

BIOGRAPHICAL INFORMATION

Pervaiz Malik

System Analyst (GIS)
Petroleum Engineering Applications Services Department
Saudi Aramco
X-5035, Dhahran 31311, Saudi Arabia
Telephone: (966-3) 874-6530
Fax: (966-3) 873-2783
E-mail: pervaiz.malik@aramco.com

Specific Responsibilities

Joined Saudi ARAMCO in 1999 as a Petroleum Engineering System Analyst in E&P Computer center. The major responsibilities included GIS application development and support. Extensively used GIS software ArcGIS, ArcPad, ArcSDE and Microsoft Visual Basic for customization. Supported requirements of a wide variety of user groups including Reservoir Management, Drilling & Workover, Reservoir Characterization & Description, Exploration, and Production Engineering. The development included a wide range of functions in ArcGIS and ArcPad.

Past Experience

Worked as Application Programmer/Senior System Analyst (1990-1999) for ESRI in Redlands California. Developed many Arc/Info and Arcview applications for electric & gas companies and local and state governments. Developed land information system for the country of Cyprus.

Educational Information

M.S. – Natural Resource Information Systems, The Ohio State University, Columbus, Ohio

MCRP. – City & regional Planning, The Ohio State University, Columbus, Ohio

Professional Memberships

GITA
SPE

LEVERAGING MOBILE GIS TECHNOLOGY IN E&P FIELD OPERATIONS

Abstract

Mobile handheld systems are becoming very popular all over the world for performing field related tasks in an easy and cost effective manner. Saudi Aramco is also benefiting from this technology. Custom mobile Geographic Information System (GIS) applications have been developed for various field operations. These applications work well on Pocket PCs, laptops, and Tablet PCs. The functions exist for locating a new well site, designing a new access road and rig site, carrying out distance estimates, and capturing and updating field data. These mobile GIS applications have been integrated with Global Positioning System (GPS) for personal navigation and tracking. This greatly helps the field personnel find their way in the desert and also to locate facilities over the rugged terrain. Currently, these GIS applications are being targeted for a wide variety of user groups at Saudi Aramco including Reservoir Management and Description, Production & Facilities Development, Drilling & Workover, Production Engineering, and Exploration.

The purpose of this paper is to present our experience in developing and testing mobile GIS technology in many of the E&P field operations and also to explore how this emerging technology can be used effectively in streamlining and reducing the cost of field operations.

TECHNOLOGY REVIEW

Mobile computers especially Pocket PC and Tablet PCs are available in the market for many years now. Today's Pocket PCs emerged from Windows CE systems when software giant Microsoft decided to enter into the PDA market that was dominated by Palm based handhelds or PDAs. Later Microsoft reinvented the more than a decade old pen based system with a new name—Tablet PC. This study is primarily focused on the Pocket PCs.

Pocket PC (the OS) was introduced in April 2000. It is Microsoft's third attempt at an operating system for handheld devices and is found in products from Hewlett-Packard, Casio, Dell, Toshiba and many others.

With the entry into the PDA market, Microsoft introduced more open OS with some of the most popular software like Word, Excel, PowerPoint, Outlook, etc. With hardware support from Intel (the most powerful mobile processor) and Compaq (iPaq) many software vendors started to have a serious look at this new emerging technology as a new direction of the future mainstream computing. Gartner reports that mobile-PCs will grow faster than desktop-PCs during the next five years (Gartner Oct. 2002). Falling prices, better performance, wider availability and wireless connectivity are some of the major factors behind Pocket PC popularity.

E&P MOBILE GIS DEVELOPMENT

Petroleum Engineering Application Services Dept.(PEASD) is a user IT support organization for E&P in Saudi Aramco. PEASD have been following up the developments in this mobile computing technology for many years. A few Windows CE 3.0 based iPaq (by Compaq) PDA were acquired to develop and test GIS and Annuli Survey applications. PCMCIA GPS cards (the first version in the market by Teletype) were also added to build the location finding and navigation function. This crude setup was functional but limited because of the software and the hardware limitations. The hardware and software selection was limited to only two vendors (Compaq for Pocket PC and Teletype for GPS card). ESRI of Redlands California was the only software vendor providing GIS software for Pocket PC (or Windows CE). The software had limited functionality with no customization options. The hardware was not rugged to survive the harsh desert climate. End users reviews were mixed. Majority of the 'test' users liked the overall functionality and mobility and were very much interested in incorporating this technology into their business process. Following were some of the limitations of these early systems:

- Limited hardware and software options
- A few hardware vendors (Compaq/HP)/Teletype
- Limited battery life and a lack of backup battery
- A potential danger of losing data with a discharged battery
- Weak performance and limited storage

- Lack of accessories like Rugged shells, car mounts, etc.
- Lack of ruggedness
- Lack of data and data loading tools
- Lack of an understanding of user's business needs
- Limitation and availability of wireless communication network
- Overall cost of a GIS/GPS integrated system
- Lack of overall confidence in the future of this emerging technology

Year 2002 could truly be called the year of mobile computing. The pocket PC market expanded from one vendor (Compaq/HP) to more than ten. Looking at the growth trends in this market major hardware vendor like Toshiba, Sharp, HP, Viewsonic, Symbol, and finally Dell jumped into this band wagon. This also resulted in a significant drop in Pocket PC price.

Development of the GPS market is no different than the Pocket PC. There are more than fifteen vendors of GPS products marketing CF type GPS cards and Bluetooth based GPS receivers for pocket PCs, laptops, and tablet PCs. The price has also gone down tremendously.

SYSTEM DESIGN AND IMPLEMENTATION

Objectives

Many user organizations in E&P are involved in the field operations. These operations range from collecting field data to designing and construction of well sites. Mostly paper maps and documents are used for finding locations.

A major goal of the GPS enabled mobile GIS was to help the users streamline their field related business processes. To achieve this goal following objectives were set:

- Automate and test the field navigation and mapping
- Develop tools for the acquisition and handling of point of interest (POI) data
- Limit the paper documents production and usage
- Automate the Rig and Access road design process
- Access to the digital wells documents in the field

Hardware and Software

Mobile GIS hardware is composed of Compaq iPaq, Cassiopeia e-200 Pocket PC from Casio and Dell Axim X5 Pocket PC. The Compaq and Casio Pocket PC uses an Intel StrongArm 206 MHz and the Dell Axim X5 used Intel Xscale 400 MHz processor. Both systems have two expansion slots. The Compact Flash (CF) slot was used for GPS card and the SD card slot was used for expanding memory by using a 512 MB Secure Digital (SD) card. The second major hardware component was the Compact Flash GPS card. The card was made by Teletype and Pharos GPS. An external GPS antenna was also used

to receive the GPS signal while driving. An auto adopter from Teletype provided the power to the system while driving.

ArcPad and ArcMap developed by ESRI of Redlands, California was used as base GIS and mapping software. ArcPad software uses data in the Shape file format. The software also uses a 'Project' concept. All the user settings can be saved in an ArcPad project. Symbology and projection information is saved as a part of the Shapefile database. ArcPad Studio was purchased to customize the software for user specific needs.

ArcPad also comes with an extensive object model and development tools called ArcPad Studio. ArcPad was customized by adding additional function using VBScript and XML. ArcPad Studio provided a nice 'visual' environment for building the additional functions easily and efficiently.

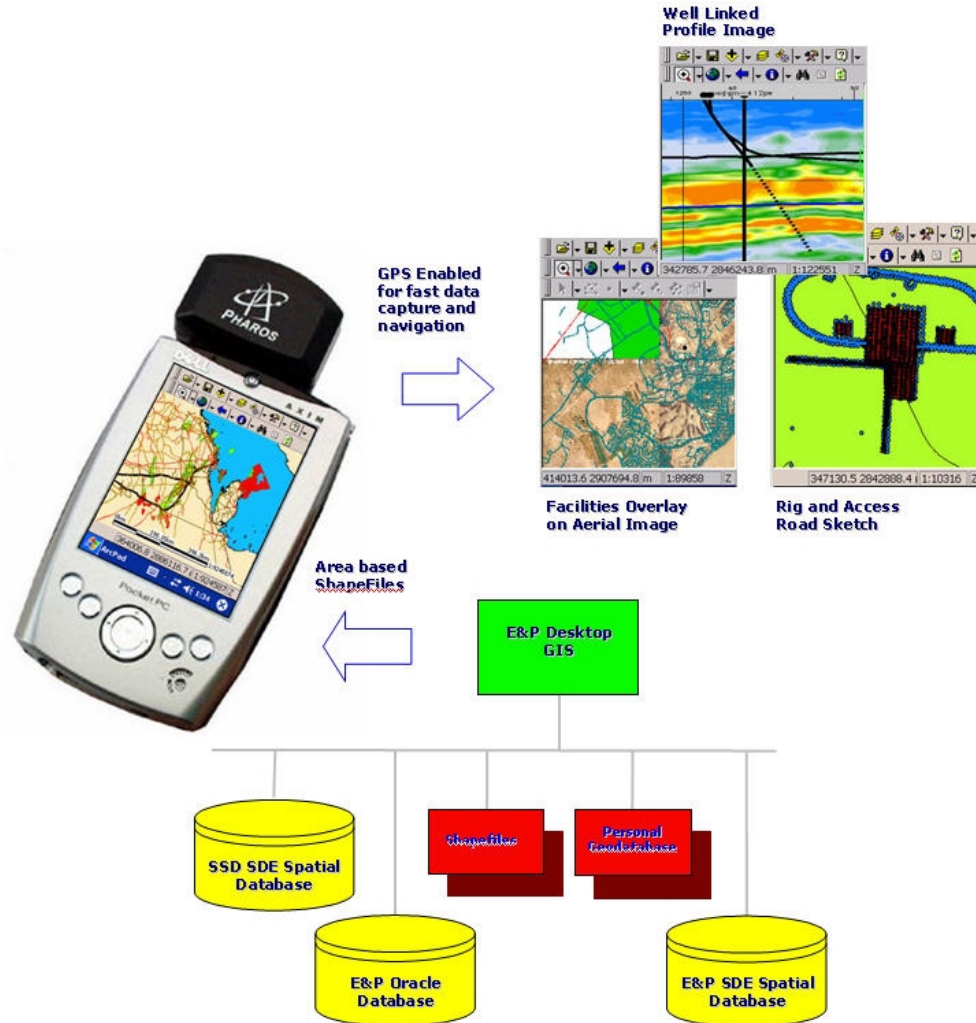
The Mobile system connects with the desktop by a USB port. Communication is established through MicroSoft Activesync.

Implementation

A customized ArcMap based PDA Loader toolbar was developed to provide functionality to create mobile projects and load data for these projects. Using these tools users have access to a number of customized data layers. The tools also allow the user to save his data and geographic extent properties. Once saved, user can load/update the data with the click of a button on the toolbar. Mostly field engineers work in their assigned geographic areas. Mobile GIS template projects were created for UTM zone 36 to 39. At the time of new mobile project creation process, the application prompts the user for a project name and the UTM zone. Respective project template is copied in to the Pocket PC My Document folder on the user's desktop. This template includes a customized ArcPad project (*.apm) and all the shape files with predefined symbology and the display properties.

The data loading routines also provide some data cleaning and trimming functions by removing extra attributes from the Feature Attribute Tables and adding custom fields for linking images to the features. The wells related images are stored in a separate 'Docs' folder on Pocket PC.

The mobile GIS application (iMap) can be launched by selecting the application from the Start menu or by pressing an assigned button on the Pocket PC. The GPS (if connected) is activated automatically and map is centered based on the current GPS location. Custom tools have been developed to find Wells based on a well number and X and Y coordinates. After selection this tools also allows the user to set the destination as a target location for the GPS to track. A simple design and components diagram is given below:



TESTING AND EVALUATION

PEASD assembled five prototype mobile GIS/GPS systems for user evaluation. The systems included two configurations: Compaq iPaq and Casio Cassiopeia e200 Pocket PCs. The first and initial system configuration used a PCMCIA GPS card from Teletype and a PC Card expansion jacket for iPaq for the GPS to work. The initial system was slow, bulky, and without any battery backup. User showed interest but did not have a serious consideration. The second system used a CF type GPS card from Teletype and used build-in CF card slot in the unit. This system had a backup battery and two internal card slots. The speed was reasonably good but high-end GIS application functions ran relatively slower. User interest and response was great and there was a demand for custom functions for various field operations.

The prototype systems were loaded with some basic data layers. These layers included Well, Transport, Rig/Skid roads, Field Area Boundaries, Hydrology, Plants, Communities, and Buildings. The extent of the data covered various oil and gas fields.

The system was tested by the users in Production & Facilities Development Dept., Drilling & Workover, and Production Engineering Depts. In addition, the system was also demonstrated to the Loss Prevention, Exploration, Reservoir Management, Avails & Well Testing, and Fire & Medical Emergencies.

The system was tested for the following major field tasks:

- Facilities search and navigation
- Rig access road data capture and sketching
- Distance analysis and simple routing
- Collection, validation and correction of data

The system performed well as a facilities search and navigation tool. The integrated GPS was almost exactly able to find the entered location within meters. Unlike a standard GPS, an intelligent map back ground helped users in locating facilities faster and with greater accuracy. User liked the Track & Find function (Arcpad). Using this function a user can search, for example, for a Well in the database and set the selected well as a GPS target. Once the target is set the GPS function tracks the target showing the direction and the remaining distance. Audio and visual alarms complement this with alerts.

Field data collection, though not very accurate, helped users collect and sketch spatial features while in the field. Users used both the hand sketching tools and the live GPS feed as a coordinate source. Considering as an initial design sketches most of the users was satisfied with the accuracy of the data.

The system was also tested for the location and design of a new rig site. The rig site design was loaded on to the system based on the rig type. The rig site shape file was created on a desktop system using a defined grid system of 5 meters as a part of a pre-processing function. All the shape coordinates were relative to the actual coordinate location of the proposed well. A grid of point features was also created and loaded on to the mobile system with actual locations related to the proposed well location. In the field user was able to quickly enter the elevation value for each grid point manually. The elevation readings are currently captured using a precision level. Later, these elevation points were loaded in to the ArcMap based Volumetric Computations application for cut/fill analysis and design.

Drilling & Workover staff used the application to sketch the new rig roads while preparing a new well site for drilling. After collecting, data was transferred to the desktop GIS application for volumetric computation.

FINDINGS

Following are some of the major findings of this study:

- Mobile computing technology is developing at a faster pace than rest of the IT.
- Pocket PCs/Tablet PCs are expected to be a major part of the mainstream computing power
- Initial user response in the use of mobile GIS is extremely positive and many major user groups are willing to adopt this technology.
- Mobile GIS technology can help the user in performing field work more easily, accurately, efficiently, and cost effectively.
- The technology can help in making more informed decisions in the field.
- More specific user projects need to be developed and deployed to fully benefit from this technology.
- For the harsh field environment more rugged devices are needed.
- A majority of users like the Pocket PC but a few user would like to have a larger screen size (Tablet PC/Laptop)
- Wireless communication methods need improvements (coverage, low cost, more bandwidth, availability, etc.)
- Accessories like car mounts, extended batteries, non-volatile data storage, etc. are very important for effective deployment.
- Rugged Tablet PC could be a better option for user looking for ease-of-use, mobility, performance, ergonomics, and disk space.
- Finally, to make mobile GIS a part of uses business process, the system needs to be customized based of specific needs and should help in streamline the business process.

CONCLUSIONS

Pocket PC based mobile computing is an emerging technology. Looking at the growth rate it appears that it will soon become a part of the mainstream computing. Much more powerful devices are available now with more processing power and storage space. This allow more 'professional' and resource oriented applications to run better and faster.

User response has been very positive. A big potential exist for this technology in helping streamline field oriented processes. Certain limitations in the old devices restricted the usage to some extent. For example, lack of ruggedness, less processing power and storage space, car mounts, battery life, etc. were some of the limiting factors in the past.

Recently, powerful 400 MHz devices with more storage are available in the market. A variety of accessories are also available making the mobile system more complete and effective for field operations. More rugged but slightly expensive devices are also available in the market. Following are the major drivers behind the current mobile systems development:

- More and custom user requirements for high performance applications

- User requests for streamlining field operations.
- Less data acquisition cost with more accuracy
- Better field crew performance
- More informed decision making in the field
- More and better personal management

Following are some of the additional supporting factors:

- More than twenty hardware vendors are manufacturing Pocket PC based PDAs
- More than Fifteen Hardware vendors marketing miniature GPS products (CF cards, Blue tooth devices)
- More than 25% drop in the hardware price
- Rugged Pocket PC and Tablet PCs are available (price and weight could be an issue)
- A wide range of accessories are available for Pocket PC (Rugged cased, Car mounts and holders, communication cards, etc.)
- More powerful devices are available 600 MHz and up to 5GB of CF Cards
- Extremely high level of confidence in the future of the mobile computing industry
- Thousands of software packages are available in the market ranging from personal management to high-end technical applications.
- Wireless communication accessories like GSM CF and Satellite phone cards are available.

Potential for mobile GIS technology in Aramco field operations is promising. The technology can greatly enhance the decision-making process, make the site design process more accurate and efficient, provide better safety for the field crew in the harsh desert climate, and help capture field data easily. All these factors greatly reduce the operational cost in the field.

REFERENCES

“*The Changing Spectrum of Mobile PC Usage*” Gammage, Brian, Gartner Report # AV-18-4898, October 30, 2002.