

On-Board Applications Development via Symbolic User Interfaces

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Key Words

**Human-Computer Interaction; On-board Application Development;
Robot Operating Systems; Embedded Applications**

Design Features of becerik

- **objective**: software development **on-board** of a robot
 - **development approach**: hardware-software **co-design** of a robot
 - **advantage**: no separate computer required
- **development concepts**: components
 - **compound application**: collection of applications
 - **application**: sequence of commands
 - **command**: functional **graphical** symbol, without text

Application Management Features of becerik

- **managing**: saving, listing, loading, running applications
- **developing**: editing an application/compound application
- **interpreter**: no compilation
- **multi-tasking**: quasi-parallel execution of one compound application
 - **scheduling**: round-robin on one symbol per application

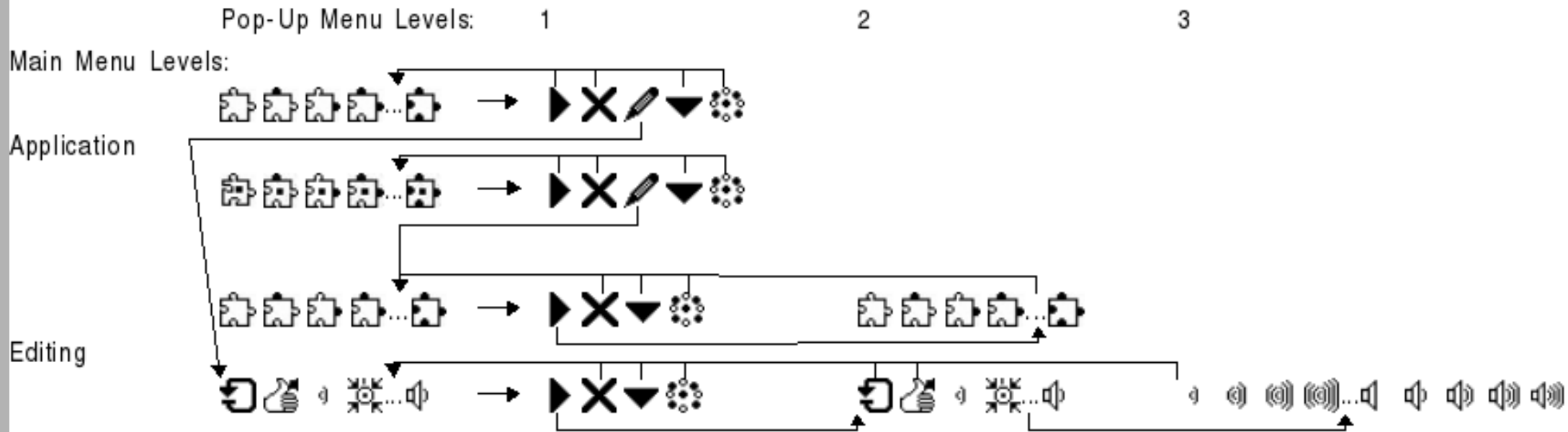
Programming Features of becerik

- **programming approach**: functional primitives
 - **programming primitives**: sensing; computing; acting
 - **robot behaviour**: reactive
- **language**: graphical symbol alphabet
 - **advantage**: independent from natural languages
 - **pre-school level**: supports language & literacy development






Display Design of becerik User Interface

Operating System Status Bar										8	64	
Gap										4		
Symbol Row	1									16		
	Gap									2		
	2									16		
	Gap									2		
	3									16		
Symbol (S)/Gap (G)		S	G	S	G	S	G	S	G	S		
		16	5	16	5	16	5	16	5	16		
		100								Pixel		



Flow of Control Between Menu Options







Generic Operation Symbols

	New object
	Delete object
	Load object
	Save object
	Run all loaded applications and compound applications



Application Management Symbols

	Application 0, 1, 2, 3, ..., 15
	Compound application 0, 1, 2, 3, ..., 15






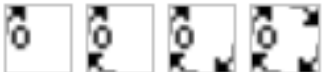
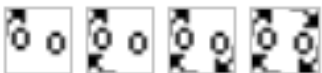
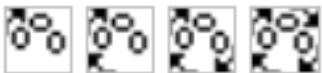
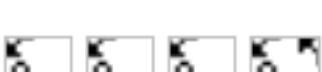
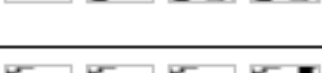
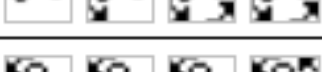
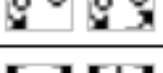

Sensor Command Symbols

	Touch
	UltrasoundVeryLow, Low, High, VeryHigh
	LightVeryDim, LightDim, LightBright, LightVeryBright
	SoundVeryLow, SoundLow, SoundHigh, SoundVeryHigh

Computer Command Symbols

	Loop
	WaitVeryShort, WaitShort, WaitLong, WaitVeryLong

Actuator Command Symbols

	ForwardVeryFast, Fast, Slow, VerySlow
	BackwardVeryFast, Fast, Slow, VerySlow
	TurnRightSlightly, Half, Full, BackHalf, BackFull
	TurnLeftSlightly, Half, Full, BackHalf, BackFull
	Stop forward, backward, turn motors
	MotorARightVerySlow, Slow, Fast, VeryFast
	MotorBRight VerySlow, Slow, Fast, VeryFast
	MotorCRight VerySlow, Slow, Fast, VeryFast
	MotorALeftVerySlow, MotorALeftSlow, MotorALeftFast, MotorALeftVeryFast
	MotorBLeftVerySlow, Slow, Fast, VeryFast
	MotorCLeftVerySlow, Slow, Fast, VeryFast
	BulbDim, BulbBright
	VolumeVeryLow, VolumeLow, VolumeHigh, VolumeVeryHigh

BNF of the Programming Language becerik

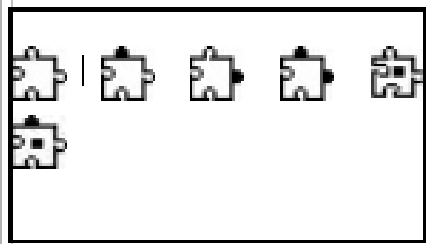
becerikProgramme ::= application | compoundApplication

compoundApplication ::= application compoundApplication

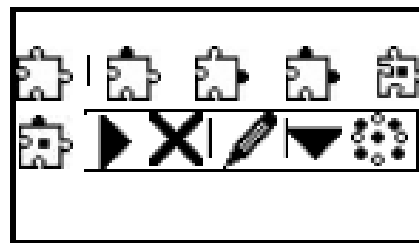
compoundApplication ::= application | application Loop application

**application ::= sensorCommandSymbol application |
computerCommandSymbol application |
actuatorCommandSymbol application | ϵ**

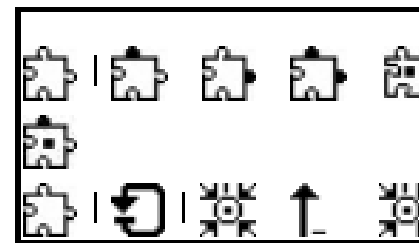
Sample User Interface Scenarios: Application Level



(a)



(b)



(c)



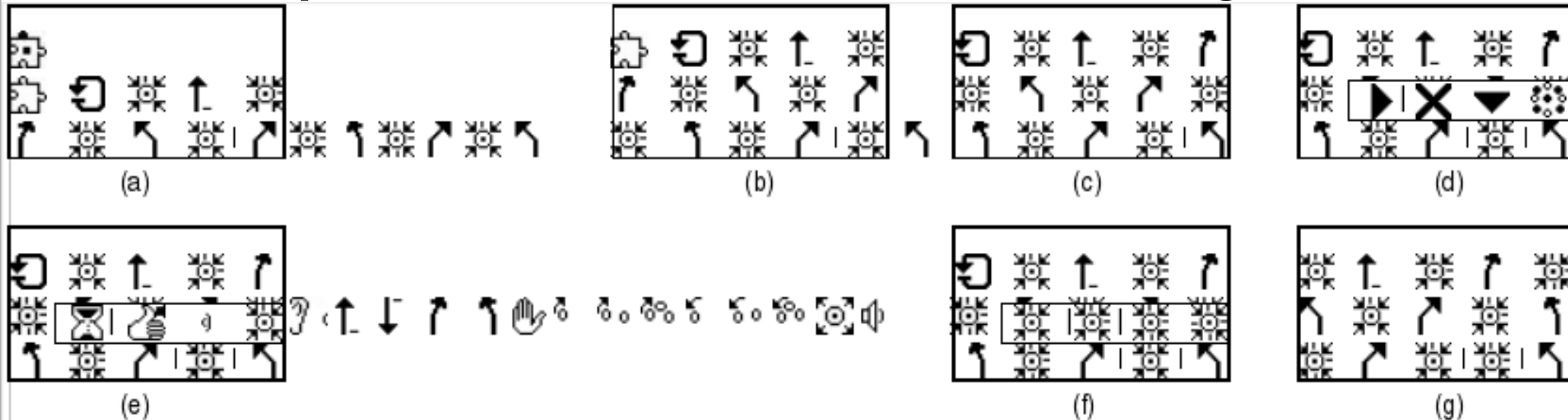
Loading sample line-following application 0 

(a) available applications 0, 1, 2, 3 and compound applications 0, 1

(b) pop-up menu for application 0

(c) first 4 commands of application 0 loaded in row 3 of display.

Sample User Interface Scenarios: Editing Level



Editing sample line-following application 0 

(a) first 9 commands visible in rows 2 and 3 of display

(b) after scrolling 5 times, one command symbol remains invisible

(c) after scrolling, all 15 commands of application 0 visible on display

(d) pop-up menu for current command

(e) first 4 commands of pop-up window visible on display

(f) all commands of new pop-up window for light sensor

(g) after inserting command LightDim from pop-up window.

Conclusion

- **programming**: interactive hardware-software **co-development**
- **child education**: pre-school development of programming skills