The absolute value of this transfer function is indicated in the upper part of Fig. 10, its phase (or argument) in the lower part. The transfer function has a zero point at $\omega = 0$, since here $z = 1$.

Fig. 9B illustrates schematically a concrete embodiment of the control loop illustrated schematically in Fig. 9A according to the prior art. In particular, the digital/analog converter 10 comprises two root calculators 12 and 14, which calculate the roots $\sqrt{f+\frac{F}{2}}$ and $\sqrt{f-\frac{F}{2}}$ and convert them into analog control signals 16, 17. In squaring units 18 these roots are squared again and thereafter the difference is formed in order to generate the quantized signal F_Q that constitutes a scaled copy of the force generated at the sensor.

As described with respect to Fig. 9A, therefrom the error E is determined in the comparison unit 20, is stored in the register 30, and is subtracted in the next sampling step by the subtractor 40 from the input signal F.

Due to the zero point at $\omega = 0$ this setup is particularly suited for sensors whose elements are operated at a nearly constant or only slowly varying signal (i.e. $\omega \approx 0$). However, this is only the case for some sensors.

In particular, as described above, for rotation rate sensors the reset force has an oscillation behavior having a specific operation or angular eigenfrequency ω_0. Then, the rotation rate sensor has to be operated also with a frequency significantly different from zero. As illustrated in Fig. 10 the transfer function G_E of the quantization error E is unequal zero for such frequencies. This means that in these regions one has to assume large errors due to quantization effects. This leads to an imprecise control of the sensor and hence to a limitation of the precision of the sensor.

Embodiments of the invention provide a device and a method for processing residual values that does not have quantization errors at an operation and/or resonance angular frequency ω_0 of a sensor to be controlled.

According to a first aspect of the present invention, there is provided a device for controlling a sensor, comprising a converter unit for converting an input signal into a control signal for controlling the sensor; a comparison unit for determining a difference signal that indicates the difference between the input signal and the control signal; and a control unit for controlling the input signal by means of the difference signal, wherein the control unit generates a transfer function of the difference signal by processing the difference signal and by feeding back the processed difference signal to the input signal; the transfer function of the difference signal has a zero point at an operating frequency of the sensor; and the operating frequency is different from zero.

According to a second aspect of the present invention, there is provided a method for controlling a sensor comprising the steps: converting an input signal to a control signal for controlling the sensor; determining a difference signal that indicates the difference between the input signal and the control signal; and controlling the input signal by means of the difference signal, wherein controlling the input signal comprises generating a transfer function of the difference signal by processing the difference signal and by feeding back the processed difference signal to the input signal; the transfer function of the difference signal comprises a zero point at an operating frequency of the sensor; and the operating frequency is different from zero.

In a first sampling step an input signal 565 having a value F_t is supplied to a converter unit 520. The converter unit 520 converts the input signal 565 having the value F_t to a control signal 560 having the value $Y_t = F_t + E_t$. The control signal 560 comprises therefore the input signal 565 having the value F_t and an, at first, unknown difference signal 570 having the value E_t. The size of the difference signal 570 is determined by a comparison unit 530 and transferred to a control unit 540.

In the control unit 540 the difference signal 570 is stored for the time T in a first register 542, wherein T is the sampling rate of the input signal 565. The sampling rate T may for example be 20 µs. Then (in time step t+T), the difference signal 570 is transferred from the first register 542 to a second register 544 and stored therein again for the time T.

Simultaneously with the transfer from the first register 542 to the second register 544 the difference signal 570 having the value E_t stored in the first register 542 is multiplied in a multiplication unit 546 with the function $2\cos(\omega_0 T)$, wherein ω_0 is the oscillation frequency of the sensor to be controlled, and then subtracted from the input signal 565.

In the next time step (t+2T) the difference signal 570 having the value E_t stored in the second register 544 is added to the input signal 565. Simultaneously, a signal having the value $2\cos(\omega_0 T)E_{t+T}$ is subtracted from the input signal 565, which signal is generated by multiplying the difference signal 570 having the value E_{t+T} stored in the first register 542 with the function $2\cos(\omega_0 T)$ in the multiplication unit 546. At time step t+2T the signal

$$F_{t+2T} - 2\cos(\omega_0 T)\, E_{t+T} + E_t$$

arrives at the converter unit 520. Here, the quantization error of the time step t+2T is added (E_{t+2T}) such that at time t+2T as control signal 560 a signal having the value

$$Y_{t+2T} = F_{t+2T} + E_{t+2T} - 2\cos(\omega_0 T)E_{t+T} + E_t$$

is output. Forming the z transform of this expression one obtains (with $z = e^{i\omega T}$, T the sampling rate and $\omega = 2\pi f$ the angular frequency)

$$Y(z) = F(z) + E(z)\,(1 - 2\cos(\omega_0 T)z^{-1} + z^{-2}).$$