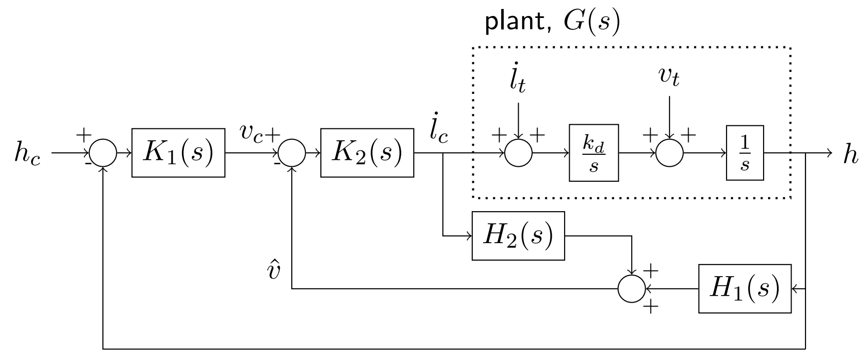
# Overview

Lasanga consists of two nested feedback loops, an outer loop that tracks an altitude and commands a velocity, and an inner loop that tracks a velocity and commands a change in lift. A block diagram of the idealized system is shown below[1]




| | |
|---|---|
| $K_1(s) = K_h$ | proportional altitude loop compensator |
| $K_2(s) = K_v$ | proportional velocity loop compensator |
| $H_1(s)$ | veloctiy estimator, lowpass filter on derivative of position |
| $H_2(s)$ | integration with decay (estimate of effect of actions, decays to 0 over time) |
| $h_c$ | commanded altitude (set by Flight Controller) |
| $v_c$ | commanded velocity (output of position loop) |
| $\dot{l}_c$ | commanded change in lift per unit time (output of velocity loop) |
| $\dot{l}_t$ | atmospheric disturbances that change balloon lift (heating/cooling) |
| $v_t$ | atmospheric disturbances that change balloon velocity (turbulence) |
| $\hat{v}$ | estimate of velocity |
| $h$ | actual balloon altitude |

Figure 1: Idealized system block diagram

"Plant" or $G(s)$ refers to the *system* (atmosphere + balloon) dynamics, whereas everything else represents the control feedback structure that is computed in the ValBal flight code.

[1] For those without much control background: block diagrams represents the structure of a control system. Each block represents some kind of system with inputs and outputs. Each solid line with an arrow on it represent a value and show how outputs of some blocks are connected to inputs of others. Circles represent adding or subtracting, (the +/- sign where the arrow enters the circle indicates which) while blocks represent *transfer functions*. Transfer functions are linear systems represented in the Leplace domain. Without going into too much detail, a simple Transfer function $K(s) = 5$ ($s$ is the variable in the Laplace domain) is simply scalar multiplication by 5. $K(s) = 1/s$ represents integration of a value, and $K(s) = s$ represents the derivative of a value.

# Constants Definitions

| Contstant | Default | Description |
|---|---|---|
| `freq` | 20 | frequency that the controller is called at (Hz) |
| `k_v` | 1e-3 | velocity Gain |
| `k_h` | 1.5e-3 | altitude Gain |
| `b_dldt` | 6e-4 | lift rate of ballast actions (kg/s) |
| `v_dldt` | 3e-3 | lift rate of valve actions (kg/s) |
| `b_tmin` | 5 | minimum ballast interval (s) |
| `v_tmin` | 5 | minimum valve interval (s) |
| `h_cmd` | 13000 | commanded altitude (m) |
| `kfuse` | 7 | atmosphere gain for velocity estimator |
| `kfuse_val` | 0.5 | velocity estimator gain modifier for valve |
| `ss_error_thresh` | 750 | error tollerance for deadband (m) |