration minimizes administrative functions at the web application host and places it on the shoulders of each entity using the MRKB system. This enables organizations to more efficiently mitigate risk, optimize their security posture, and enforce privacy policies.

3.2 Content Integrity

Users are able to submit various types of data to specific sections of the MRKB. In order to screen the data for potential breaches of integrity, an intermediate step between content updates and data display has been implemented. The approval scheme that is in place holds all modifications until they are approved by an authorized organization. Once the modifications are approved, the content is moved into the corresponding MRKB section and is available to all users that are authorized to view it.

3.3 Additional Application Tools

Additional tools are required to check the integrity of the MRKB systems and data. To fulfill these functions, a tool section is available to system administrators of the MRKB. The tool section currently holds the following applications.

3.3.1 Global User Administration

This tool allows authorized system administrators to view the users and groups of the MRKB system as a whole.

3.3.2 Database Analyzer

This feature allows authorized system administrators to view the raw data in the MRKB including reports on errors that the users are encountering.

3.3.3 Bug Tracker

This application allows authorized system administrators to create/modify/track bug reports for all sections of the MRKB. This enables the system designers to track and correct any bugs that may be found in the system.

3.3.4 E-mail Alerts

This tool allows authorized system administrators to add alerts to certain user events and define lists of administrators that will be notification of these events.

3.4 Data Management

The MRKB datasets are stored in a large central repository built on top of Microsoft's latest Relational Database Management System (RDBMS)--SQL Server 2000. The database is structured in a way that requires little or no assumptions about how robotics data is related or how it will be extracted from the database. As a result, the MRKB robotics datasets can be viewed in many different ways depending on the users' needs.

4. CONCLUSION

The MRKB provides system developers, program managers, and end-users with a centralized online technology resource for mobile robots. It also supports a forum for discussion, collaboration, and exchange within the robotics development community.

The MRKB covers many technical aspects of robotic and autonomous system development. From hardware to software, from undersea to aerial systems, it provides market research information that is publicly available with the objective of minimizing redundant product research efforts and maximizing efficiency and responsiveness of the robotics development community. It strives to manage technology information in an environment of rapid-expansion of both players and technology.

ACKNOWLEDGEMENTS

This project is funded by the Office of the Secretary of Defense as part of the Joint Robotics Program.