

Paparazzi - The Free Autopilot: Scientific Usage

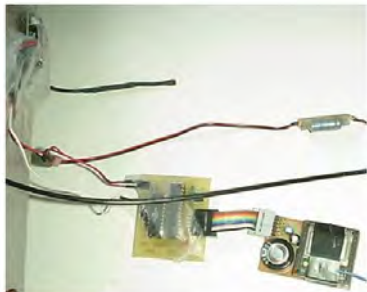
Martin Müller (MME) / Antoine Drouin (ENAC)

COST Workshop March 2011





2003







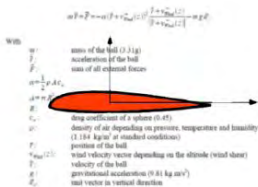
2004





2005

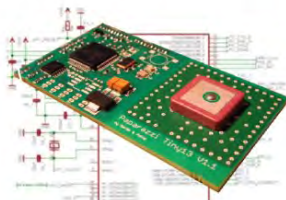




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100 // ...

```





2006





2007



2008





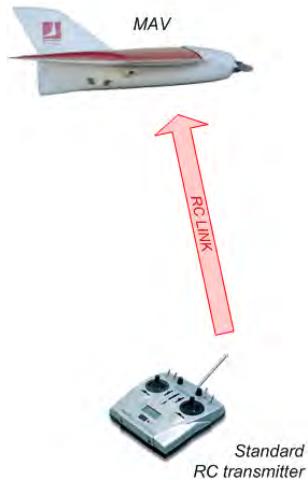
2009



What is Paparazzi



What is Paparazzi



What is Paparazzi

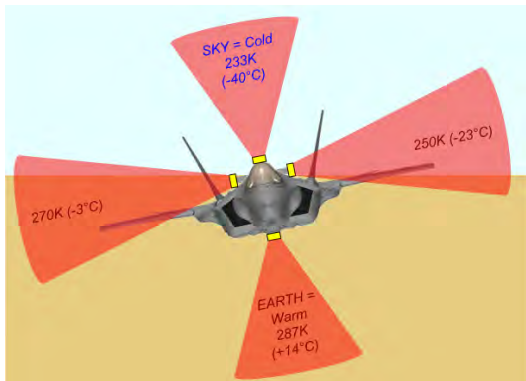
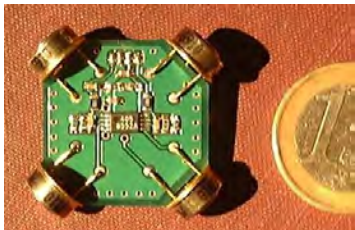


What is Paparazzi





Infrared Sensors (thermopiles)

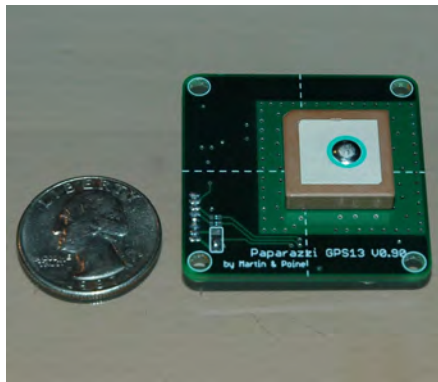
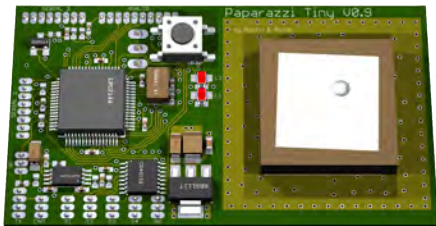


Inertial Measurement Units (IMU)





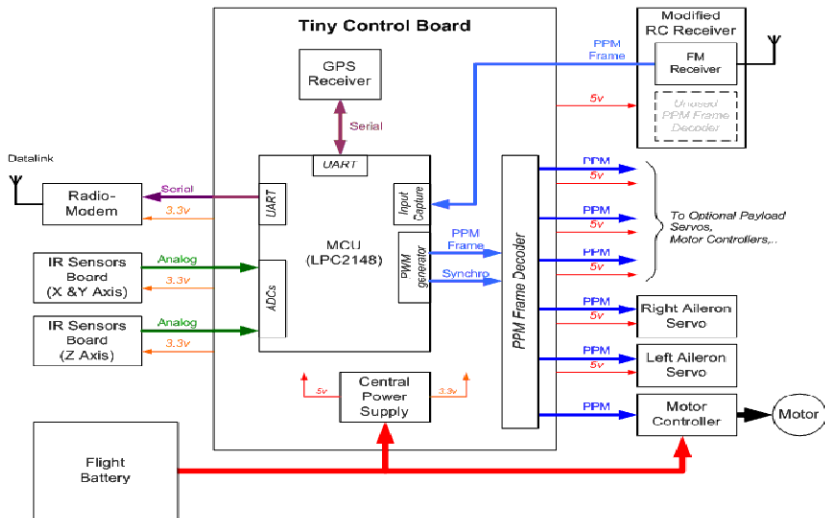
GPS





Modems

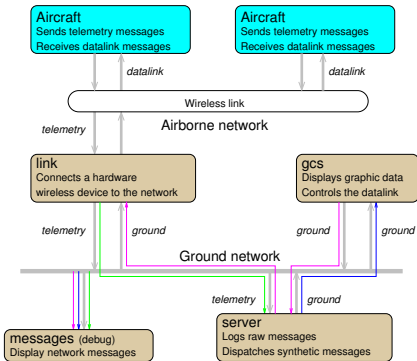






Multi Agents

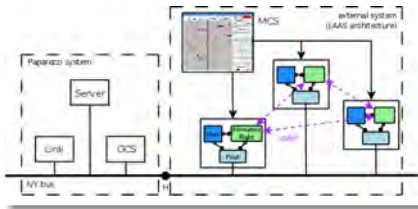
- Small programs performing small well defined tasks
- Flexibility for development
- Ease of connection with other systems
- Flexibility of operation





Multi Agents

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Multi Agents

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- Flexibility of operation





- 1 **gp2y** Sharp GP2Y1010AU0F particle sensor
- 2 **dpicco** IST DigiPicco humidity sensor
- 3 **hih** Honeywell HIH-4030 humidity sensor
- 4 **sht** Sensirion SHT75 humidity sensor
- 5 **mlx** Melexis 90614 infrared radiation sensor
- 6 **temt** Vishay TEMT6000 ambient light sensor
- 7 **lm75** National LM75 temperature sensor
- 8 **temod** Hygrosens TEMOD-I2C-Rx temperature sensor for PT1000
- 9 **tmp102** Texas Instruments TMP102 temperature sensor



- 1 **enose** TGS822 chemical sensor
- 2 **adc** driver for airspeed sensor based on analog voltage
- 3 **ets** Eagle Tree Systems airspeed sensor
- 4 **srf08** Devantech Ultrasonic Range Finder SRF08
- 5 **bmp** driver for Bosch BMP085 pressure sensor
- 6 **ets** Eagle Tree Systems pressure sensor
- 7 **MS5534A** Intersema MS5534A pressure sensor
- 8 **scp** VTI SCP1000 pressure sensor
- 9 **micromag** PNI Micromag magnetic sensor



- 1 **digital cam** shoot/zoom/on/off/take pictures at regular intervals
- 2 **cam** pointing of a simple camera (servo for tilt, heading for pan)
- 3 **cam roll** roll camera
- 4 **drop** drop mechanism
- 5 **light** control blinking speed of the LEDs for night flights
- 6 **formation** formation flight control for fixed-wing aircraft



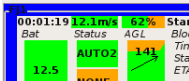
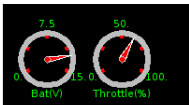
- 1 payload data collection
- 2 timestamping
- 3 logging

example message definition

```
<message name="HIH_STATUS" id="96">  
  <field name="humid" type="uint16"/>  
  <field name="fhumid" type="float" unit="rel_hum"/>  
  <field name="ftemp" type="float" unit="deg_celsius"/>  
</message>
```

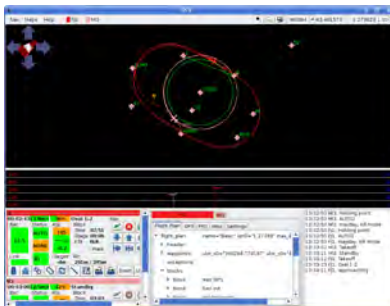
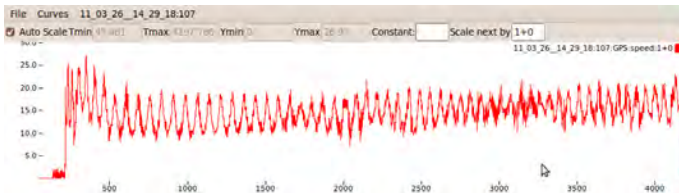
Live data through autopilot or extra measurement computer

Messages	
telemetry:161	
ALIVE	uint8 mode (byte_mask): 3
ATTITUDE 1	int32 utm_east (cm): 36025490 (360254.900000m)
BAT	int32 utm_north (cm): 481359212 (4813592.120000m)
CALIBRATION	int16 course (decideg): 699 (69.900000deg)
COMMANDS	int32 alt (cm): -331 (-3.310000m)
DESIRED	uint16 speed (cm/s): 0 (0.000000m/s)
DL_VALUE	int16 climb (cm/s): -4 (-0.040000m/s)
DOWNLINK	uint16 week (weeks): 0
ENERGY	uint32 itow (ms): 111737720
ESTIMATOR	uint8 utm_zone : 31
FBW_STATUS	uint8 gps_nb_err : 0
GPS 1	
GPS_SOL	
IR_SENSORS	
NAVIGATION	
NAVIGATION_REF	
PPRZ_MODE	
SVINFO	
WIND_INFO_RET	
WP_MOVED	



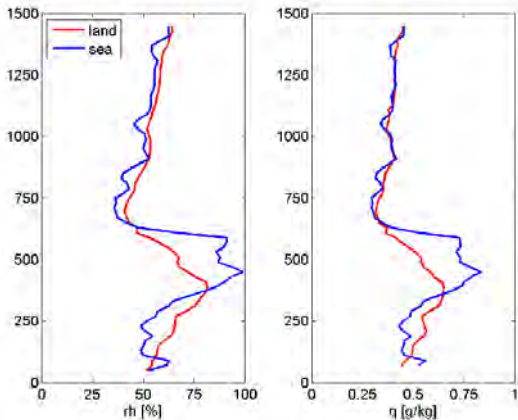


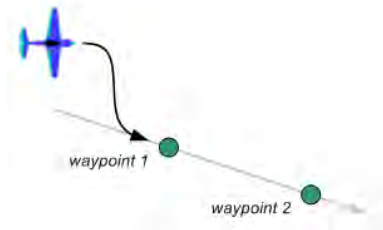
Live or recorded data analysis, replay

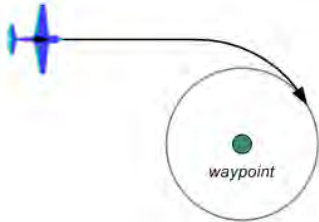
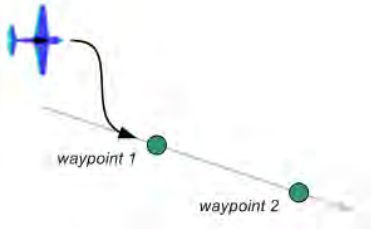


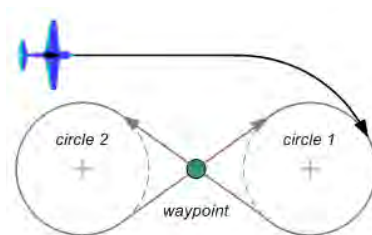
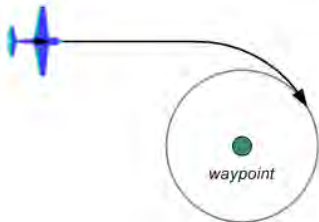
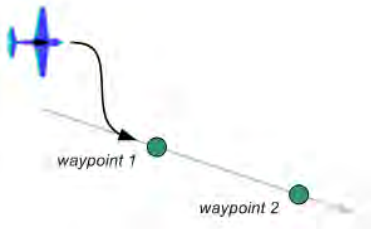


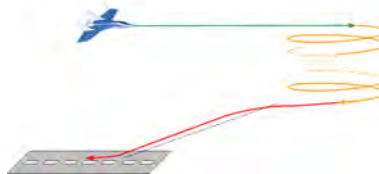
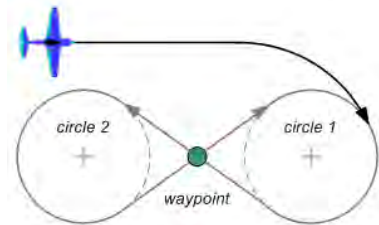
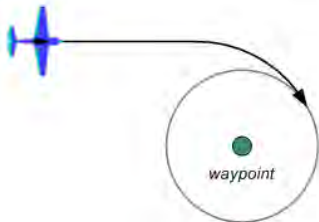
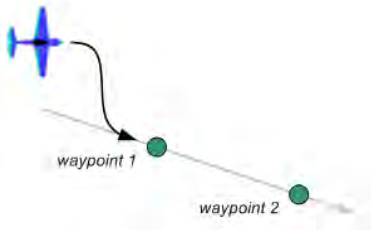
Import data to data analysis tools

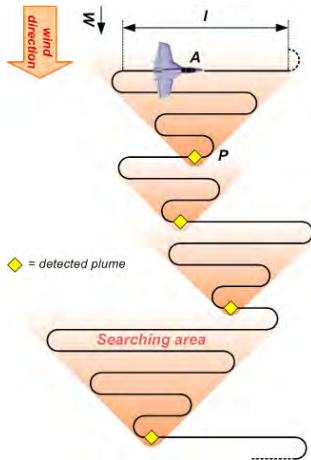














The more you can program, the less you have to control

The system provides a way to automate a mission

Control, Statements, Expressions, exceptions...

```
<for var = "i" from = "1" to = "5">  
  <circle wp = "HOME" radius="75"  
    alt = "ground_alt+50*$i"  
    until = "stage_time>60" />  
</for>
```

```
<exception cond="time_since_last_datalink > 22"  
  deroute="Standby"/>
```

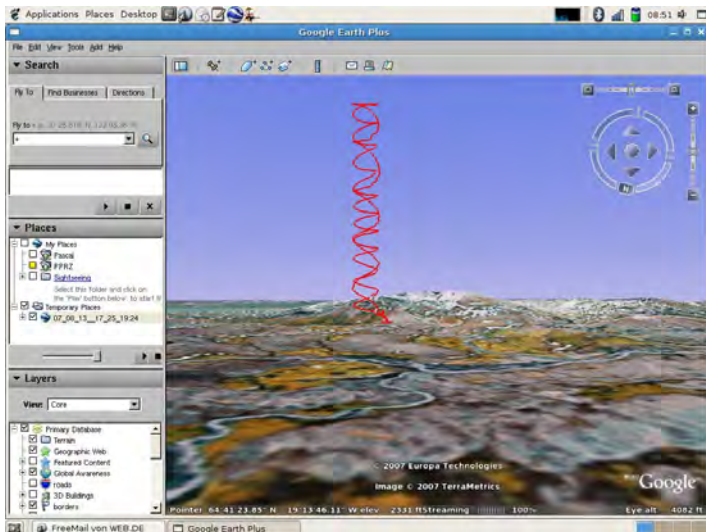


A Versatile Graphical User Interface



GCS using Google, Microsoft, OpenStreetMap or own maps

The screenshot displays the Paparazzi Ground Control Station (GCS) interface. At the top, a window titled 'GCS' shows a 2D aerial map with various colored markers and flight paths. A red box highlights a specific area on the map, labeled '2D Map'. Below the map, there are two status windows for T1 and T2. The T1 window shows '00:00:35 11.8mcs 81% Standby' and '12.5 HOHE +0.3'. The T2 window shows '00:00:28 82.1mcs 85% Standby' and '12.5 HOHE +0.6'. To the right, a 'Notebook' window displays a circular gauge with a needle pointing to approximately 10, and a 'Console' window shows a list of system messages and timestamps.





- 1 look into the source
- 2 you can change whatever is needed to suit your requirements
- 3 add sensors easily
- 4 other open source autopilots or parts can be included



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📄 57 📄 40

Source Commits Network Pull Requests (3) Issues (21) Graphs Search across


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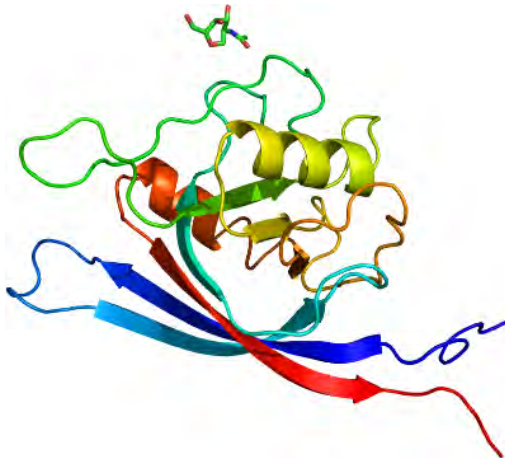
paparazzi / Commit History 

2011-03-27

 flor (author) about 7 hours ago	add settings_arch for sim, and add it to rotorcraft sim	commit 3c2647da9c1289c775b tree 59447a7f9b2a89d47196 parent 5854870448a143ac1d
 flor (author) about 12 hours ago	removed manual assignment of uart VIC slots for ipc based rotorcrafts, default assignments in uart arch used	commit 5854870448a143ac1d tree 70c2b943498b839a6c5f parent 0b981a18199e67520c29
 flor (author) about 12 hours ago	update airframe file	commit d8e1a167b89a370c53 tree 849979a24929405a0c17 parent 0b981a18199e67520c29
 flor (author) about 13 hours ago	updated info on vic slots	commit 82a64f258f6aa6384e tree 99812aa1d096b8a2517 parent 385ad189e67520c29

2011-03-26

 flor (author) 1 day ago	updated info about VIC slots on rotorcraft after changing some	commit 399e647728794c99329 tree 70c2b943498b839a6c5f parent 6899e647728794c99329
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- 1 large user base
- 2 created/tested/used over a long period of time
- 3 affordable
- 4 absolute versability
- 5 proven to work in harsh environments
- 6 commercially available



- 1 tell others you do so
- 2 share code and hardware, let the "open source" community find bugs and improve
- 3 publish early, adapt to coding styles/architectural layout
- 4 discuss with others : wiki, mailing list, irc, skype
- 5 better implement it once good than multiple times bad, don't reinvent the wheel
- 6 it is not rocket science



<http://paparazzi.enac.fr>