GPS/GIS Activities Summary

Group activities 

Outdoor activities 

Use of GPS receivers 

Use of computers 

Calculations 

Relevant to robotics 

Relevant to agriculture 

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1. Information technologies in agriculture 

Define GPS/GIS and robotics as components of IT.

- Information technologies are everywhere.
- Agriculture is a very important industry.
- For the new generation it is important to effectively adopt information technologies in agriculture, which was traditionally viewed as a low-tech industry.

2. Problem solving and engineering 

Formulate everyday problems and apply consistent solving skills.

- You do not need to be an engineer to apply problem solving skills that most engineers use.
- Proper use of problem solving skills can relieve a lot of stress and save time in everyday life.
- Every solution is limited to given conditions that eventually may change.

3. Direction 

Define direction from one location to another.

- Direction is important when relating different objects in space.
- Geographic direction can be expressed in words and numbers.
- Although the concept is the same, angular representation of direction is different from the traditional representation of an angle in polar coordinates that mathematicians use.

4. Triangulation and space 

Understand how GPS works and what positioning accuracy can be expected.

- Triangulation is used by many professionals and involves some basic math.
- GPS is only one of GNSS, which uses triangulation to find position in space.
- A GPS receiver uses time measurements to calculate distance to several GPS satellites with known locations at every moment of time.
- A minimum of three visible satellites are needed to achieve “position fix”.
- More visible satellites and use of a differential correction service assures a better accuracy of a GPS receiver.

5. Geographic coordinates 

Obtain geographic coordinates from a given positioning device.

- Every location on Earth has a unique pair of coordinates (longitude and latitude)
- Elevation is the third geographic coordinate
- Longitude and latitude are angular measurements when elevation is in linear units
- In US, longitude increased when one moves to West, not East, and therefore each longitude should be assigned a negative sign.

6. Coordinate conversions 

Represent known latitude and longitude in decimal degrees.

- Longitude and latitude are angles.
- Angles have different unit representations.
- Decimal degrees with proper sign are the optimum representation of longitude and latitude.

7. Untangling latitude and longitude 

Determine the distance represented by a unit of longitude/latitude.

- Geographical latitude and height above ellipsoid are the only factors affecting the distance that correspond to 1º of longitude and latitude.
- WGS-84 is one of many models describing the Earth, which is used by GPS.

8. Distance between two points 

Find the distance between two sets of geographic coordinates.

- Longitude denotes X value and latitude denotes Y value in terms of rectangular coordinates.
- Pythagoras theorem has many applications in everyday life.
- Distance can be specified using several alternative units.

9. Setting waypoints 

Mark locations using a GPS receiver.

- There are several ways to create waypoints.
- Each waypoint represents one and only one geographic location.

10. Navigation 

Navigate to a given waypoint using a GPS receiver

- Many handheld GPS receivers act as a compass and map when used for navigation.
- The true benefit of GPS is that it provides the ability to know your location all the time.
- Navigation using a GPS receiver is limited when signal is not available (e.g., forest, buildings, under water, etc.)
- For an actual pathway planning, accurate base maps with different geographic features are needed.

11. GPS games 

Participate in an outdoor geocashing activity

- Any GPS receiver does not always lead to the exact destination
- To move around landscape, one needs to take into account any obstacles.
- Efficient teamwork can be the key to a winning strategy.

12. Path tracking 

Create and display a logged track.

- Using GPS to log tracks is a very useful tool.
- Track logs can be made with fixed time or distance intervals.
- Many receivers tend to simplify logs to save memory.

13. Reading a paper map 

Obtain information from a printed map

- There can be many different maps of the same place.
- Maps are made for specific audiences showing limited number of map features.
- Every map should contain all the basic map elements

14. Mapping symbology 

Understand various components of a map

- Elements of symbology used to create geographic maps are subjective (depend on the taste and visual associations of the author.
- Map objects are represented by points areas and polygons.
- Color, size and shape of symbols communicate critical graphical information.

15. Virtual world 

Explore thee world using Google Earth.

- It is a good idea to travel virtually in order to better understand relative location of geographic objects.
- Google Earth is an example of free software allowing virtual travel.
- Finding locations using street address or business name and visualizing travel directions are only a few of many options available.

16. Basics of GIS 

*Obtain information from multiple digital data layers.*Data on different types of geographic features are stored in separate data layers.

- Every two-dimentional map of the Earth is a projected map and, therefore, misrepresents true data.
- Raster and vector data are two major types of information processed through GIS.

17. Digital map customization 

Customize an existing GIS project.

- Map customization is a subjective process that reveals your taste for visual appeal and ability to communicate with others.
- Paper maps contain no attribute data while GIS specifies the spatial relationship between features.

18. Printing a digital map 

Prepare and print a digital map.

- Spatial data analysis is the main advantage of GIS versus paper maps.

- Many elements of digital maps have information that corresponds to attribute tables that can help answer different questions.
- Like paper maps, digital maps should contain all the basic map elements.

19. Digital map competition 

Identify a good quality digital map.

- Map creation is an art that is based on scientific data.
- It is relatively easy to see a good map.
- Trying different options can improve your creativity.

20. Aerial imagery 

Learn the basics of aerial imagery.

- With a constant field of view, the distance between the camera and target and length/width of the targeted area change proportionally.
- Rules of right triangle define the relationship between FOV, height above target and the size of the image.
- More pixels mean higher resolution, which result in a sharper image.

21. Georeferencing an image 

Georeference images using ArcGIS and GoogleEarth software.

- Georeferencing allows relating an aerial image with other spatial data layers.
- Control points are used to match location on a non-referenced image with corresponding locations with known coordinates.

22. Mapping with GPS 

Download and visualize GPS log data.

- With GPS technology, mapping different geographic objects is mach easy than using conventional surveying tools.
- Mapping your daily activities may be a lot of fun.

23. Community mapping 

Plan an community mapping project.

- The importance of planning a project before implementing it.
- Efficiency of a team depends on the input by individual members.

24. Robot tracking 

Use GPS data logger to track the path of a robot.

- The importance of GPS for vehicle tracking.
- GPS receivers can be use to log historic data or in real-time.

25. Map Digitizing 

Use background imagery to construct point, line and polygon data layers.

- Using ArcCatalog you can create a new point, line or polygon shapefile.
- ArcMap is used for digitizing features.
- The quality of your digitization depends on the source data and personal skills.

26. Yield Mapping 

Display yield measurements as a scatter of points with different colors.

- Longitude is the X value and latitude is the Y value in terms of rectangular coordinates.
- A long yield history is essential to avoid drawing conclusions that are affected by the weather or other unpredictable factors during a particular year.
- A yield map is a critical piece of the precision agriculture “puzzle” that many crop producers and consultants analyze every year.

27. Soil Mapping 

Import and display a soil survey data layer.

- Soil data (SSURGO) is important to make different land use decisions.
- It is a typical “shape” file that contains geographic features represented as polygons.

28. Interpolation 

Interpolate surfaces representing spatial distributions of important soil properties.

- Interpolation is estimating an unknown value that falls between known values.
- Surface interpolation functions create a continuous surface from sampled point values.
- Spatial data analysis is one of the main advantages of GIS versus paper maps.

29. Field Map Layout 

Construct deliverable maps of an agricultural field.

- Like paper maps, digital maps should contain all the basic map elements.
- In agriculture, it is important to see different data layers and maps at the same time.

30. Robot Sensor Exploration 

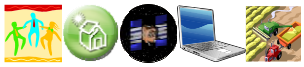
Remotely control the robot and observe sensor output in real time.

- Robot using in this activity has a computer inside that relies on the relationship between sensor inputs and motor outputs.
- With remote control option, explorer plays the role of such computer.
- You can steer the robot using sensor feedback and/or clock.

31. Sensor Log Investigation 

Plot time series graphs of sensor output logs.

- Graphs are used to communicate information visually.
- Facts are made clearer and more understandable with the use of a graph.
- Sensor history plots help analyze sensor response and improve your program (e.g., establish threshold values).

32. Boundary Mapping 

Created field polygon feature using a point-based GPS log.

- Recorded tracks could be downloaded as points, lines or polygons from the GPS receiver.
- Polygon representation of any given area is a powerful tool in landscape management.
- GPS receivers can help define boundary of a targeted area.

33. Surfacing Land Measurements 

Map ground properties using robot-based sensors.

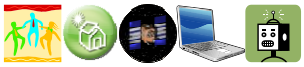
- Sensors can be used to detect surface conditions in different locations of a field.
- It is hard to make measurements everywhere.

- Robots can help make data collection more efficient.
- Data interpolation is needed to determine measured parameter through he field.

34. GPS Event Tracking 

Investigate travel speed and direction history while tracking your teammate.

- *GPS log is more than just a list of geographic locations*
- *Travel speed is distance traveled in a unit of time*
- *Travel velocity includes speed and direction*

35. Mission in Progress 

Remotely control the robot based on real-time GPS positioning.

- *There are many uses for a GPS log*
- *With automated equipment, there is always a chance for things to go wrong*

36. Robotic Navigation 

Send your robot to a complete outdoor mission.

- *For point to point navigation, current position and relative location of the target must be known or, at least, assumed*
- *GPS positioning error causes robot to arrive certain distance away from the target*
- *Obstacles avoidance is a typical navigation issue*