

Knowledge and mission skills representations and development for future AUVs

- Natural Language Programming in a nutshell -

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Warning: Purely MATLAB™ based sEnglish

- ▶ Written early 2010, this talk describes a MATLAB™ GUI based sEnglish authoring and execution system. The latest version of the sEnglish authoring tools has an *Eclipse* front end and is also capable of processing executable papers for journal and web publishing for the next generation of the semantic web.
- ▶ Since this purely MATLAB based software was written a new *sEnglish Publisher* (for authoring and reading executable papers) and the *Cognitive Agents Toolbox 2.01* has been created for intelligent agent programming under Jason+sEnglish.

Outline

- ▶ Principles of natural language programming
- ▶ Declarative programming of systems
- ▶ The deployment phase
- ▶ NLP software demo
- ▶ Conclusion and the future

Why the proposed system in this talk?

- ▶ Software **systems for** realtime control (SRTC) operations that do **sensing/perception processing and definitions in terms of concepts** and diagnostic logic in a simple way **are non-existent** .
- ▶ Conceptual and logic processing systems that computer scientist created by description logic (OWL)/ common logic (CL) for conceptual graphs are **insufficient for engineering applications** that are dominated by feedback control computations and signal processing
- ▶ Existing systems do **not provide an English document** that is a program, an advantage for programmers and users.

1. Principles of natural language programming

Sentence to be interpreted:

Move towards position Pnxt but avoid collisions.

sEnglish codes

Definition of its meaning:

Find your current position P_c . Define Hd as a 'heading direction'. Execute " $Hd = P_{nxt} - P_c$ ";. Detect obstacle position Obst in heading direction Hd. If Obst is empty, then move in heading direction Hd. If Obst is not empty, then do the following. Compute turned heading direction Hds from Hd. Detect obstacle position Obst2 in heading direction Hds. If Obst2 is empty, then move in heading direction Hds. If Obst2 is not empty, then do the following. Compute turned heading direction Hds2 from Hds. Detect obstacle position Obst3 in heading direction Hds2. If Obst3 is empty, then move in heading direction Hds2. Finish conditional actions for second heading. Finish conditional actions for first heading.

Natural language programming?

It has been often said that it is a “dream” but is not possible as natural language is context dependent and ambiguous

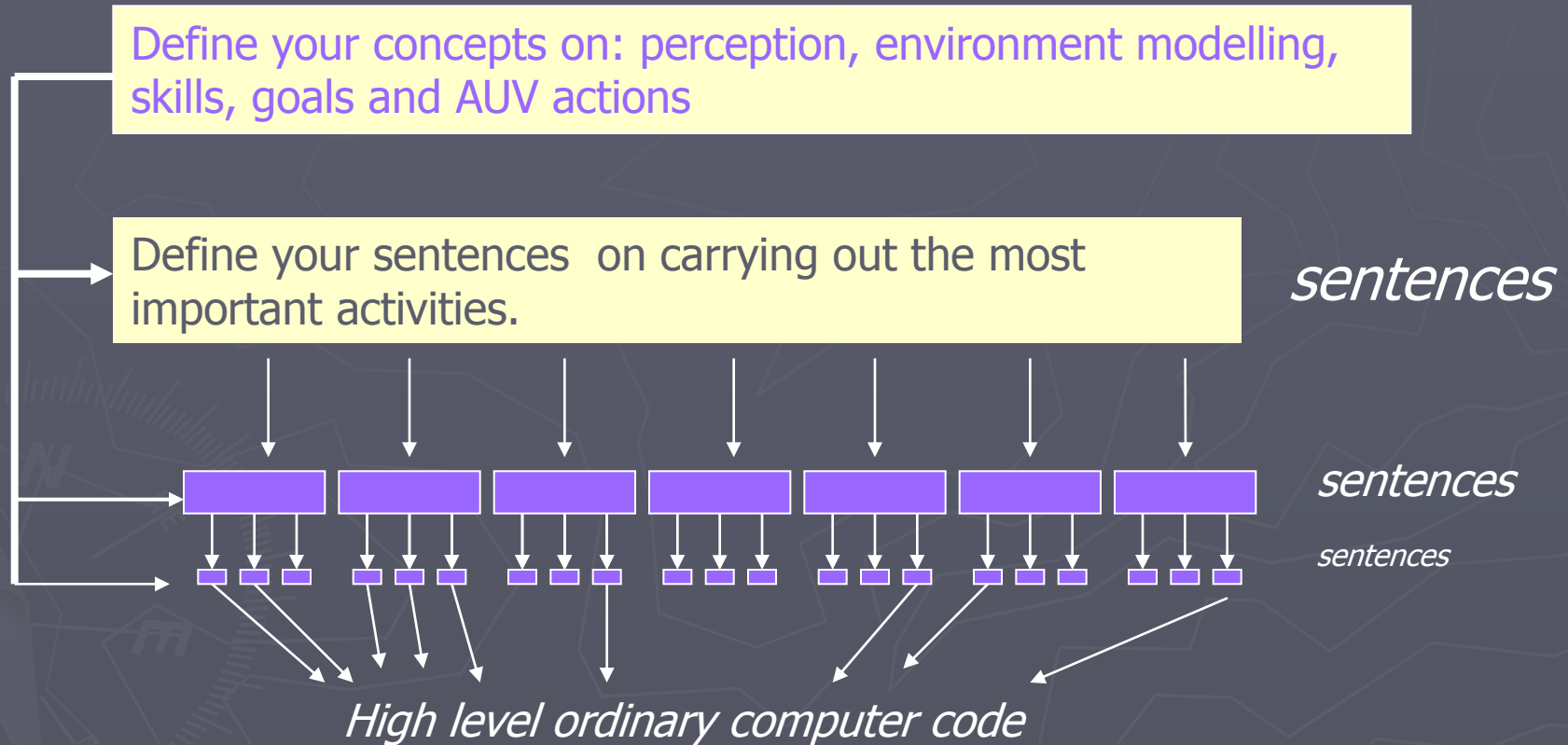
Why would NLP be highly desirable?

It would allow us to combine a manual of a robot with its program.

It would allow the user of the robot to understand how it works.
Less misunderstandings with respect to capabilities.

It would allow programmers to build very well structured, easy to understand, high level and yet very complex robot programs.

How would NLP as programming paradigm work?



Top-down design

Accommodates the human brains design process

Example on a prototype program

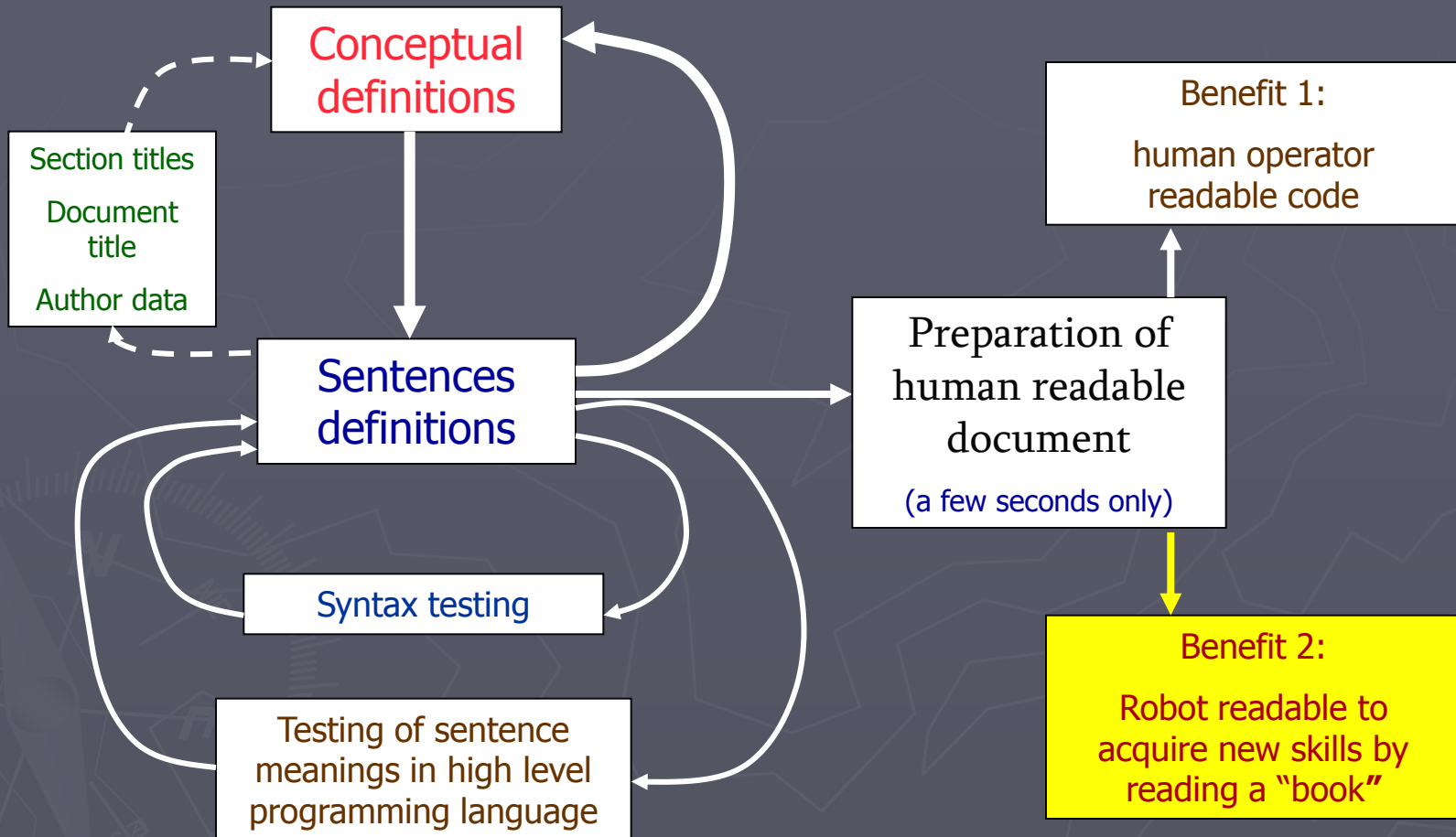
The screenshot displays the sEnglish software interface, which is used for creating and editing ontologies and generating documents. The interface is divided into several windows:

- MOL Ontology Editor:** Shows the ontology structure with various classes and their attributes. The current file is `C:\Program Files\sEnglish t`. The ontology includes classes like `>coordinate system`, `>gps location`, `>quaternion`, `>image sequence`, `>image`, `>image cutout`, `>environmental object`, `>environmental object sequence`, `>>terrain feature`, `>>>hill`, and `>>>plane`.
- sEnglish Sentences Editor:** Shows the document being generated. The title is "On Movement Techniques for Agents" by X. Y. Author, published by The Ultimate Defense Company Inc. The document content includes:
 - 2 Main Actions**
 - 2.1 Moving towards position with collision avoidance**
 - Sentences to use:**
 - Move towards position Pnxt but avoid collisions .
 - Available things are: Pnxt(position) .
 - Details of the meaning:**
 - Find your current position Pc. Define Hd as a 'heading direction'. Execute " Hd = Pnxt-Pc; ". Detect obstacle position Obst in heading direction Hd. If Obst is empty, then move with heading direction Hd. If Obst is not empty, then do the following. Compute turned heading direction Hds from Hd. Detect obstacle position Obst2 in heading direction Hds. If Obst2 is empty, then move in heading direction Hds. If Obst2 is not empty, then do the following. Compute turned heading direction Hds2 from Hds. Detect obstacle position Obst3 in heading direction Hds2. If Obst3 is empty, then move in heading direction Hds2. Finish conditional actions for second heading. Finish conditional actions for first heading.
- Comments & Errors:** Shows a message: "Ontology reading for 'C:\Program Files\sEnglish t'... This ontology was interpreted successfully given below."

How does it work?

The screenshot shows the 'sEnglish Sentences Editor' application. On the left, a list of 'Meaning tags' includes 'detecting obstacle', which is highlighted with a blue box. On the right, the configuration panel for this tag is shown. The 'Meaning tag' is 'detecting obstacle', the 'sEnglish sample sentences' is 'Detect obstacle position Obst in heading direction Hd.', and the 'Available' field is 'heading direction [Hd]'. The 'Resulting' field contains the code: 'Execute "Obst=detect_obstacle_by_infrared(Hd); if norm(Hd-Obs)>2*norm(Hd), Obst=[];end"'. A blue callout box points to this code with the text 'High level code used when no further details are needed' and '- Corresponds to "sub-conscientious" !'. A red callout box points to the 'Test meaning' button.

Summary



Contents

- ▶ Principles of natural language programming
- ▶ **Declarative programming**
- ▶ The deployment phase
- ▶ NLP software demo
- ▶ Conclusion and the future

2. Declarative programming

- ▶ What concepts to use for AUVs?
- ▶ How to declare background information?
- ▶ How to pass on skills?
- ▶ How to declare goal achievement tactics?

What concepts to use for AUVs? (1)

Possible concepts of objects in the environment model:

Seabed terrain formations: flat, hill, road, rocky surface, sand surface, pockmarks, ramp, etc.

Animated objects: humans, other AUVs, human operated ships, etc.

Possible concepts for the environment reference frames:

Environment model frames (granulated, multilevel): GPS frame, earth fixed, body fixes, locality model, region realtime model, immediate vicinity model, own body health model, etc.

What concepts to use for AUVs? (2)

Possible action concepts for AUVs:

Actions: Start mission, plan route, go to location, shoot target, return to base, move erratically, choose target, decide on next committed action, execute committed action, abort committed action, send images to base, send report to command centre, report if fatal injury occurs, etc.

Actions constraints : avoid collision, avoid being exposed-shot, avoid losing power, avoid losing all ammunition, avoid water surface, avoid pits, etc.

Possible goal concepts for AUVs:

High level goal examples: Survey terrain. Cooperate with other AUVs on exploration. Go for mission with goal set G341. Carry out system checks.

Subgoal examples: Take seabed images for mapping. Go to a target area. Return to command centre. Investigate new features found. Report unusual changes to command centre. Return in case of essential malfunction.

1. Why to use environmental concepts?

- ▶ 1.1 To link available terrain models with realtime robot perception
- ▶ 1.2 To enable the robot to model changes in the environment
- ▶ 1.3 To enable the programming engineer to define rules of behaviour in terms of environmental features
- ▶ 1.4 To enable easy definition/alteration of perception processes of the robot by engineers → maintainability

Why to use environmental concepts?

1.1 To connect different resolution models of the environment

sEnglish code example for a sentence:

Identify objects of the locality model.

Its meaning definition by other sentences:

Link global seabed terrain model Gtm. Scan environment using 'MBE' to obtain image sequence Ims. Identify new features Suobs using Ims and sonar wavelet bank Vwb. Build locality model Mloc using Ims and Suobs. Record and send Mloc to command centre Cc2.

Relevant concepts used: global terrain model [Gtm], image sequence[Ims], suspicious targets[Sp], visual wavelet bank[Vwb], locality terrain 3d model [Mloc]

Why to use environmental concepts

1.3 To enable the programming engineer to define rules of behaviour in terms of environmental features

sEnglish code example for a sentence:

Keep yourself to standard survey mission behaviour rules.

Its meaning definition by other sentences:

Continuously inform your command centre Cc2 about new feature positions Enpos. Know all mission relevant terrain maps. Investigate new terrain features Enpos with recognition strength 0.9. Constantly record MBE survey data. Return when power is at ~20%.

Relevant concepts used: command centre[Cc2], feature positions[Enpos], new feature positions[Fpos], target regions[Sp], etc.

2. Why to use predefined goals and subgoals?

- ▶ 2.1 Realtime computational speed limitations: contemplative goal synthesis is time consuming. Predefined goals/sub-goals facilitate realtime decision making.
- ▶ 2.2 Situational decision rules can be formulated in terms of the perceived environmental model features, so can be goals/sub-goals under execution.

Software

- ▶ sEnglish document Authoring Tool:
interactive environment to define data structures for concepts and sentence meanings
- ▶ Reader agents: can read HTML sEnglish document and run sentences
- ▶ Mission agents - can be created by the Cognitive Agents Toolbox – CAT

The screenshot shows the 'sEnglish Sentences Editor' window. The interface includes a menu bar (Files, Meta data, Compile Paper, Tools, Help), a title bar, and a main workspace. The workspace is divided into several sections:

- Meaning tags:** A list of tags on the left, with 'defending compound' and 'patrolling' highlighted by red and blue boxes respectively. A red callout box labeled 'complex goal' points to 'defending compound'.
- Meaning tag:** A text field containing 'defending compound'.
- sEnglish sample sentences:** A text area containing 'Defend military compound Campbase02.' with a 'Test syntax' button below it.
- Available:** A dropdown menu showing 'compound [Campbase02]'.
- Resulting:** A dropdown menu.
- sEnglish interpretation using sentences:** A text area containing several lines of text, with 'Follow Patroute anticlockwise and patrol by engagement rules Engrules.' highlighted by a blue box. A red callout box labeled 'How to achieve it' points to this text.
- Informal English explanation:** A text area.
- Fixed attributes:** Fields for 'M-funcs location' (c:\my_auv_navigation_methods) and 'MOL location' (C:\Program Files\sEnglish Editor & PA\ag\agv.mol).
- Author data:** A text field containing 'S M Veres, July 2008'.
- Web lookup:** A button.
- Buttons:** 'Edit & Test syntax', 'Copy & Paste', 'Formats & M-files', 'Syntax test', 'Test meaning', 'New item', and 'Erase item' are visible.
- Paper sections:** A dropdown menu showing 'Technical Details'.

Self contained meanings

sEnglish Sentences Editor

Files Meta data Compile Paper Tools Help

sENGLISH Binary paper file: C:\Program Files\English Editor & PA\agv3\C:\Program Files\English Editor & PA\agv3\sentences.sebk

Meaning tag: patrolling

sEnglish sample sentences: Follow Patroute 'anticlockwise' and patrol by engagement rules Engrules.

Test syntax

Available: route of patrol[Patroute], quote[U_], engagement rules[Engrules]

Resulting:

sEnglish interpretation using sentences: Start tracking Patroute by feedback loops of 'laserscan, gps' in direction 'anticlockwise'. Start monitoring using 'camera recognition system' and engagement rules Engrules.

Edit & Test syntax

Copy & Paste

Formats & M-files

Syntax test

Test meaning

Informal English explanation:

Fixed attributes

M-funcs location: c:\my_auv_navigation_methods

MOL location: C:\Program Files\English Editor & PA\agv\agv.mol

Author data: S M Veres, July 2008

Web lookup

New item Erase item Paper sections: Technical Details

Meaning tags:

- asking route of patrol
- being in set
- computing nearest position on path
- computing next position on path
- computing turned heading direction
- defending compound
- defining attribute by object
- defining object by attribute
- defining the end position
- detecting obstacle
- determining heading
- executing loop
- exiting loop of tracking
- finding next position on path
- finding own position
- following a path
- going to patrol route
- moving in heading direction
- moving towards position with collision avoidance
- object is empty
- object is not empty
- patrolling
- planning a path
- receiving engagement rules
- starting monitoring process
- starting to track path
- strings being equal
- taking image sequences
- waiting for command
- searching by infrared
- examining selected areas
- applying engagement rules
- inform central command

activity

Further nesting of meanings....

sEnglish Sentences Editor

Files Meta data Compile Paper Tools Help

Binary paper file: C:\Program Files\sEnglish Editor & PA\agv3\C:\Program Files\sEnglish Editor & PA\agv3\sentences.sebk

sENGLISH

Meaning tags:

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- computing nearest position on path
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- taking image sequences
- waiting for command
- searching by infrared
- examining selected areas
- applying engagement rules
- inform central command

Meaning tag: starting to track path

sEnglish sample sentences: Start tracking Patroute by feedback loops of 'laserscan, gps' in direction 'anticlockwise'.

Test syntax

Available: route of patrol[Patroute]. quote[U1_], quote[U2_]

Resulting:

sEnglish interpretation using sentences: Execute in loop the following.
Take image sequences lms from devices U1_
Determine heading H on Patroute in direction U2_ using lms.
Determine next position Pnxt in Patroute in distance ~5m using H.
Move towards position Pnxt but avoid collisions.
If message received is 'stop tracking path' then exit loop.

Edit & Test syntax

Copy & Paste

Formats & M-files

Syntax test

Test meaning

Informal English explanation:

Fixed attributes

M-funcs location: c:\my_auv_navigation_methods

MOL location: C:\Program Files\sEnglish Editor & PA\agv\agv.mol

Author data: S M Veres, July 2008

Web lookup

New item Erase item Paper sections: Technical Details

A (sub-)subgoal definition:

The screenshot shows the 'sEnglish Sentences Editor' window. The title bar includes the application name and standard window controls. The menu bar contains 'Files', 'Meta data', 'Comple Paper', 'Tools', and 'Help'. The main window is divided into several sections:

- Binary paper file:** C:\Program Files\sEnglish Editor & PA\agv3\C:\Program Files\sEnglish Editor & PA\agv3\sentences.sebk
- Meaning tags:** A list of tags on the left, with 'starting monitoring process' highlighted in a red oval. Other tags include 'asking route of patrol', 'being in set', 'computing nearest position on path', etc.
- Meaning tag:** A text field containing 'starting monitoring process'.
- sEnglish sample sentences:** A text area containing 'Start monitoring using engagement rules Engrules and visual wavelet databank Visbank. .'. Below this are buttons for 'Test syntax', 'Available:', and 'Resulting:'.
- sEnglish interpretation using sentences:** A large text area containing the following text:


```
Execute in loop the following.
Do infrared search to spot suspicious target set Sp.
Examine Sp using light beams and cameras to obtain object classifications
CI using visual wavelet databank Visbank.. If 'human object' is in CI, then
apply engagement rules[Engrules] to CI to obtain situation outcomes Out.
Inform central command Cc using Out.
If message received is 'stop moniotring' then exit loop.
```

 This area is circled in red. To its left are buttons for 'Edit & Test syntax', 'Copy & Paste', 'Formats & M files', and 'Syntax test'.
- Informal English explanation:** An empty text field.
- Fixed attributes:** Fields for 'M-funcs location' (c:\my_auv_navigation_methods) and 'MOL location' (C:\Program Files\sEnglish Editor & PA\agv\agv.mol).
- Author data:** S M Veres, July 2008
- Web lookup:** A button.
- Bottom bar:** Contains 'New item', 'Erase item', and 'Paper sections: Technical Details'.

Summary 2

Natural language programming (sEnglish) enables you to **write your sensing, signal processing, perception processes** and optionally also behaviour rules and also (sub-)goals (and how to achieve them) in terms of sentences that the engineer in the field can understand.

It is not tied to any particular agent architecture such as reactive, multilayered or BDI (belief-desire-intention) agents. Any of these architectures can include sEnglish code. In fact natural language programming can be the “flash on the bone” for an agent system, defining interaction with the real world in an understandable way.

Contents

- ▶ Principles of natural language programming
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Deployment phase

sEnglish descriptions of

- (1) Perception processes
- (2) Skills of physical interaction skills
- (3) Skills of planning
- (4) Goal definitions
- (5) Rules of behaviour

Some agent framework

Some hardware platform

UAV Control for Agents

3D Space Understanding for Agents
S M Veres

Planar Geometry for Agents
S M Veres

Learning Methods for Agents
S M Veres

sEnglish for Scientist. This document is understandable by agents that have the sEnglish interpreter and suitable architecture of their memory. To get the details become a member of www.sysbrain.org or read the book Natural Language Programming from amazon.com

sEnglish

Manuals

Documentation for operating personnel = code of operation

Pages of sEnglish papers

On Patrol of Compounds for Agents

X. Y. Author, The Ultimate Patrol Company Inc.
Email: xyauthor@gmail.com

sEnglish for Scientist, Engineers and Agents
This document is understandable by
agents that have the sEnglish interpreter and suitable
architecture of their memory. To get the details become a member of
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C O N T E N T S

1. **Conceptual structures used**
2. **Main Actions and Goals**
 - Defending compound
 - Moving towards position with collision avoidance
 - Starting monitoring process
 - Starting to track path
3. **Technical Details**
 - Applying engagement rules
 - Asking route of patrol
 - Computing nearest position on path
 - Computing next position on path
 - Computing turned heading direction
 - Defining the end position
 - Detecting obstacle
 - Determining heading direction
 - Examining selected areas
 - Executing loop
 - Exiting loop of tracking
 - Finding next position on path
 - Finding own position
 - Following a path
 - Going to patrol route
 - Informing central command
 - Moving in heading direction
 - Patrolling
 - Planning a path
 - Receiving engagement rules
 - Searching by infrared
 - Strings being equal
 - Taking image sequences
 - Waiting for command
4. **Appendix**
 - Being in set

Pages of sEnglish papers

An route of patrol is a special case of environmental feature.

An suspicious target set is a special case of environ terrain feature.

An tree is a special case of environmental object and

An vehicle is a special case of environmental object a

An water surface is a special case of environmental feature.

1.1.1 The special cases of the most significant c

Special cases of animal are human, human commander, and enemy soldier.

Special cases of environmental object are terrain fe human commander, animal, bush, central command, cliff dier, grass, house, military compound, pathway, plane, route of patrol, suspicious target set, tree, vehicle and w

Special cases of human are human commander, cent enemy soldier.

Special cases of signal are measured signal and actua

Special cases of terrain feature are hill, bush, cliff, c military compound, pathway, plane, post, road surface, r picious target set, tree, vehicle and water surface.

1.1.2 Attributes of an actuator signal

An 'actuator signal' has the following properties: its 'actu that is a text, its 'd2a converter' that is a text, its 'actua a text, its 'actuator dynamics' that is a dynamics, its 'syn its 'time axis' that is a number array, its 'data' that is a 'dimension' that is a text, its 'voltage range' that is a te agent' that is a text.

1.1.3 Attributes of an agv

An 'agv' has the following properties: its 'make' that is a that is an equation, its 'actuator signals' that is a set of actuator values' that is a set of double, its 'sensor signa char and its 'current sensor values' that is a set of doubl

2 Main Actions and Goals

2.1 Defending compound

Sentences to use:

Defend military compound Campbase02

Available things are: Campbase02(milit

Details of the meaning:

Ask human commander for route of patrol rules Engrules from human commander. W then do the following. Go to route of pati 'anticlockwise' and patrol by engagement ru

2.2 Moving towards position with

Sentences to use:

Move towards position Pnxt but avoid co

Available things are: Pnxt(position) .

Details of the meaning:

Find your current position Pc. Define Hd cute " Hd = Pnxt-Pc; ". Detect obstacle pos Hd. If Obst is empty, then move in headin empty, then do the following. Compute turn Hd. Detect obstacle position Obst2 in head empty, then move in heading direction Hds do the following. Compute turned heading tect obstacle position Obst3 in heading dire then move in heading direction Hds2. Finish heading. Finish conditional actions for first

2.3 Starting monitoring process

Sentences to use:

Start monitoring using 'camera recogni rules Engrules .

Available things are: U_(quote) , Engrul

Details of the meaning:

Execute in loop the following. Do infrared search to spot suspicious target set Sp. Examine Sp using light beams and cameras to obtain object classifications Cl using visual wavelet databank Visbank. If 'human object' is in Cl, then apply engagement rules Engrules to Cl to obtain situation outcomes Out. Inform central command Cc using Out. If message received is 'stop monitoring' then exit loop.

2.4 Starting to track path

Sentences to use:

Start tracking Patroute by feedback loops of 'laserscan, gps' in direction 'anticlockwise' .

Available things are: Patroute(route of patrol) , U1_(quote) , U2_(quote) .

Details of the meaning:

Execute in loop the following. Take image sequences Ims from devices U1_. Determine heading direction H on Patroute in direction U2_ using Ims. Determine next position Pnxt in Patroute in distance 5m using H. Move towards position Pnxt but avoid collisions. If message received is 'stop tracking path' then exit loop.

Pages of sEnglish naners

3 Technical Details

3.1 Applying engagement rules

Sentences to use:

Apply engagement rules Engrules to Cl to o

Available things are: Engrules(engagement cations) .

Details of the meaning:

Execute code "Out=engage_targets(Cl, En

Resulting things are: Out(situation outcon

3.2 Asking route of patrol

Sentences to use:

Ask human commander for route of patrol

Details of the meaning:

Execute code "Patroute=object_definition_

Resulting things are: Patroute(route of pat

3.3 Computing nearest position on p

Sentences to use:

Compute nearest position Np on path Pth

Available things are: Pth(path) .

Details of the meaning:

Define Tr as the 'track' of Pth . Find your Np as a 'position' . Execute "Np=get_nearest_

Resulting things are: Np(position) .

3.4 Computing next position on pat

Sentences to use:

Determine next position Pnxt in Patroute

5 Data formats

5.1 The special data types of and text with constraints

'classifications' which is an cell array .

'current position' which is an array

'environmental object sequence' wh

'equation' which is text .

'gps location' which is text .

'heading direction' which is an arra

'image' which is a int8 .

'image sequence' which is an cell ar

'matlab code' which is text .

'number' which is an array of numb

'object classifications' which is an c

'obstacle position' which is an array

'perception data' which is an cell an

'physical quantity' which is text .

'position' which is an array of numl

'quaternion' which is an array of nu
 $length(x)==4$.

'quote' which is text .

'situation outcomes' which is an cel

'visual wavelet databank' which is a

4 Appendix

4.1 Being in set

Sentences to use:

The 'string' is in Messages .

Available things are: U_(quote) , Messages(*) .

Details of the meaning:

Execute "B=ismember(U_,Messages);"

Resulting things are: B(relation Boolean) .

4.2 Defining attribute by object

Sentences to use:

Define the 'something' of Object by Another .

Available things are: U_(quote) , Object(*) , Another(*) .

Details of the meaning:

Execute "Object=setfield(Object,U_, Another);"

Resulting things are: Object(*) .

4.3 Defining object by attribute

Sentences to use:

Define Obj as the 'attribute' of Obj2 .

Available things are: U_(quote) , Obj2(*) .

Details of the meaning:

Execute "if isfield(Obj2,U_) , Obj=getfield(Obj2,U_);else Obj=[];end"

Resulting things are: Obj(*) .

4.4 Object is empty

Sentences to use:

Obs is empty .

Available things are: Obs(*) .

Details of the meaning:

Summary

- ▶ The signal processing of sensing and action procedures of robotic engineering systems can be programmed in natural language in sEnglish – the logic of the system is left to agent programming – there is sEnglish to Jason/Agentspeak interface via the Cognitive Agents Toolbox
- ▶ In the deployment phase this provides users with some advantages for creators and operators:
 - (1) better understanding of capabilities and limitations of operation
 - (2) maintenance and upgrades become easier for engineers

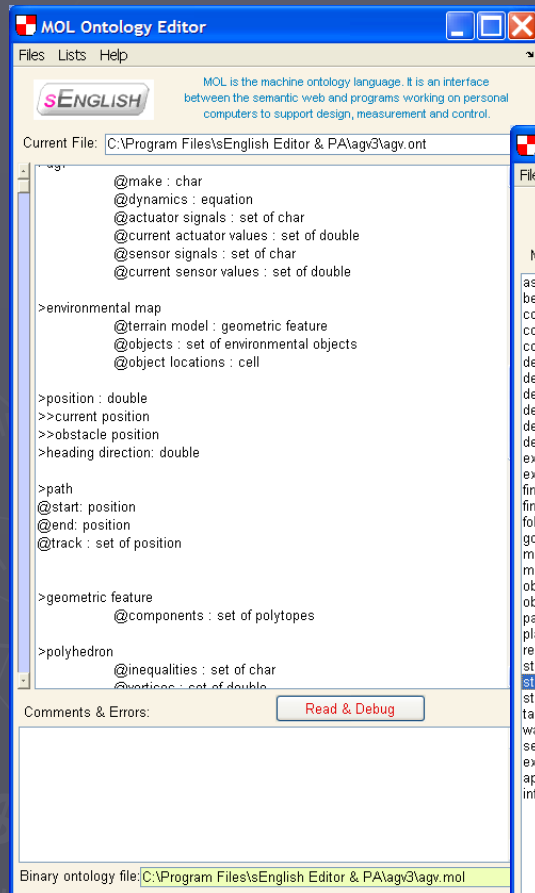
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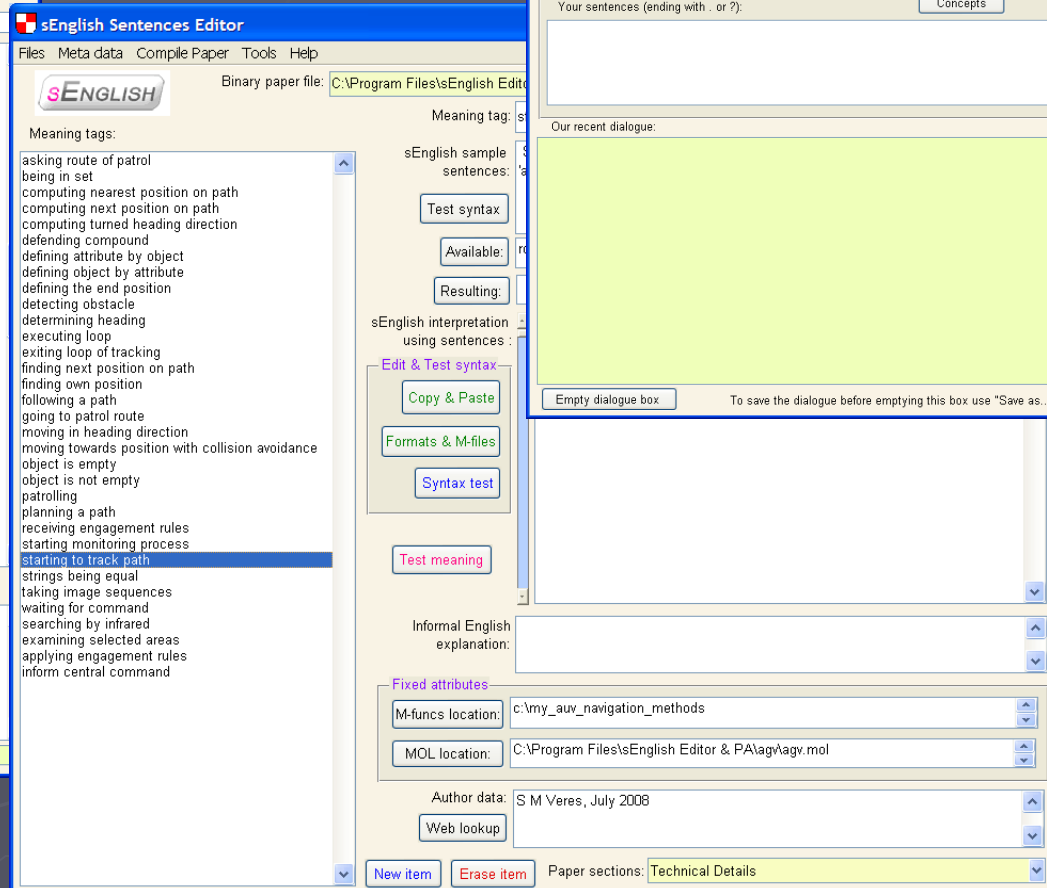
NLP software demo

A prototype sEnglish programming environment and document compiler + personal assistant

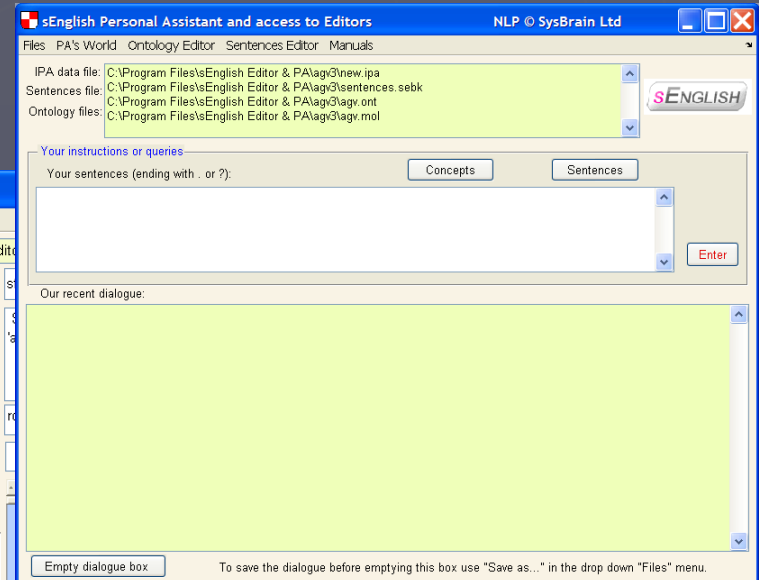
Ontology editor



Sentences editor



Host program (personal



NLP software demo

sEnglish to MATLAB compiler

meta data

Author data: S M Veres, July 2008

MOL location: C:\Program Files\sEnglish Editor & PA\ag\tag

M-functions location: c:\my_auv_navigation_methods

Transfer these to all sentences

compile sEnglish paper .tex file

sEnglish to MATLAB

1. Test & Compile All Sentences to MATLAB Done

Progress:

Put M-files into Appendix

Produce Index from meaning tags

Paper title: On the for Agents (...)

Author(s) data: X. Y. Author
... Institution/Company address,
Email: xyauthor@googlemail.com

Filename to save book to: *.tex

Results: 2. Produce Paper .tex file

Document LaTeX compiler (for PS/PDF)

NLP demo in action ...

- Show the **ontology window and explain some of the notations** and basic classes in the high level language – demonstrate ontology compilation.
- Explain the **parts of the Sentences Editor** and illustrate syntax testing, compilation to high level code
- **Demonstrate compilation** of all sentences as they hang together
- Demonstration of **producing a HTML/LaTeX documents**, going back to the editor and showing how sentences are associated with **readable sEnglish document sections**. Activities represented by sentences becoming subsections of the document.
- **Show the precompiled PDF** document with all its parts.

Contents

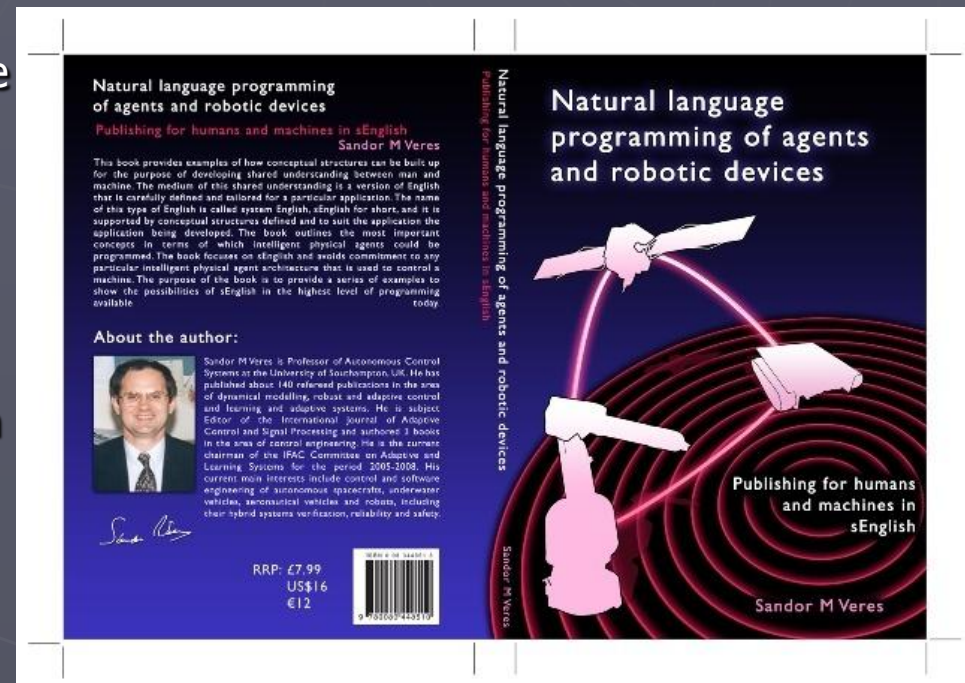
- ▶ Principles of natural language programming
- ▶ Declarative programming
- ▶ The deployment phase
- ▶ NLP software demo
- ▶ **Conclusion and the future**

Conclusions and the future

Conclusions

- ▶ **sEnglish directly links sentences with meanings** (in terms of executing some code) unlike other controlled natural languages which first compile into logic that still needs to link to a "world model" first for its meaning.
- ▶ Its advantages are that it **clarifies the operations of robots** for programmer teams and users alike
- ▶ It is applicable to various existing agent architectures, **it does not prescribe or constrain agent decision making procedures.**
- ▶ A prototype **natural language programming environment** has been created. It demonstrated that it is potentially applicable to AUVs
- ▶ It is currently working with MATLAB but its compilation method **can be extended to other high level languages (ADA, Python, C++, Simpol)**

A book is available:



Available on [amazon.co.uk](https://www.amazon.co.uk) –
£14.99