海洋观测网实时监控系统的设计与实现

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摘　要：综合 GIS、数据库和富客户端开发等技术，设计一套 B/S 环境下的海洋观测网实时监控系统，实现了海洋台站、浮标和志愿船等海洋观测设备的实时状态监控、预警和故障统计分析等功能，能为相关部门及时掌握观测网运行状况、提升海洋环境观测预报管理水平提供高效的解决方案。

关键词：Flex；ArcGIS Server；海洋台站；浮标；运行监控

海洋观测是研究海洋、开发海洋、利用海洋的基础[1]。海洋观测所获取的资料，对海洋的防灾减灾、权益维护、资源开发、环境保护、国防建设及海洋科学研究等方面具有重大意义[2]。海洋台站、浮标、志愿船等是海洋观测信息获取的重要手段，经过多年的建设，我国已建成以海洋台站、浮标为主，志愿船和断面调查船为辅，覆盖渤海、黄海、东海和南海等海域的较为系统、完善的海洋观测网[3]。但这些观测设施的运行维护大多由沿海省市海洋部门负责，监管分散，缺乏统一的运行监控系统，不利于相关部门及时掌握各个观测设备的运行状态，无法提供高效的决策辅助。本文针对海洋观测网运行监控的迫切需求，建设了一套监控实时、界面友好、操作流畅的海洋观测网运行监控系统。

1　总体设计

1.1　系统架构设计

本系统采取轻量级开发框架 PureMVC 进行设计，分为数据层、服务层和应用层，3 个层之间通过消息响应机制进行通信，模块之间耦合度低，系统功能易扩展和维护（图 1）[4]。

1）数据层。数据层包含空间数据库和属性数据库两个部分，前者主要以图层的形式存储海洋台站、浮标、志愿船及底图等数据，如设备参数、所属分局/中心站及位置信息等，通过 ArcSDE 接口与服务层交互；后者主要存储观测设备的实时运行状态、历史故障信息、统计信息及实时采集的数据等，通过 JDBC 进行数据读取。

2）服务层。服务层对系统的业务逻辑进行设计，并以服务的方式进行发布。按照数据特征，可分为针
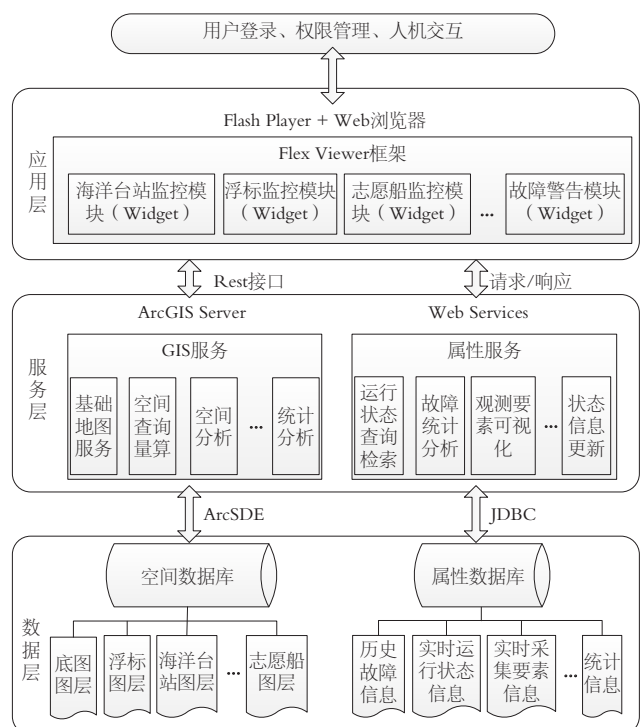

图 1　系统设计架构图

对空间数据的 GIS 服务和针对属性数据的属性服务。GIS 服务提供了基础地图服务、空间查询量算、空间分析和统计分析服务，该服务采用 ESRI 公司提供的 ArcGIS Server 通过 REST 接口对外发布[5]。属性服务包括运行状态查询检索、故障统计分析、观测要素可视化及状态信息更新等服务，这些服务被封装成 Web Services 服务，以请求/响应机制对外发布服务。

3）应用层。应用层将根据业务需要构建专题应用模块，直接为用户服务。本系统针对我国海洋观测网运行状态监控的业务需求，选取 Flex Viewer 作为开发框架，开发了海洋台站监控模块、浮标监控模块、志愿船监控模块及故障警告模块等应用模块，以 Flash

Player 和 Web 浏览器的方式为用户提供应用服务。该 Flex Viewer 框架中自带了一些基本地图功能模块（Widget），如鹰眼视图、导航控件等，满足了基本地图操作。系统建设只需要开发业务相关的 Widget，并配置到 config.xml 文件中[6]，框架将自动完成模块的加载应用，极大地提高了系统开发效率。
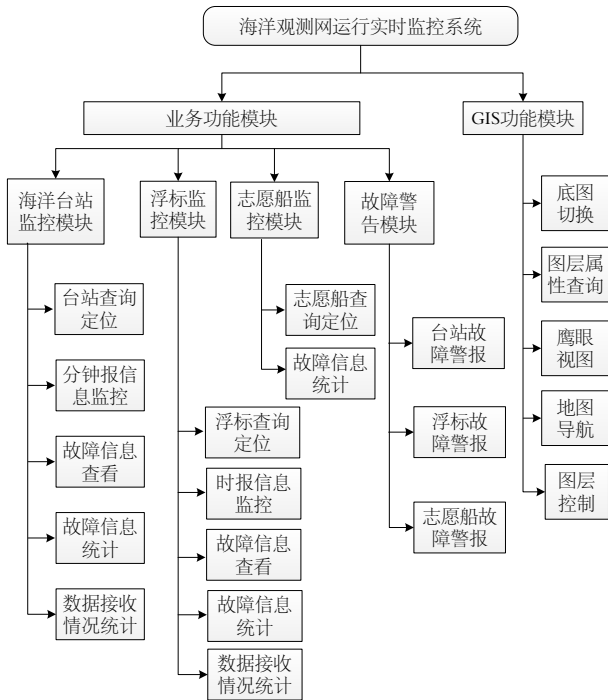
1.2　系统功能设计

海洋观测网运行实时监控系统包含业务功能模块和 GIS 功能模块两大类（图 2）。

图 2　系统功能结构图

1.2.1　业务功能模块

业务功能模块根据运行监控对象的不同，划分为海洋台站、浮标、志愿船 3 个监控模块，同时为了便于用户操作，本系统将故障警告模块单独安置，动态提示故障报警信息，方便决策者及时掌握台站、浮标和志愿船当前运行状况并制定决策方案。

1）海洋台站监控模块将所有海洋台站按照管辖归属划分为 3 大类，再根据管辖归属范围内的沿海市划分小类。将台站以"海区－沿海市－台站"三级列表的形式进行组织，通过点击列表中的台站进行地图定位并显示到地图上。点击地图上该台站的位置图标，查询该台站的属性信息。海洋台站模块同时实现了分钟报信息监控，能够实现分钟级的台站观测要素，如潮位、气温、水温、盐度、气压、风速、风向和降水量等要素的监控，并能够将部分要素当天观测数据以曲线的形式绘制出来。数据接收情况统计和故障信息统计实现了按分局、中心站、台站、时间段进行历史故障统计。

2）浮标监控模块与海洋台站类似，实现了浮标定位及信息查询功能、小时级的浮标观测数据接收、监控与观测要素可视化功能、浮标故障查看及历史故障统计、观测数据接收情况统计等一系列功能。

3）志愿船监控模块主要实现了志愿船定位查询和故障信息统计功能。志愿船主要分为执法船、考察船、搜救船及其他船舶 4 类，其他船舶包括科考船只、勘探船、渔船及隶属其他企业法人的船舶。由于志愿船的组成较为复杂，且船舶采集的数据较为重要，其实时采集的数据不在本系统中查询可视化，但是志愿船的运行状态、实时位置信息的监控，对海洋决策者宏观把握、统一调度、辅助决策存在重大的意义。

4）故障警告模块实时监控海洋台站、浮标及志愿船的工作状态，实时列出产生故障的观测设备，并在地图上展示出来，其中运行正常的设备以绿色图标指示，出现故障的设备以红色闪烁图标指示出来。用户可以直观、快速地关注并定位到故障设施，并作出维修、更换等应急决策。

1.2.2　GIS 功能模块

GIS 功能模块主要实现地图相关基本操作，包括底图切换控制、图层控制、属性查询、鹰眼视图、底图导航等功能。

地图切换功能支持多个不同类型底图的切换，主要有两种类型，一种是 Dynamic 类型，它支持地图操作的无级缩放，但是这种类型的底图显示效率较差；另一种是 Tiled 类型，它首先需要用 ArcGIS Server 进行切片处理，设定好几个固定比例尺，以地图瓦片的形式发布，地图只能在设定好的几个比例尺间进行放缩，优点是显示效率较高。Flex Viewer 框架还支持 Google 地图和百度地图服务的导入。考虑到底图显示效率及系统部署，将采取瓦片的形式提供底图服务。

其他几项 GIS 功能直接采用了 Flex Viewer 框架提供的插件进行修改实现，满足用户基本地图操作，组件样式美观、操作流畅。

2　系统实现

2.1　实时监控数据获取

海洋观测设备实时监控数据的获取、传输与存储是系统建设的基础和前提。为了有效获取海洋台站、浮标及志愿船的实时信息，将不同观测设备进行分别处理。

海洋台站和浮标观测设备本身具备数据传输和通信机制，其运行状态及观测数据将实时传输到地方海洋监测站，再由地方海洋监测站传输到所属海区，然

后由各海区经专网传输到数据管理中心。志愿船的监控状况较为复杂，本系统只对已经安装船舶监控自动识别系统（AIS）的部分志愿船进行信息采集，将船舶实时信息以短报文的形式发送到数据管理中心，由相关部门对这些数据进行接收和入库处理。

2.2 系统开发实现

本系统采用 Flex 进行富客户端应用程序开发，将展示逻辑和业务逻辑转移到客户端，能够很大程度上提升服务器并行服务的用户访问量。选取 ESRI 公司推出的 Flex Viewer 作为 WebGIS 应用程序的开发框架。Flex Viewer 框架采用了模块化架构，并以插件的形式搭建一个应用程序框架，它提供了一套模块的接口标准，负责协调各个模块之间的通信，控制程序的页面布局，以配置文件的形式对功能模块进行组织[7]。空间数据采用 ArcSDE 进行管理，属性数据存储到 SQL Server2008 中。数据访问采用 Web Services 的方式，用 Java 语言编写并以 Tomcat 进行发布，以 WSDL 语言发送请求，响应结果以 JSON 字符串的形式返回到客户端，数据访问过程遵守 SOAP 协议，如图 3 所示。采用 ArcGIS Server 提供地图发布服务，底图包括 Tiled 和 Dynamic 两种类型，前者为 tiff 格式全球地形瓦片底图，后者为 shape 格式地形底图。

客户端（Flex） → WSDL SOAP协议 / JSON → Web Services（Java）

图 3 Web Services 数据调用

2.3 系统部署与试运行

目前，该系统已经在相关职能部门完成了部署及试运行，运行状况良好。接下来将根据系统试运行状况，对海洋观测设备的数目和类别进行适当增加，并依照用户的反馈意见进一步完善系统功能。系统部分功能示例如图 4。

3 结 语

本文通过对 WebGIS 相关技术进行研究，设计研发了海洋观测网运行监控系统，实现了海洋台站、浮标和志愿船的实时监控。从功能角度而言，系统实现
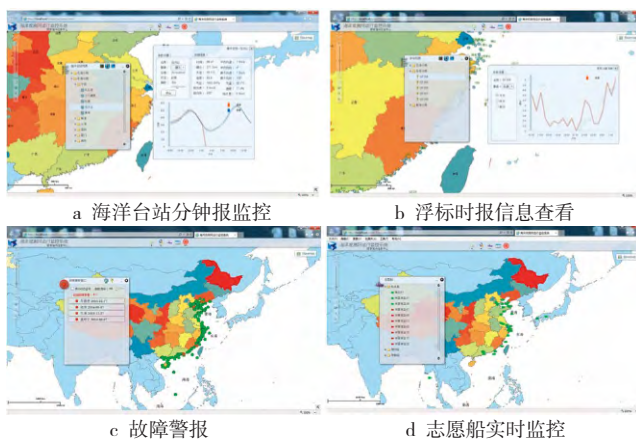

a 海洋台站分钟报监控 b 浮标时报信息查看
c 故障警报 d 志愿船实时监控
图 4 系统部分功能截图（系统采用的是 ArcGISonline 网络地图，审图号：GS(2010)6011）

了海洋观测设备监控业务的主要功能模块，涉及到设备的观测要素实时监控与可视化、数据接收情况及故障信息查询统计、实时故障警报等功能。从实现角度而言，本系统采用 PureMVC 3 层架构、基于 Flex Viewer 框架并以功能插件的形式完成了 B/S 模式富客户端应用系统开发。该系统的建立将为海洋相关部门及时掌握观测设备运行状况、辅助决策提供了一套高效的解决方案。

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and achieve the integrated management from the mine figure to table of the water resources information. The method provides some help to the management of the mine topographic maps and the water hazard prediction and prevention.

Key words water resources information, visualization, Visual Basic6.0, MapGIS, integration　　　(Page:58)

Design and Realization of Major Hazard Sources Monitoring System Based on GIS　　　by *CHEN Dequan*

Abstract Based on Digital Zhangzhou geospatial framework and WebGIS techniques, this paper designed and implemented Zhangzhou City major hazard sources monitoring system, which realized quick correlation of major hazard information and GIS information. This system made major hazard supervision more intuitive, and provided some foundation for scientific decision making.

Key words GIS, Digital City, major hazard sources　　　(Page:61)

Construction of Land and Resources Data Integrated Management System　　　by *YAO Jing*

Abstract According to land and resources data has the characteristics of large amount, multi-type, multi-scale, more tense and data resource management mainly face the difficulty of the data resources transfer, distribution process mechanism tedious, combining with the management business, this paper built the land and resources data integrated management platform. This platform can unify manage the result data, the business data, thematic data etc, and realize the standardization of the usage and management of land and resource, and improve the efficiency of data management.

Key words land and resources, integrated management, office system, data　　　(Page:63)

River Network Information Extraction in Western Sichuan Region Based on DEM　　　by *XU Huixi*

Abstract The river network in this study area was extracted based on DEM data and D8 algorithm. The extracted method of hydrological features in the study area was determined by the second derivative relations between catchments area in the study area and the drainage density, river source density. This method avoided the repeatedly process determining threshold value, and helped to the effectiveness of the simulation results and accuracy when extraction of basin river based on DEM. The threshold value of different catchments area has small effect for determining the spatial position of main channel, but more effect on the extracted characteristics of river network. The threshold value of catchments area has important effects on the detail of river network, the bigger the threshold value of the water area is, the sparser the river network is.

Key words DEM, hydrological feature, spatial analysis of GIS, threshold　　　(Page:65)

Design and Implementation of General Association Rule Mining Framework　　　by *DONG Lin*

Abstract According to probability theory, we used a limited measure to calculate the support of an item set. Based on this conclusion, a general association rule mining framework was designed and implemented. The implementation of this framework was tested with transactional, spatial and spatio-temporal data. The coherent results inferred the feasibility, universality and validity of this framework.

Key words association rules, spatial association rules, spatio-temporal association rules, support, measure, general framework　　　(Page:68)

Construction of Geographic Name and Address Management System Based on GIS　　　by *DING Xiaolu*

Abstract This paper described the geographic name and address management system based on 2D GIS component ArcGIS Engine and 3D geographic platform TerraExplorer at first. And then, the paper introduced software functions and key technologies in detail. This system realized the standardization storage, address element association based on conditional random fields, standard storage, association between 2D and 3D features, data analysis and so on.

Key words GIS, geographic name and address, system design, conditional random fields　　　(Page:72)

Road Centerline Extraction in Urban Area Based on Airborne LiDAR Data　　　by *YANG Wei*

Abstract A method of extracting road centerlines based on discrete LiDAR point cloud was proposed. Firstly, ribbon-like road points were extracted from the original data by using multiple features (e.g., elevation, intensity and geometric feature) constraint. And then, an iterative Meanshift algorithm was used to gather the strip road points into a linear point set, and road centerlines were finally extracted by the following piecewise Hough transform. The results show that this method overcomes the accuracy loss caused by transforming the discrete point cloud into raster image.

Key words airborne LiDAR, road centerline, iterative Meanshift, piecewise Hough transform　　　(Page:75)

Discussion on CGCS2000 Coordinate Conversion Method of GPS Control Network of Xinjiang　　　by *XUE Weigang*

Abstract However, there are a certain errors to be discovered on geodetic height of a part of the first triangulation points and the second triangulation points on CGCS2000 during data are analyzed. The errors directly influence accuracy of 3D adjustment of GPS control network. How to solve this problem, this thesis discussed a new method that taking advantage of near IGS stations calculates original data again to achieve coordinate of control network on CGCS2000.

Key words GPS control network, coordinate transformation, method　　　(Page:78)

Design and Implementation of the Ocean Observing Networks Real-time Monitoring System　　　by *LV Chongjing*

Abstract To monitor the observing networks real-time operating conditions, the article combined GIS, database, and rich client development technologies, designed and developed a GIS-based real-time monitoring system of ocean observing networks under B/S environment. The system realized the functions, such as real-time operation monitoring, state warning, fault statistical analysis and so on. This system can provide a set of efficient solutions for the relevant departments to grasp the observing networks operating conditions.

Key words Flex, ArcGIS Server, ocean stations, buoy, real-time monitoring　　　(Page:80)

Object-oriented Information Extraction of Wetland Vegetation Using Hyperspectral Image Data　　　by *CHAI Ying*

Abstract In this paper, we mapped wetland vegetation with 3 m spatial resolution, 126-band HyMap image data in California's Sacramento-San Joaquin delta. Based on spectral response curves analysis of typical wetland vegetation, the spectral response characteristics used for guiding object-oriented classification rules were extracted. The study shows that the classification accuracy of the object-oriented method based on spectral feature is about 88.03%, and the classification accuracy is about 72.08% in case it is not based on spectral characteristics. The result shows that the object-oriented classification method with spectral response characteristic extraction is effective in improving the accuracy of wetland vegetation classification and allowing for species-level detection necessary to map invasive species.

Key words hyperspectral, spectral response characteristics, object-oriented, wetland vegetation, HyMap　　　(Page:83)

Fine Classification of Hyperspectral Image Based on Spectral Features Parametrization　　　by *LI Jie*

Abstract A novel method based on the extracting of the diagnostic spectral absorption peaks of object was proposed to make a refined classification of hyperspectral image in this paper. OMIS data was used in this experiment. The morphological characteristic parameters of continuum removed spectrum curve were extracted to classify