Virtual Telescope service for mobile devices

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Outline

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3. Underlying technologies
4. Mathematical part of service
5. Architecture of service
6. Interface of service
7. Current project stage and future plans

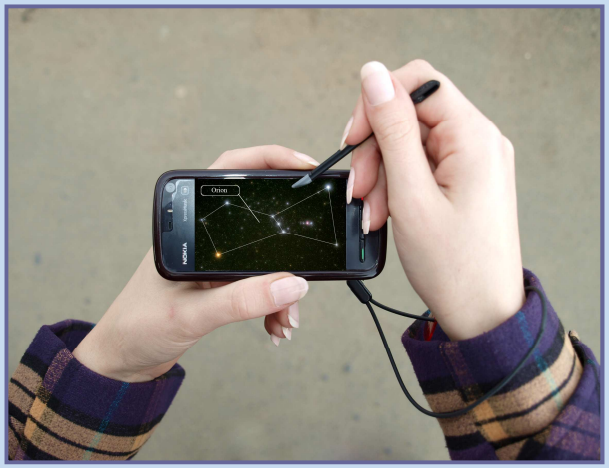
Motivation

- Fulfill people's aspiration to know more about our universe
- Provide access to the best astronomical content without special astronomical tools
- Astronomical service available at any time and any place by means of mobile device

Use-case scenarios

Starpedia

Access to the map of stars observable in the given time and location and information about sky objects (name of constellations, stars, etc.)



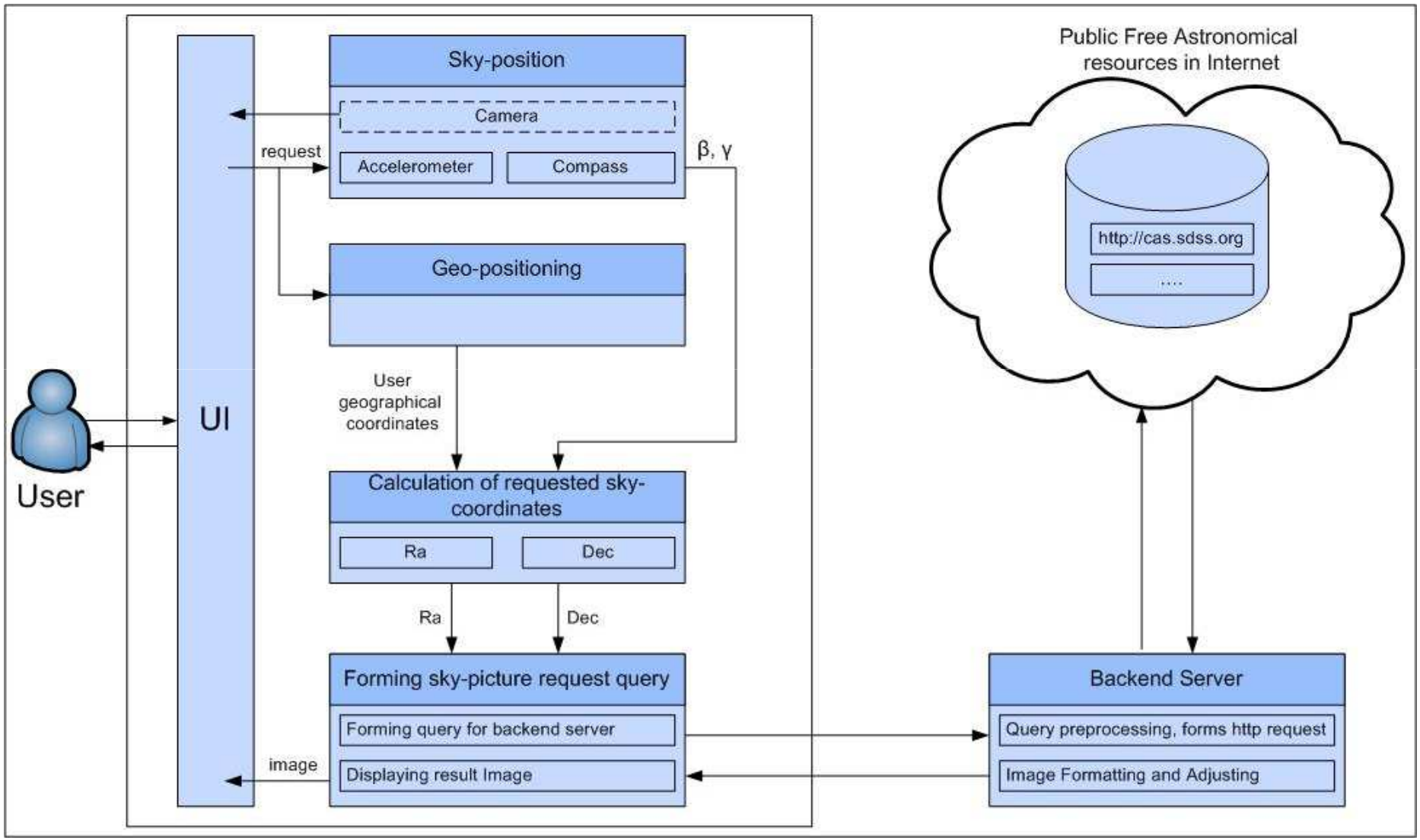
Stars-identifier

Gets the starpedia page that corresponds to the area of sky to which the device camera is pointing in the given moment of time

Virtual Telescope

Gets real pictures of the sky object in scale and for area defined by the user → the virtual telescope experience

Architecture of service



Underlying technologies

The services require that the device has:

- Accelerometer sensor
- Compass sensor
- Internet connection

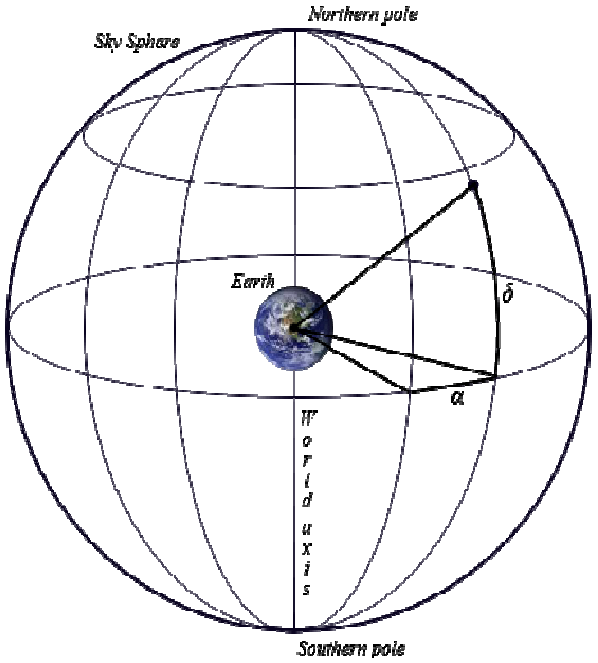
The following optional elements are useful:

- GEO-positioning module (GPS)
- High resolution digital camera

Mathematical part of service

3 steps of sky-requested coordinates calculation:

1. Transformation of user coordinates to format Ra and Dec (α and δ)
2. Taking into consideration the angle of inclination of the mobile device
3. Taking into consideration the angle between north and a direction on which the user is pointing



Mathematical part of service

Transforming the user coordinates into the Ra and Dec format (α and δ)

δ = n° nn’ nnn” N or δ = -n° nn’ nnn” S

α(t) = α_g(t) + λ, where

$$\lambda = \begin{cases} w^o\ ww'\ www'' & W \\ 360^o - w^o\ ww'\ www'' & E \end{cases}$$

$\alpha_g(\Delta t) = \alpha_g(0h) + \omega^* \Delta t$, where

α_g(0h) – time for 0h of certain data,

ω – speed of rotating the Earth,

ω = 7.29211510 × 10-5 radian/s

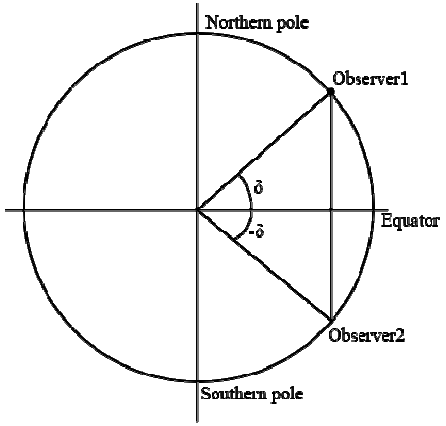
Δt – UTC-time

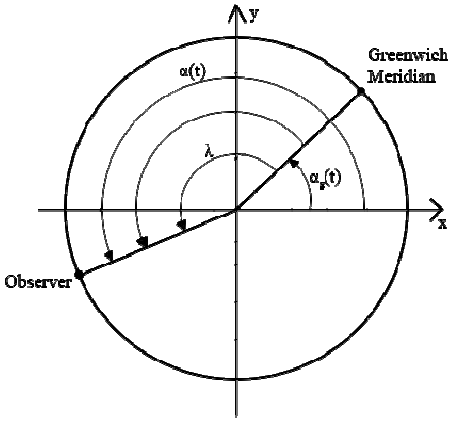
α_g(0h) = 24110s.54841 +

8640184s.812866 *Tu* +

0s.093104 *Tu*2 - 6.2 × 10- 6 *Tu*3

Tu = *du*/36525, *du* – number of days since JD 2451545.0 (1 January 2000, 12h UT1)

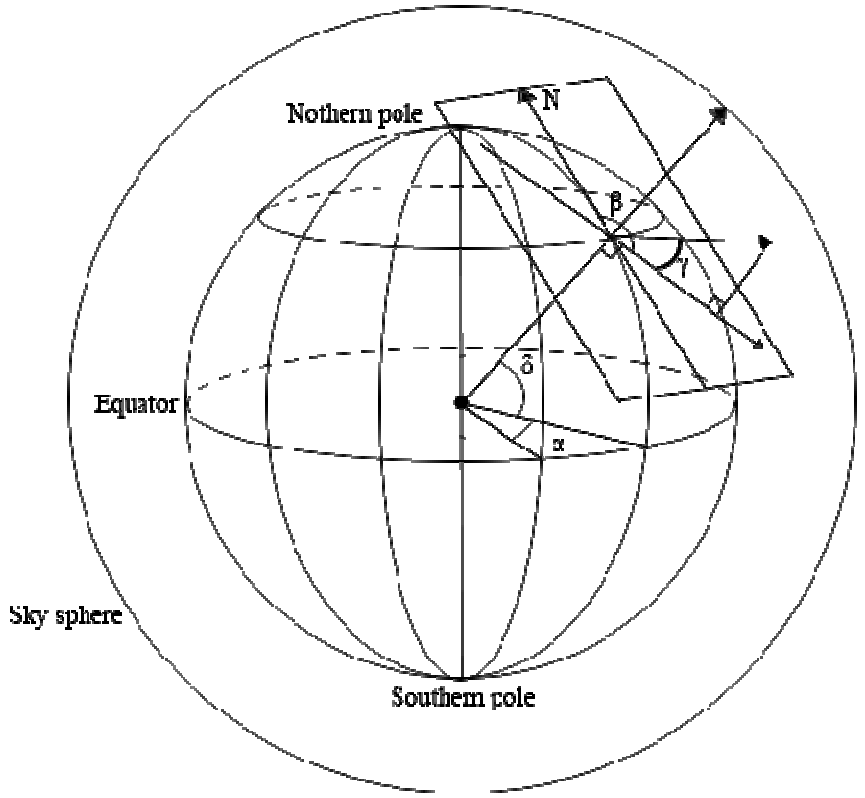




Mathematical part of service

Steps 2 and 3:

- β - angle between direction on the north and direction to which user is pointing
- γ - angle between the Earth plane and a direction to which the user is pointing
- N – tangent plane to the Earth in point where the user is located



Mathematical part of service

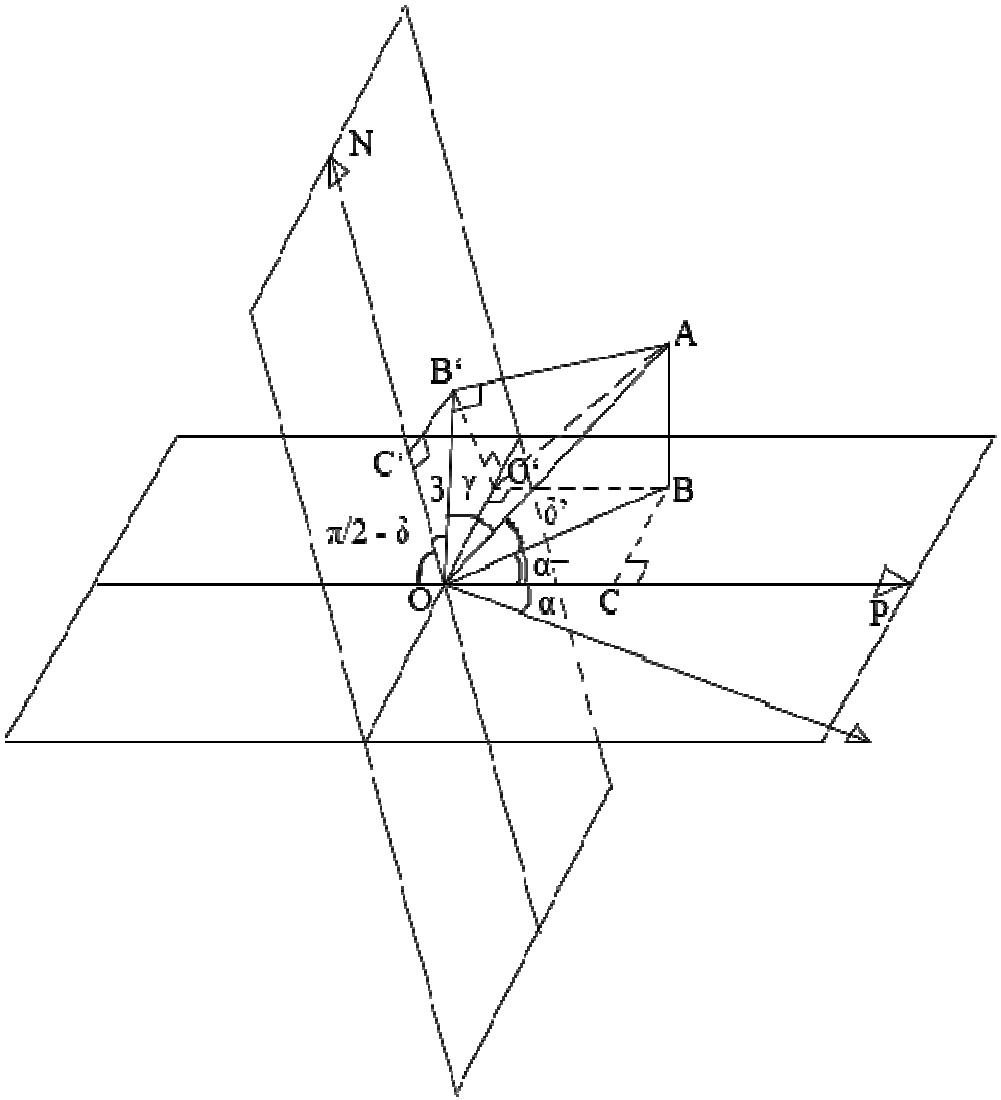
- P – plane parallel to the equatorial plane
- δ’ – new declination
- α’ – new direct ascension

For Nothern hemisphere:

$$\delta' = \arcsin(\sin\delta \sin\gamma + \\ + \cos\delta \cos\gamma \sin\beta)$$

For Soutern hemisphere:

$$\delta' = -\arcsin(\sin\delta \sin\gamma + \\ + \cos\delta \cos\gamma \sin\beta)$$



Mathematical part of service

α+=arcsin(sin β cos γ /cos δ')

1. $0<\alpha\le 90^o$

$$\alpha'=\begin{cases}\alpha+\alpha^+, & 0<\beta\le 180^o\\ \alpha-\alpha^+, & 180^0<\beta\le 360^o,\ \alpha^+\le\alpha\\ 2\pi+\alpha-\alpha^+, & 180^0<\beta\le 360^o,\ \alpha^+>\alpha\end{cases}$$

2. $90^o<\alpha\le 180^o$

$$\alpha'=\begin{cases}\alpha+\alpha^+, & 0<\beta\le 180^o\\ \alpha-\alpha^+, & 180^0<\beta\le 360^o\end{cases}$$

3. $180^o<\alpha\le 270^o$

$$\alpha'=\begin{cases}\alpha+\alpha^+, & 0<\beta\le 180^o\\ \alpha-\alpha^+, & 180^0<\beta\le 360^o\end{cases}$$

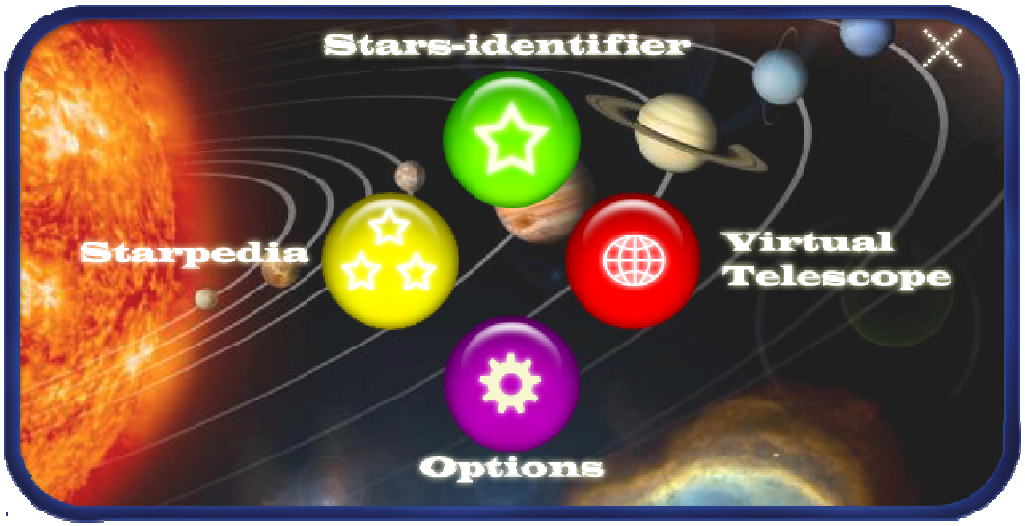
4. $270^o<\alpha\le 360^o$

$$\alpha'=\begin{cases}\alpha+\alpha^+-2\pi, & 0<\beta\le 180^o,\ \alpha^+>360^o-\alpha\\ \alpha+\alpha^+, & 180^0<\beta\le 360^o,\ \alpha^+\le 360^o-\alpha\\ \alpha-\alpha^+, & 180^0<\beta\le 360^o\end{cases}$$

Interface of service

First page:

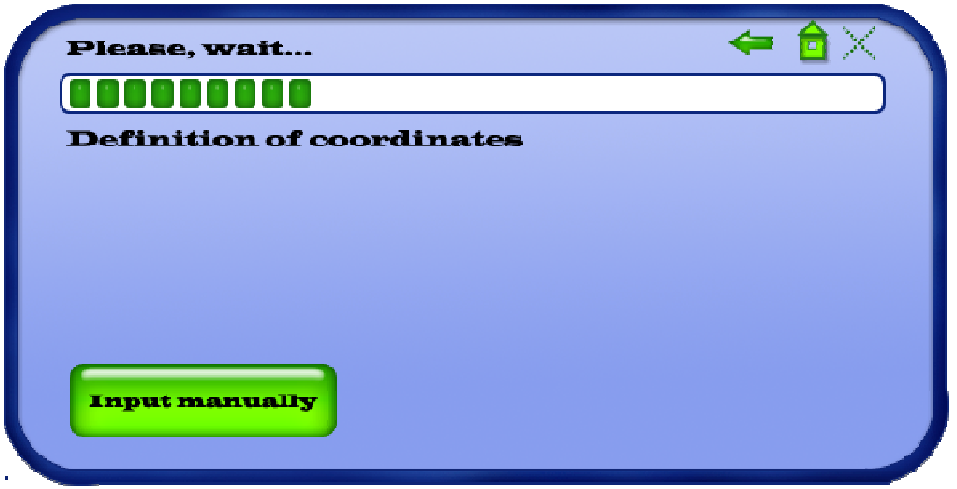
- Starpedia service
- Stars-identifier service
- Virtual Telescope service
- Options (interface adjustment, connection, loaded images configuration, etc)



Interface of service

Starpedia mode

- Definition of user geographical coordinates (by means of GPS or GSM base station)

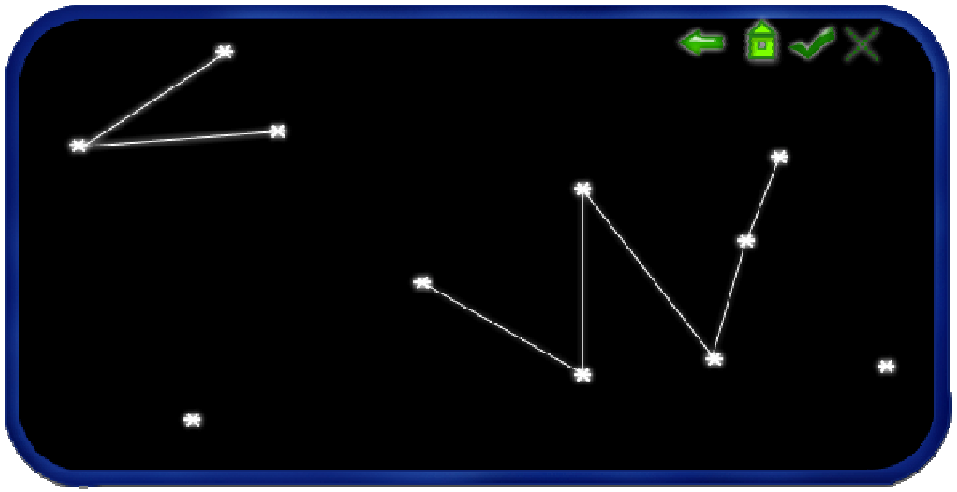


- User has possibility to input geographical coordinates manually

Interface of service

Starpedia mode:

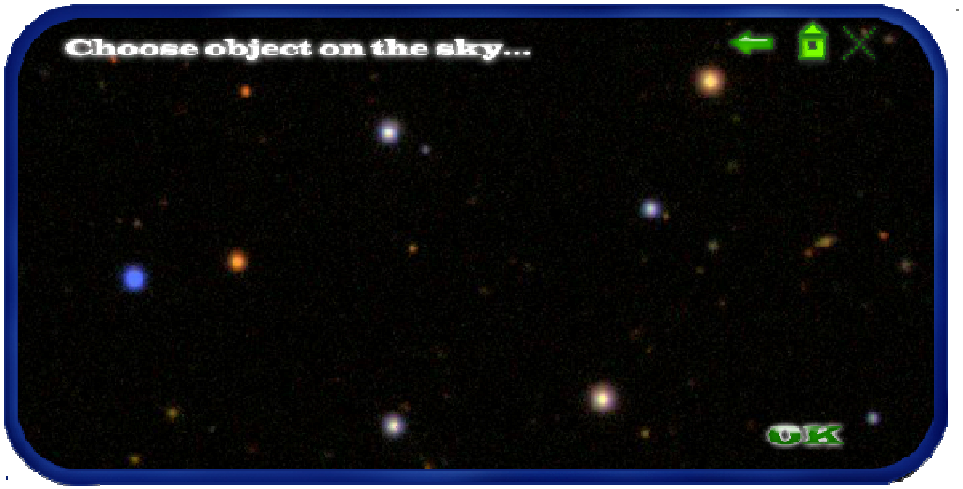
- When geographical coordinates are defined user gets scheme of stars, observable in the current moment of time in the given location
- User also can save picture on mobile device

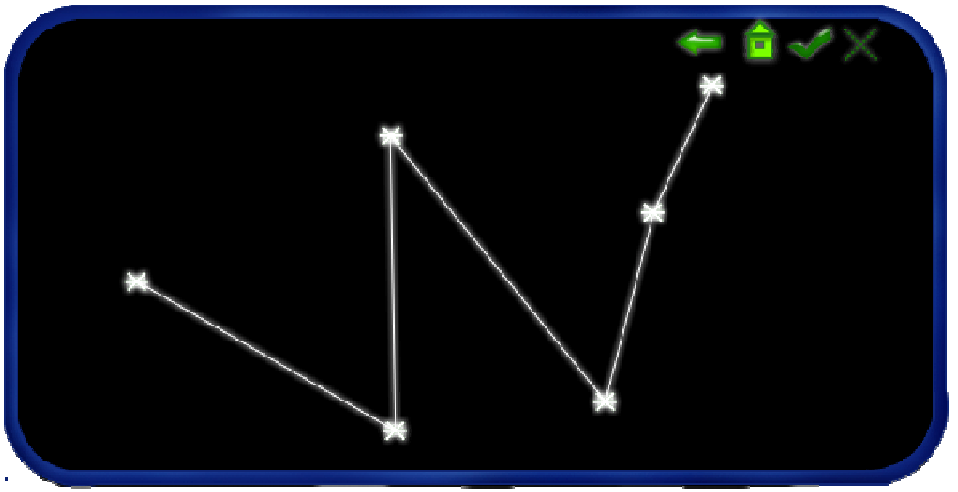


Interface of service

Stars-identifier mode:

1. User points to the interested area of the sky by means of mobile device camera
2. Press “OK” or take photo
3. After definition of geographical coordinates and angles, which define location of device in the space user gets starpedia page of the necessary area of the sky





Interface of service

Virtual telescope mode:

- User gets real image of sky area in necessary scale from on-ground or orbital telescopes

Results and future plans

What has been done:

- Basic service requirements are defined
- The service architecture is defined
- Mathematical model is developed
- The overall design of all services is completed
- Paper and presentation at Redundancy 2009 conference
- Status presentation of the project at AIS/CAD 2009 congress
- Submitted application to Russian Mobile VAS Awards contest in category “Innovative services” (result on Nov 19, 2009)

Nowadays the project in implementation stage

The next milestone:

- Development of the demo service (WRT and Qt for Symbian)

Thanks for your attention!

For more information visit:

http://www.fruct.org/vt