

Transregional Collaborative Research Center 28 "Cognitive Automobiles"

established by the Deutsche Forschungsgemeinschaft

Technische Universität München



Interfaces for Integrating Cognitive Functions into Intelligent Vehicles

Matthias Goebl and Georg Färber {goebl,faerber}@rcs.ei.tum.de

Cognitive Functions

- Intelligent behavior requires a large set of cognitive functions
- Challenges in the integration process:
 - Every function needs several software modules
 - Interdependencies between different modules
 - Software contributed by different (groups of) developers

Simulation and Logging

- RTDB-Recorder logs all (selected) data and changes
 - Enhanced AVI (any size)
 - Videos play everywhere
 - Speed optimized (>40MB/s)
 - Precise timestamp (1 ns)

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VI four character code (fcc) "RTDB"									
VI chunk size									
bsolute timestamp (64 bit)									
dentifier of affected object (OID, valid only within the recorded RTDB)									
og entry type ADD, DELETE, REFRESH, UPDATE, UPDATE–IMAGE, ERROR }									
og type determined data	a block 🚽								
object meta data	objec	t data	image o	hiert header					

- Deployment to several vehicles
- Manageable interfaces essential for successful collaboration:
 - Transparent communication for easy debugging
 - Clear design for fast comprehension
 - Stability and easy handling provides maximum benefit



Interfaces for Integration

Automotive industry: Busses (CAN, FlexRay, AUTOSAR VFB,...)

- Transient information, limited bandwidth, serialization, static
- Robotics: Frameworks (OROCOS, Corba, Carmen, CLARAty,...)
 - Sizeable functionality, often component design according to

- Tools to cut or filter logs

Standard AVI image chun

- RTDB-Player replays (selected) events into (another) RTDB
 - Offline analysis of (raw) data, timing, results, activity, runtime
 - Mounting position and configuration of sensors in database
 - No difference for connected modules in replay and simulation
 - Evaluation of different algorithms



- programming paradigm, big libraries, intensive occupation
- Cognitive Automobiles: Lightweight fast data based approach
 - Acceptable to distinct research areas (AI, CV, EE, ME, ...)
 - Database with unified interface as central information hub
 - Publication of all available qualitative and quantitative data
 - Situation awareness gain from consistent information pool
- Real-Time Database for Cognitive Vehicles (KogMo-RTDB):
 - Used as outer integration framework
 - Easy specification of data structures in RTDB objects
 - Hard real-time capable, integrates also non real-time (GUIs,..)
 - API: insert, update, search, retrieve, wait for, delete object
 - Efficient implementation (update:8.3µs retrieve:4.6µs IPC:29.6µs)
 - Utilizes "cluster-in-a-box" hardware platform (multicore/HT)
 - Absolute timestamps to guarantee a consistent view
 - Data history preserved for specified time
 - Lock-less isolation between real-time and non-rt modules
 - Consistent view for knowledge processing with lower cycles
 - Sensor data association and interpolation

Integration and Results

- Successful application in several vehicles and at DARPA UC
- Reference platform (close specification for binary compatibility)
- Definition of modules sets for each individual vehicle
- Configuration for road following with an active camera platform:
- Video timestamp used to retrieve matching gaze direction from history
- All camera parameters available
- Video annotations in separate object, GUI shows overlay:





Real-time watchdog monitors and controls system via RTDB

• RTDB on embedded system (ARM,266MHz,32/8MB RAM/Flash)

	Object Type	Size	Update	n	Bandwidth	History	Memory
	Vehicle Status	100 Bytes	250 Hz	1	0.024 MB/s	10s	0.238 MB
-	Vehicle Command	96 Bytes	25 Hz	1	0.002 MB/s	10s	0.023 MB
	Platform State	60 Bytes	10 Hz	1	0.0005 MB/s	10s	0.006 MB
	Platform Command	68 Bytes	2 Hz	1	0.0001 MB/s	10s	0.001 MB
	Camera Ext.Cal.	76 Bytes	10 Hz	1	0.0007 MB/s	10s	0.007 MB
	Camera Image	307248 Bytes	33 Hz	4	9.669 MB/s	5s	48.347 MB
23	Lane Parameters	184 Bytes	33 Hz	1	0.006 MB/s	10s	0.058 MB
	Lane Visualization	388 Bytes	33 Hz	1	0.012 MB/s	10s	0.122 MB
	IMU/GPS Position	328 Bytes	10 Hz	1	0.003 MB/s	10s	0.031 MB
	LIDAR(Sick)	3008 Bytes	37.5 Hz	0	0.108 MB/s	5s	0.538 MB
	Velodyne HDL-64	1280124 Bytes	10 Hz	0	12.208 MB/s	5s	61.041 MB
	Process Status	76 Bytes	depends			10s	
	Total sum				\approx 38.73 MB/s	10s	≈193.874 MB

Xscale board with RTDB Data rates of an example RTDB recording and memory use

Univ.-Prof. Dr.-Ing. Georg Färber Technische Universität München Lehrstuhl für Realzeit-Computersysteme

