Around(J2)ME

`http://aroundj2me.googlecode.com`

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Abstract

This report describes the Around(J2)ME midlet application that has been developed as a project for the Mobile Services course at the Free University of Bozen-Bolzano. The aim of the application is to provide information what is around the user (e.g. banks, bars, pubs, restaurants) using the mobile phone's current location. In particular, the report presents the system functionalities, the architecture, the user interface, development strategies and technical problems that have been discovered during development.

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1 System functionalities

1.1 General description of the major user functions

Around(J2)ME is a location-based J2ME application that uses the phone's current location in order to provide all nearby places that are either belonging to a pre-defined category (e.g. banks, bars, pubs, restaurants, taxis, theaters, parking) or that match a certain search criteria (e.g. name, description, address). Similar to a car navigation system, the user is able to connect to the Around(J2)ME-server to download location-related data organized into continents (i.e. Africa, Asia, Europe, North America and South America) to the mobile device. The user can then browse the retrieved locations offline without having to rely on network connectivity. Furthermore the current position and the place of interest can be displayed on a Google Map for a better understanding of its location.

1.2 Use case diagram

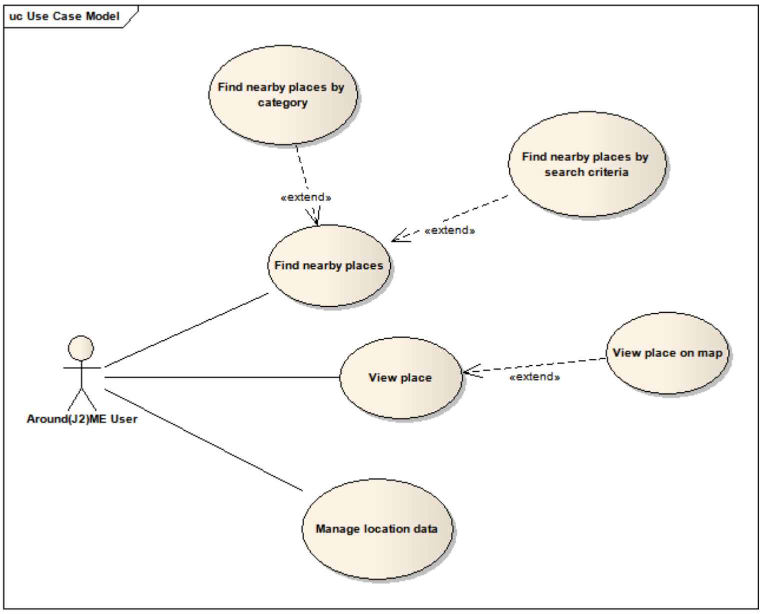

Figure 1: Use case diagram

1.3 Detailed description of the use cases

Name	Find nearby places
Description	The user has the possibility to select a category from a list of possible ones (e.g. banks, bars, pubs, restaurants, taxis, theaters, parking) which are provided by the application. By choosing a category, the application will retrieve all places that are nearby the user's current position.

Table 1: Find nearby places

Name	Find nearby places by category
Description	The user has the possibility to select a category from a list of possible ones (e.g. banks, bars, pubs, restaurants, taxis, theaters, parking) which are provided by the application. By choosing a category, the application will retrieve all places that are nearby the user's current position.

Table 2: Find nearby places by category

Name	Find nearby places by search criteria
Description	The user can open a search form on the mobile phone where he can enter a search query. By clicking on the search button, a search for places matching the entered search query and being around the current location of the user will be done and the result displayed to the user.

Table 3: Find nearby places by search criteria

Name	View place
Description	By clicking on the different places on the list, found by one of the different possibilities (see use cases 1, 2 and 3), the user can view the details about that place. This detail view shows information such as the distance from the user's current position, address information (i.e. street, city,. . .), contact information such as the phone number and a short textual description about the place of interest.

Table 4: View place

Name	View place on map
Description	When viewing a place found by one of the different possibilities (see use cases 1, 2 and 3), the user can display this place on a map.

Table 5: View place on map

Name	Manage location data
Description	All of the location data is managed locally on the device. The user can manage this data by retrieving/updating it from the server. The places can be downloaded for each continent indipendently.

Table 6: Manage location data

2 Architecture

2.1 Used libraries and software tools

The following table shows the tools and libraries that have been used for the development of the Around(J2)ME application.

Name	**Description**	**URL**
Eclipse	Main development IDE	`http://www.eclipse.org`
WTK	Sun Wireless Toolkit	`http://java.sun.com/products/sjwtoolkit/download.html`
MTJ	Eclipse plugin Mobile Tools for Java (former EclipseME)	`http://www.eclipse.org/dsdp/mtj/`
Apache Tomcat	Used webserver	`http://tomcat.apache.org/`
kXML2	XML pull parser library	`http://kxml.sourceforge.net/`
J2MEUnit	Unit testing library for J2ME	`http://j2meunit.sourceforge.net/`
JSR-179	Location API	`http://jcp.org/en/jsr/detail?id=179`

Table 7: libraries and tools used for development

2.2 Internal logic

This section describes the internal logic of the application in terms of appropriate UML diagrams.

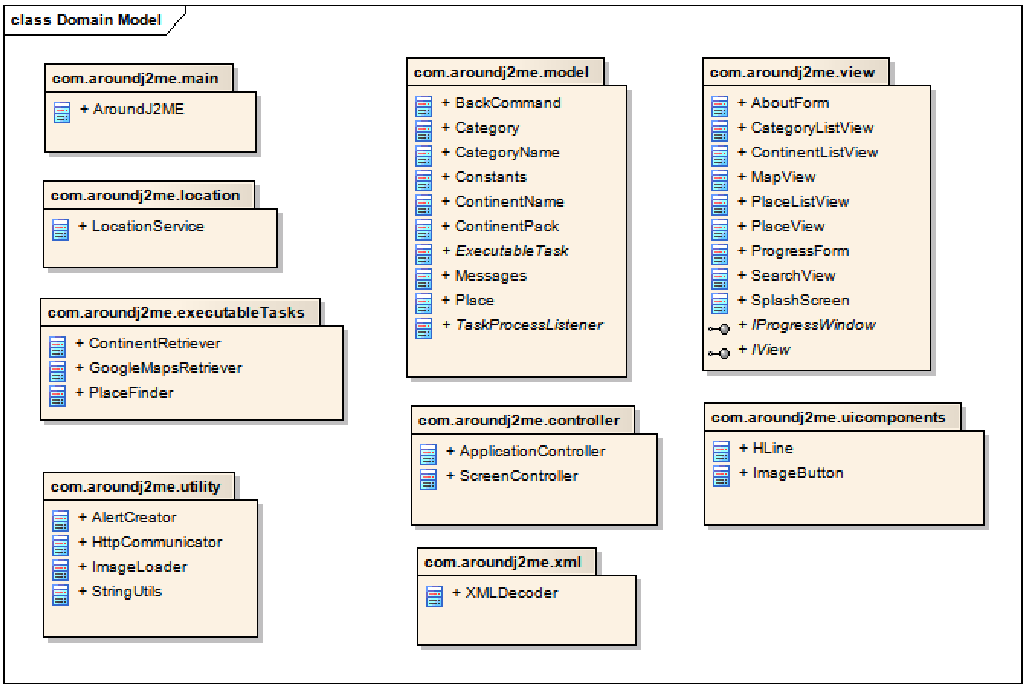

Figure 2: Packages

2.2.1 Package "com.aroundj2me.main"

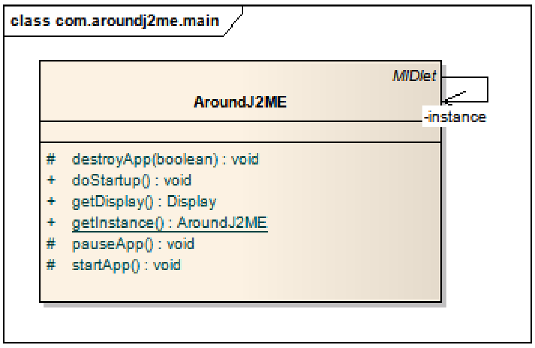

Figure 3: Packages

Class	**Description**
AroundJ2ME	This is the application MIDlet and is the entry point of the Around(J2)ME application. This class is responsible for starting up the application and for calling the appropriate application initialization methods.

2.2.2 Package "com.aroundj2me.location"

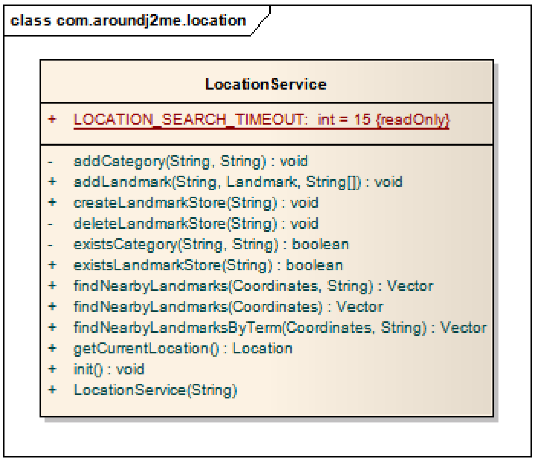
class com.aroundj2me.location
LocationService
+ LOCATION_SEARCH_TIMEOUT: int = 15 {readOnly}
- addCategory(String, String) : void
+ addLandmark(String, Landmark, String[]) : void
+ createLandmarkStore(String) : void
- deleteLandmarkStore(String) : void
- existsCategory(String, String) : boolean
+ existsLandmarkStore(String) : boolean
+ findNearbyLandmarks(Coordinates, String) : Vector
+ findNearbyLandmarks(Coordinates) : Vector
+ findNearbyLandmarksByTerm(Coordinates, String) : Vector
+ getCurrentLocation() : Location
+ init() : void
+ LocationService(String)

Figure 4: Packages

Name	**Description**
LocationService	The LocationService is the central point of interaction with the JSR-179 Location API. It provides methods for retrieving the current location as well as for storing and retrieving Landmark objects to and from the LandmarkStore.

2.2.3 Package "com.aroundj2me.controller"

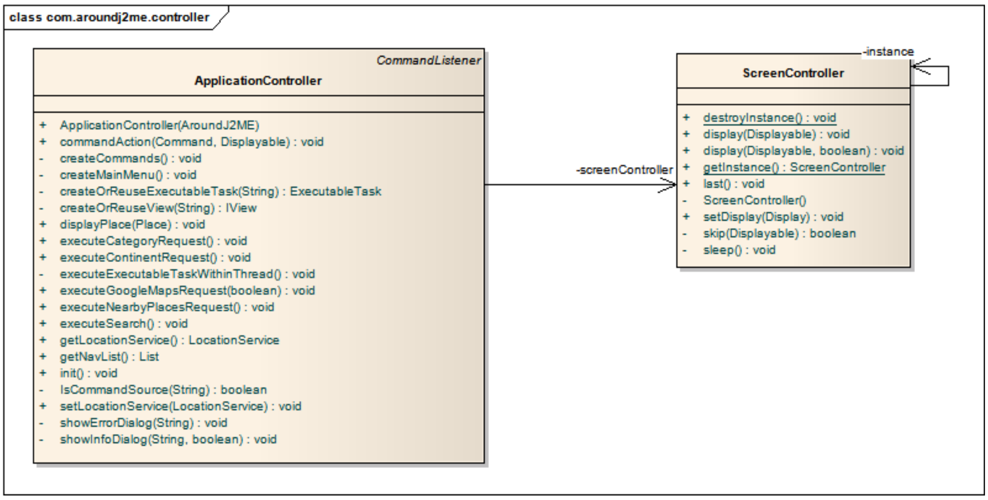
class com.aroundj2me.controller
CommandListener
ApplicationController
+ ApplicationController(AroundJ2ME)
+ commandAction(Command, Displayable) : void
- createCommands() : void
- createMainMenu() : void
- createOrReuseExecutableTask(String) : ExecutableTask
- createOrReuseView(String) : IView
+ displayPlace(Place) : void
+ executeCategoryRequest() : void
+ executeContinentRequest() : void
- executeExecutableTaskWithinThread() : void
+ executeGoogleMapsRequest(boolean) : void
+ executeNearbyPlacesRequest() : void
+ executeSearch() : void
+ getLocationService() : LocationService
+ getNavList() : List
+ init() : void
- IsCommandSource(String) : boolean
+ setLocationService(LocationService) : void
- showErrorDialog(String) : void
- showInfoDialog(String, boolean) : void
-screenController
-instance
ScreenController
+ destroyInstance() : void
+ display(Displayable) : void
+ display(Displayable, boolean) : void
+ getInstance() : ScreenController
+ last() : void
- ScreenController()
+ setDisplay(Display) : void
- skip(Displayable) : boolean
- sleep() : void

Figure 5: Packages

Name	Description
ApplicationController	This class contains the main domain logic. It is the main point of interaction between the user interface. Each user interface class contains a reference to the ApplicationController. For more details about this MVC-like structure refer to section 2.4.
ScreenController	The ScreenController class is responsible for managing the different kind of J2ME Displayable objects on the UI. All the displaying and removing of Displayable objects is done over this class. This guarantees to have a single point of handling UI windows and a clean structure throughout the application. For managing the different Displayable's, this class uses a Stack (java.util.Stack) datastructure. Moreover it includes convenient functionalities such as to automatically add a "back" command to the Displayable that is being displayed. More in section 4.4

2.2.4 Package "com.aroundj2me.model"

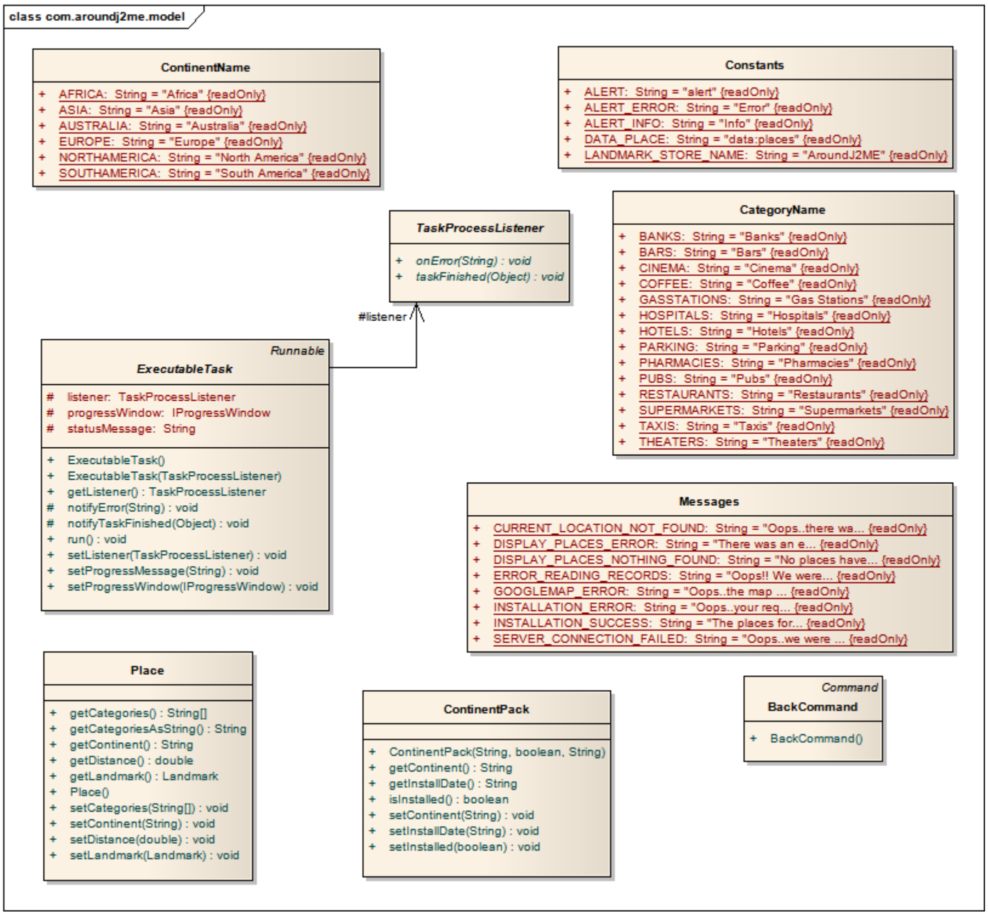
class com.aroundj2me.model
ContinentName
+ AFRICA: String = "Africa" {readOnly}
+ ASIA: String = "Asia" {readOnly}
+ AUSTRALIA: String = "Australia" {readOnly}
+ EUROPE: String = "Europe" {readOnly}
+ NORTHAMERICA: String = "North America" {readOnly}
+ SOUTHAMERICA: String = "South America" {readOnly}
Constants
+ ALERT: String = "alert" {readOnly}
+ ALERT_ERROR: String = "Error" {readOnly}
+ ALERT_INFO: String = "Info" {readOnly}
+ DATA_PLACE: String = "data:places" {readOnly}
+ LANDMARK_STORE_NAME: String = "AroundJ2ME" {readOnly}
TaskProcessListener
+ onError(String) : void
+ taskFinished(Object) : void
#listener
CategoryName
+ BANKS: String = "Banks" {readOnly}
+ BARS: String = "Bars" {readOnly}
+ CINEMA: String = "Cinema" {readOnly}
+ COFFEE: String = "Coffee" {readOnly}
+ GASSTATIONS: String = "Gas Stations" {readOnly}
+ HOSPITALS: String = "Hospitals" {readOnly}
+ HOTELS: String = "Hotels" {readOnly}
+ PARKING: String = "Parking" {readOnly}
+ PHARMACIES: String = "Pharmacies" {readOnly}
+ PUBS: String = "Pubs" {readOnly}
+ RESTAURANTS: String = "Restaurants" {readOnly}
+ SUPERMARKETS: String = "Supermarkets" {readOnly}
+ TAXIS: String = "Taxis" {readOnly}
+ THEATERS: String = "Theaters" {readOnly}
Runnable
ExecutableTask
# listener: TaskProcessListener
# progressWindow: IProgressWindow
# statusMessage: String
+ ExecutableTask()
+ ExecutableTask(TaskProcessListener)
+ getListener() : TaskProcessListener
# notifyError(String) : void
# notifyTaskFinished(Object) : void
+ run() : void
+ setListener(TaskProcessListener) : void
+ setProgressMessage(String) : void
+ setProgressWindow(IProgressWindow) : void
Messages
+ CURRENT_LOCATION_NOT_FOUND: String = "Oops..there wa... {readOnly}
+ DISPLAY_PLACES_ERROR: String = "There was an e... {readOnly}
+ DISPLAY_PLACES_NOTHING_FOUND: String = "No places have... {readOnly}
+ ERROR_READING_RECORDS: String = "Oops!! We were... {readOnly}
+ GOOGLEMAP_ERROR: String = "Oops..the map ... {readOnly}
+ INSTALLATION_ERROR: String = "Oops..your req... {readOnly}
+ INSTALLATION_SUCCESS: String = "The places for... {readOnly}
+ SERVER_CONNECTION_FAILED: String = "Oops..we were ... {readOnly}
Place
+ getCategories() : String[]
+ getCategoriesAsString() : String
+ getContinent() : String
+ getDistance() : double
+ getLandmark() : Landmark
+ Place()
+ setCategories(String[]) : void
+ setContinent(String) : void
+ setDistance(double) : void
+ setLandmark(Landmark) : void
ContinentPack
+ ContinentPack(String, boolean, String)
+ getContinent() : String
+ getInstallDate() : String
+ isInstalled() : boolean
+ setContinent(String) : void
+ setInstallDate(String) : void
+ setInstalled(boolean) : void
Command
BackCommand
+ BackCommand()

Figure 6: Packages

Name	Description
Place	This is the class for holding data of a place retrieved from the local landmark store that is being displayed on the UI to the user.

Name	**Description**
ContinentPack	This class is used for transporting the data about installed continents.
ExecutableTask	This abstract class is being inherited by classes that encapsulate so-called “executable tasks”. This is a pattern that has been used in the Around(J2)ME application for handling threaded code in a uniform and convenient way. For more information please refer to section 4.3.
TaskProcessListener	This is an abstract class that is used for attaching to the execution of an ExecutableTask for getting notified about the successful termination or occurence of errors.
Constants	This class contains commonly used constants throughout the application
CategoryName	This is a class containing all of the category names as constant strings in order to have a central point in the program for changing category names.
ContinentName	Similar to the CategoryName, this class holds constant strings for all of the available continents.
Messages	This class holds the messages that are being displayed to the user on the UI.
BackCommand	This class extends the javax.microedition.lcdui.Command class and is used by the ScreenController to automatically hook a “back” command on the Displayable objec that is being shown on the UI.

2.2.5 Package “com.aroundj2me.view”

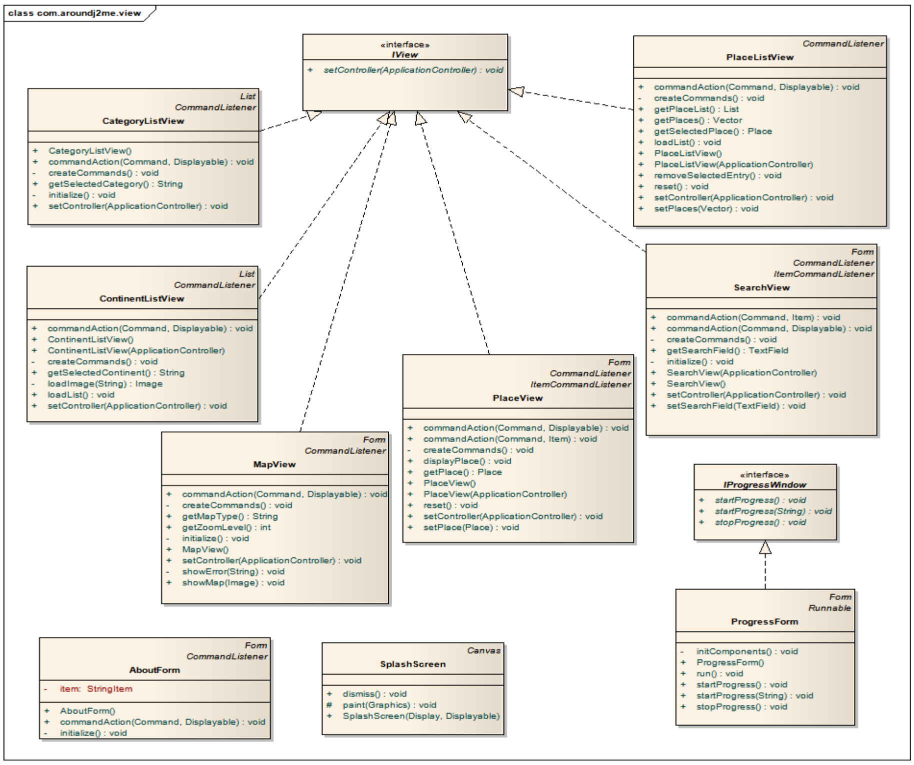
class com.aroundj2me.view
«interface»
IView
+ setController(ApplicationController) : void
List
CommandListener
CategoryListView
+ CategoryListView()
+ commandAction(Command, Displayable) : void
- createCommands() : void
+ getSelectedCategory() : String
- initialize() : void
+ setController(ApplicationController) : void
CommandListener
PlaceListView
+ commandAction(Command, Displayable) : void
- createCommands() : void
+ getPlaceList() : List
+ getPlaces() : Vector
+ getSelectedPlace() : Place
+ loadList() : void
+ PlaceListView()
+ PlaceListView(ApplicationController)
+ removeSelectedEntry() : void
+ reset() : void
+ setController(ApplicationController) : void
+ setPlaces(Vector) : void
List
CommandListener
ContinentListView
+ commandAction(Command, Displayable) : void
+ ContinentListView()
+ ContinentListView(ApplicationController)
- createCommands() : void
+ getSelectedContinent() : String
- loadImage(String) : Image
+ loadList() : void
+ setController(ApplicationController) : void
Form
CommandListener
ItemCommandListener
SearchView
+ commandAction(Command, Item) : void
+ commandAction(Command, Displayable) : void
- createCommands() : void
+ getSearchField() : TextField
- initialize() : void
+ SearchView(ApplicationController)
+ SearchView()
+ setController(ApplicationController) : void
+ setSearchField(TextField) : void
Form
CommandListener
ItemCommandListener
PlaceView
+ commandAction(Command, Displayable) : void
+ commandAction(Command, Item) : void
- createCommands() : void
+ displayPlace() : void
+ getPlace() : Place
+ PlaceView()
+ PlaceView(ApplicationController)
+ reset() : void
+ setController(ApplicationController) : void
+ setPlace(Place) : void
Form
CommandListener
MapView
+ commandAction(Command, Displayable) : void
- createCommands() : void
+ getMapType() : String
+ getZoomLevel() : int
- initialize() : void
+ MapView()
+ setController(ApplicationController) : void
- showError(String) : void
+ showMap(Image) : void
«interface»
IProgressWindow
+ startProgress() : void
+ startProgress(String) : void
+ stopProgress() : void
Form
Runnable
ProgressForm
- initComponents() : void
+ ProgressForm()
+ run() : void
+ startProgress() : void
+ startProgress(String) : void
+ stopProgress() : void
Form
CommandListener
AboutForm
- item: StringItem
+ AboutForm()
+ commandAction(Command, Displayable) : void
- initialize() : void
Canvas
SplashScreen
+ dismiss() : void
# paint(Graphics) : void
+ SplashScreen(Display, Displayable)

Figure 7: Packages

Class	Description
IView	This is the interface that is implemented by all of the view classes defined in the application. This construct facilitates the easy construction and reuse of view objects in the application.
CategoryListView	This is the UI list where all of the available categories are displayed to the user. The user can choose a category for getting all of the according places.

Class	**Description**
ContinentListView	This is the list showing all the available continents. Here the the user can download or update his places from the server. Appropriate icons show whether a certain continent with its data is already installed or whether it has still to be downloaded.
MapView	This view shows a Google Map with the current position of the user marked with a red point and the desired place with a blue point.
PlaceListView	This is the list displayed to the user with all of the retrieved nearby places.
PlaceView	On this view, the details about the selected pace such as the title, description, address etc... are displayed to the user.
SearchView	This is the view where the user can enter search queries for retrieving nearby places.
SplashScreen	This is the initial splash screen that is shown during initialization at the application startup.
AboutForm	This is a view for showing information related to the Around(J2)ME application such as the version and the authors.
IProgressForm	This is the interface for views showing progress information to the user. It defines the methods that should be implemented.
ProgressForm	This class implements IProgressForm and displays a progress bar together with a status message for informing the user about the ongoing operations.

2.2.6 Package “com.aroundj2me.executableTasks”

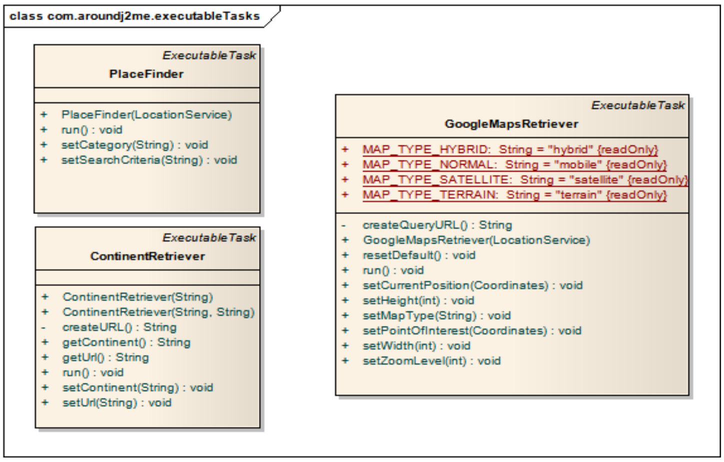
class com.aroundj2me.executableTasks
ExecutableTask
PlaceFinder
+ PlaceFinder(LocationService)
+ run() : void
+ setCategory(String) : void
+ setSearchCriteria(String) : void
ExecutableTask
ContinentRetriever
+ ContinentRetriever(String)
+ ContinentRetriever(String, String)
- createURL() : String
+ getContinent() : String
+ getUrl() : String
+ run() : void
+ setContinent(String) : void
+ setUrl(String) : void
ExecutableTask
GoogleMapsRetriever
+ MAP_TYPE_HYBRID: String = "hybrid" {readOnly}
+ MAP_TYPE_NORMAL: String = "mobile" {readOnly}
+ MAP_TYPE_SATELLITE: String = "satellite" {readOnly}
+ MAP_TYPE_TERRAIN: String = "terrain" {readOnly}
- createQueryURL() : String
+ GoogleMapsRetriever(LocationService)
+ resetDefault() : void
+ run() : void
+ setCurrentPosition(Coordinates) : void
+ setHeight(int) : void
+ setMapType(String) : void
+ setPointOfInterest(Coordinates) : void
+ setWidth(int) : void
+ setZoomLevel(int) : void

Figure 8: Packages

All of the classes extend the abstract class “ExecutableTask”. For more information about this kind of pattern see section 4.3.

Class	**Description**
PlaceFinder	This class is responsible for reading the places that match the current user’s location from the local landmark store.
ContinentRetriever	This class is responsible for establishing a connection to the server and for downloading the according data for the continent chosen by the user.
GoogleMapsRetriever	This class is responsible for contacting the Google Maps API for retrieving the map for displaying the user’s location and selected point of interest.

2.2.7 Package "com.aroundj2me.utility"

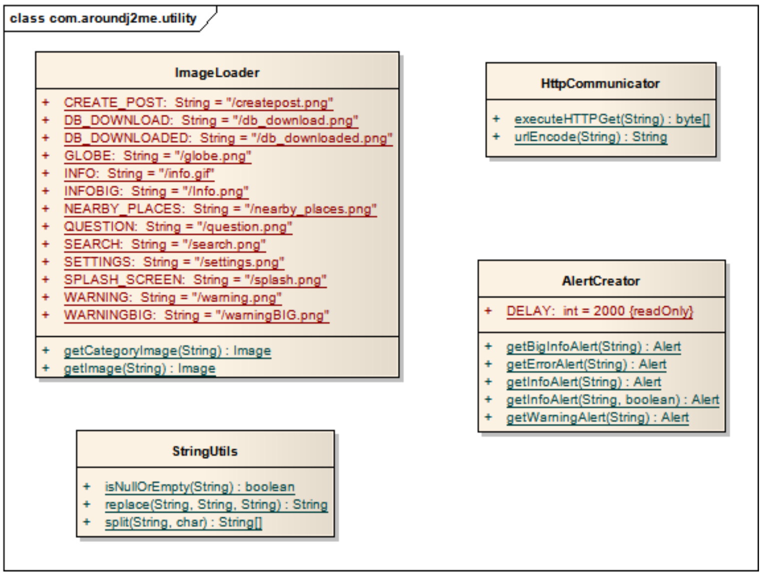
class com.aroundj2me.utility
ImageLoader
+ CREATE_POST: String = "/createpost.png"
+ DB_DOWNLOAD: String = "/db_download.png"
+ DB_DOWNLOADED: String = "/db_downloaded.png"
+ GLOBE: String = "/globe.png"
+ INFO: String = "/info.gif"
+ INFOBIG: String = "/Info.png"
+ NEARBY_PLACES: String = "/nearby_places.png"
+ QUESTION: String = "/question.png"
+ SEARCH: String = "/search.png"
+ SETTINGS: String = "/settings.png"
+ SPLASH_SCREEN: String = "/splash.png"
+ WARNING: String = "/warning.png"
+ WARNINGBIG: String = "/warningBIG.png"
+ getCategoryImage(String) : Image
+ getImage(String) : Image
HttpCommunicator
+ executeHTTPGet(String) : byte[]
+ urlEncode(String) : String
AlertCreator
+ DELAY: int = 2000 {readOnly}
+ getBigInfoAlert(String) : Alert
+ getErrorAlert(String) : Alert
+ getInfoAlert(String) : Alert
+ getInfoAlert(String, boolean) : Alert
+ getWarningAlert(String) : Alert
StringUtils
+ isNullOrEmpty(String) : boolean
+ replace(String, String, String) : String
+ split(String, char) : String[]

Figure 9: Packages

Name	**Description**
ImageLoader	This class provides static constants with the uri to the corresponding images and a static utility method for loading them and creating the according in-memory image object.
StringUtils	This class contains utility methods for working with strings which are missing in the J2ME library such as replace and split methods.
HttpCommunicator	This class provides the logic for performing HTTP calls and for reading the returned data.
AlertCreator	This class contains utility methods for creating various Alert objects to be displayed on the screen.

2.2.8 Package “com.aroundj2me.xml”

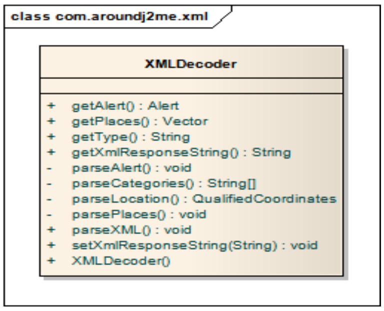

Figure 10: Packages

Name	**Description**
XMLDecoder	This class is responsible for parsing XML documents by using the XML pull parser technology (kXML).

2.2.9 Package “com.aroundj2me.uicomponents”

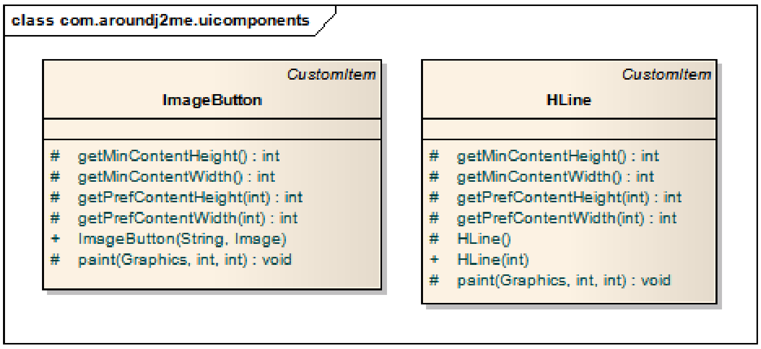
class com.aroundj2me.uicomponents
CustomItem
ImageButton
# getMinContentHeight() : int
# getMinContentWidth() : int
# getPrefContentHeight(int) : int
# getPrefContentWidth(int) : int
+ ImageButton(String, Image)
# paint(Graphics, int, int) : void
CustomItem
HLine
# getMinContentHeight() : int
# getMinContentWidth() : int
# getPrefContentHeight(int) : int
# getPrefContentWidth(int) : int
# HLine()
+ HLine(int)
# paint(Graphics, int, int) : void

Figure 11: Packages

Name	**Description**
HLine	This is a custom UI component that is used for drawing a horizontal line on the screen in order to separate different UI parts.
ImageButton	This class is a custom UI component that draws an image button on the UI.

2.3 Client - Server communication

The main application logic is performed offline, without relying on a server for providing the data. The only communication with the server is for downloading the location data to the client where it is then stored for performing operations locally.

The application connects to the server by performing a HTTP GET operation passing the continent as parameter. The server processes the request and encodes the result as XML file which is sent back to the mobile client. There the result is parsed by using the kXML parser and stored locally inside a LandmarkStore.

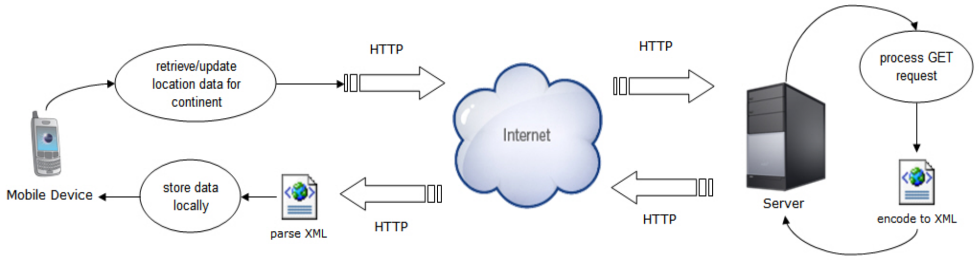

Figure 12: Free form diagram showing the client - server communciation

2.4 MVC like structuring

For separating the user interface logic, the domain logic and the model classes, a very simplified MVC like structure has been used. Mostly the concept of the layering and decoupling has been taken from the MVC pattern.

- **Controller**
  The ApplicationController class plays the role of the controller. All of the calls to the actual application logic go through this class. It functions as a mediator that gets the UI actions initiated from the user's

interaction, executes the appropriate actions on the different domain classes (model) and then displays the changed model data again on the user interface.

- **Model**
  The model part of the MVC is represented by the classes in the com.aroundj2me.model package. These are the classes that contain the data that is being displayed (by the ApplicationController) on the UI.

- **View**
  The view part is represented by the classes in the com.aroundj2me.view package. All of these classes contain mainly user interface related logic such as constructing the appropriate elements for showing the data and for handling user events.

It has to be stated that a full implementation of the MVC pattern has been avoided for minimizing the amount of objects that are involved in such a structure. The MVC[1] or MVP[2] model in a J2SE or J2EE environment involves a lot of objects and event handling which could pose a possible overhead on the mobile device.

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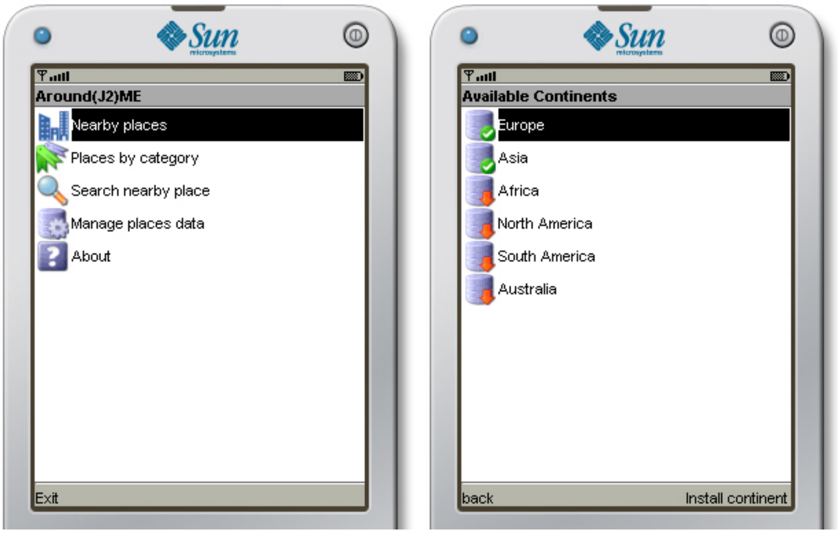
[1] `http://blog.js-development.com/2008/03/logical-separation-with-mvc.html`

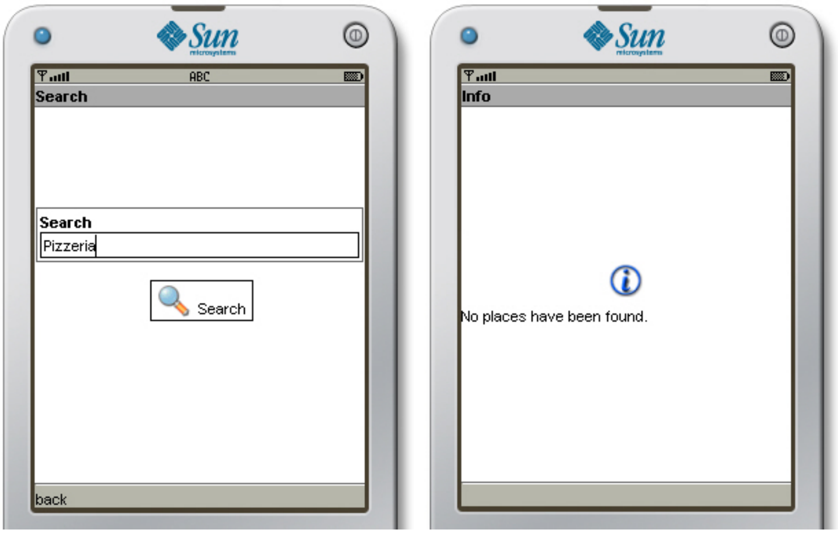
[2] `http://martinfowler.com/eaaDev/ModelViewPresenter.html`, `http://msdn.microsoft.com/en-us/library/cc304760.aspx`

3 User interface

This section shows some screenshots presenting the main functionalities of the Around(J2)ME application.



(a) Main menu (b) Manage places

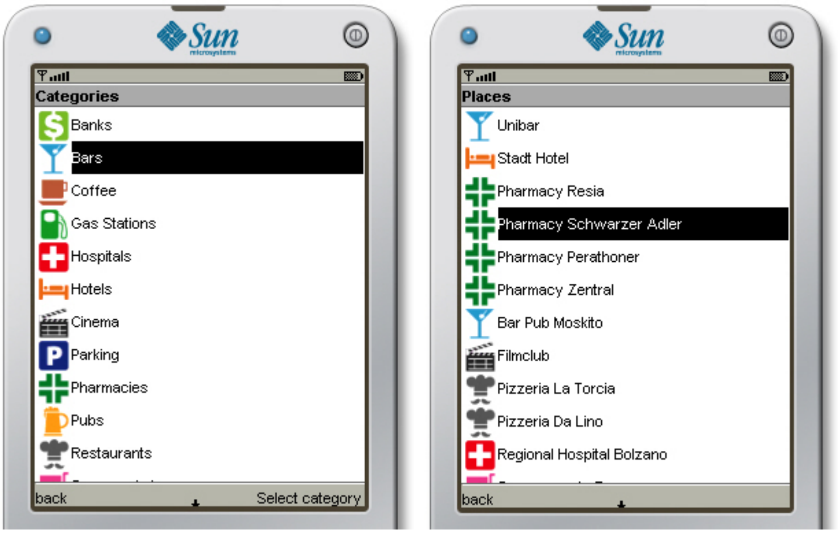


Search: Pizzeria

No places have been found.

(c) Places search (d) Information message

Figure 13: Screenshots showing the main functionalities



Categories

Banks
Bars
Coffee
Gas Stations
Hospitals
Hotels
Cinema
Parking
Pharmacies
Pubs
Restaurants

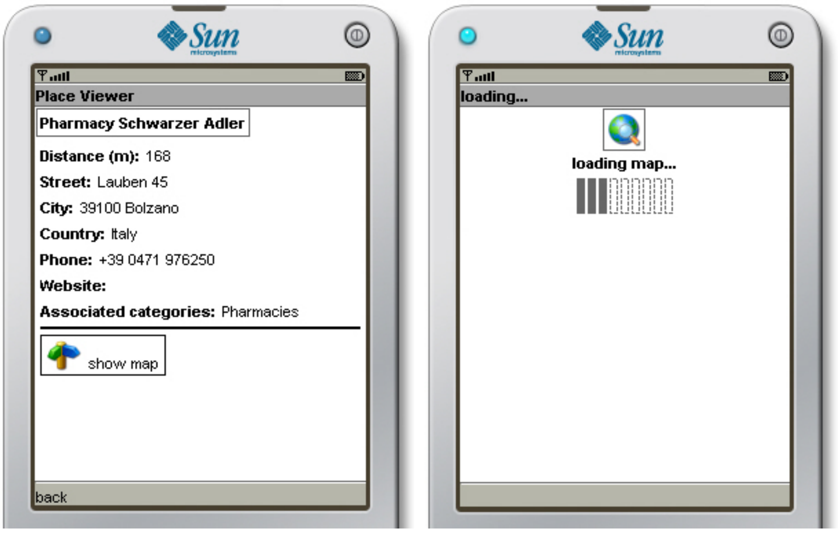
back
Select category

Places

Unibar
Stadt Hotel
Pharmacy Resia
Pharmacy Schwarzer Adler
Pharmacy Perathoner
Pharmacy Zentral
Bar Pub Moskito
Filmclub
Pizzeria La Torcia
Pizzeria Da Lino
Regional Hospital Bolzano

back

(a) Places by category (b) Nearby places



Place Viewer

Pharmacy Schwarzer Adler

Distance (m): 168
Street: Lauben 45
City: 39100 Bolzano
Country: Italy
Phone: +39 0471 976250
Website:
Associated categories: Pharmacies

show map

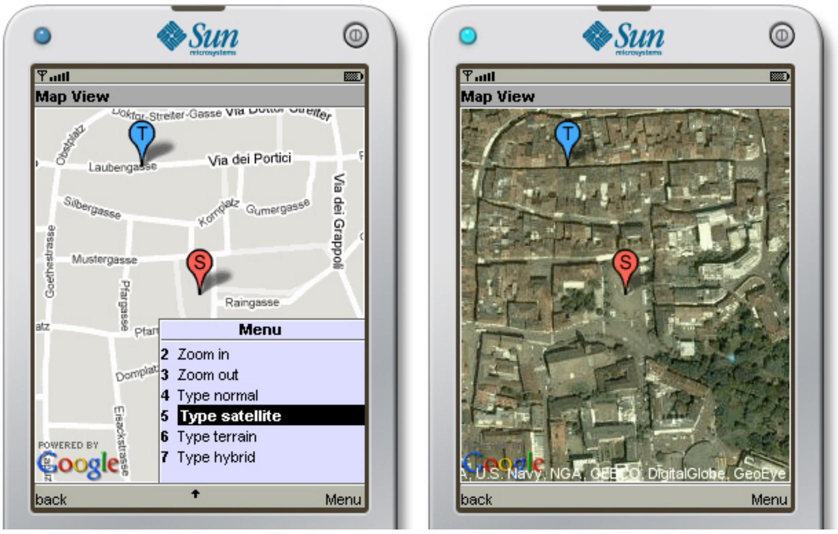
back

loading...

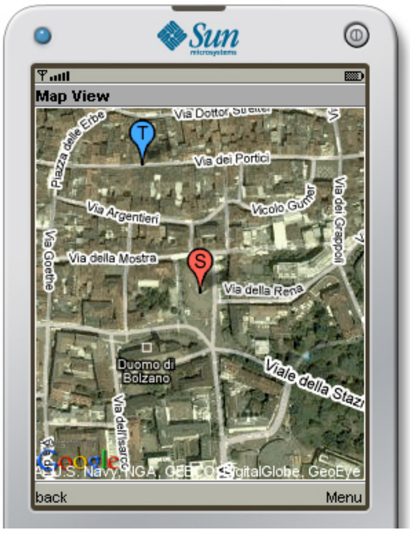
loading map...

(c) Place detail view (d) Progress indicator

Figure 14: Screenshots showing the main functionalities



(a) Map view normal (b) Map view satellite



(c) Map view hybrid

Figure 15: Screenshots showing the main functionalities

4 Development strategies

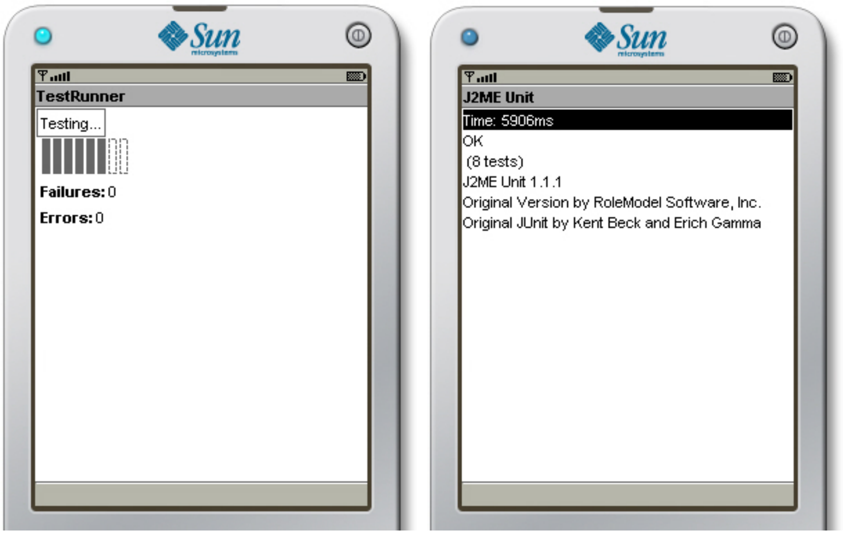
4.1 Handling location data

Location data is managed by heavily using the JSR-179 Location API. Places are represented by the Location API's Landmark class, which are stored inside a LandmarkStore together with appropriate categories. There is one landmark store for each continent.

When the user wants to retrieve places around his current position by one of the available functionalities (either through a search, by a certain category or just all nearby places), the local landmark stores are queried for locations of about 3 kilometers around the user's current position.

4.2 JUnit testing

The J2MEUnit[3] library has been used for writing JUnit tests for the mobile device. This ensured the proper working of the implemented features during the development lifecycle.



```
Failures: 0
Errors: 0
```

```
Time: 5906ms
OK
 (8 tests)
J2ME Unit 1.1.1
Original Version by RoleModel Software, Inc.
Original JUnit by Kent Beck and Erich Gamma
```

Figure 16: JUnit tests running on the WTK simulator

---

[3] http://j2meunit.sourceforge.net/

4.3 ExecutableTask "pattern"

When developing J2ME applications there are always again operations that have to be launched inside a separate thread in order to first not block the main user interface and second to be able to provide valuable information at the same time to the user, e.g. a progress window about the ongoing operation. In order to have the same reusable structure for handling these threaded operations throughout the Around(J2)ME application, a so-called "Executable task pattern" has been created.

The base classes involved in this construct are the ExecutableTask and the TaskProcessListener. Both are abstract classes and get implemented by the actual executable task classes (see section 2.2.6). The ExecutableTask implements the runnable interface for being launched inside a thread and it accepts a TaskProcessListener for being notified about the status of the ongoing operation.

Executing an operation that extends the ExecutableTask class can then be handled in this simple way:

```
executableTask.setListener(new TaskProcessListener() {
  public void onError(String status) {
    //an error happened, notify the user
  }

  public void taskFinished(Object result) {
    //everything went fine..
    //do something with the ``result''
  }
});
..
Thread t = new Thread(executableTask);
t.start();
```

4.4 The ScreenController - managing Displayables

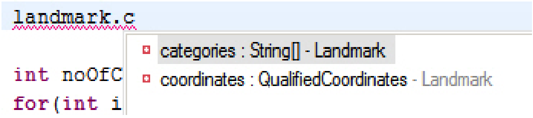
Mobile phones don't dispose of a multi-window environment as in normal desktop environments. Always just one window at a time can be shown on the display where users can usually navigate forward and backward between different windows. This kind of behaviour matches perfectly a stack datastructure: if the user navigates to a new screen, the current screen will be pushed on the stack. When the user activates the back button, the last screen will be popped from the stack and again displayed.

These kind of operations are managed by the ScreenController. It is a singleton class that is used throughout the Around(J2)ME application as a central point for handling display related operations.

5 Technical problems

5.1 Location API - Landmark, LandmarkStore and Categories

One of the major technical issues that have been encountered during development was a problem with the JSR-179 Location API. Around(J2)ME uses categories such as "Bars, Restaurants, Pubs, Hotels,. . . " for organizing places. These categories are associated to the landmarks when they are persisted in the LandmarkStore. When retrieving a certain landmark from the store it is however not possible to know which kind of category it has associated. A Landmark object has an array of associated categories but provides no public accessor for retrieving it.



```
landmark.c

int noOfC
for(int i
```

categories : String[] - Landmark
coordinates : QualifiedCoordinates - Landmark

Figure 17: Landmark's categories array not publicly accessible

Such information is however needed by the Around(J2)ME application. When the user retrieves nearby places without any restriction, he would like to know immediately which kind of category a found place belongs to. For instance whether it is a bar, pub or restaurant. As a workaround, the description field of the Landmark class has been used to store the category information.

6 Future development

Future development of the application could go in the direction of extending the server logic for providing features like

- letting the user enter new interesting places locally and submit them to the server.
- letting the user rate/comment places (i.e. rate restaurants, pubs, bars. . .)

Another feature could be to enhance the navigation support, that is, enhancing the Google Map to continuously track and update the user's position on the map by exploiting the LocationListener of the JSR-179 Location API.