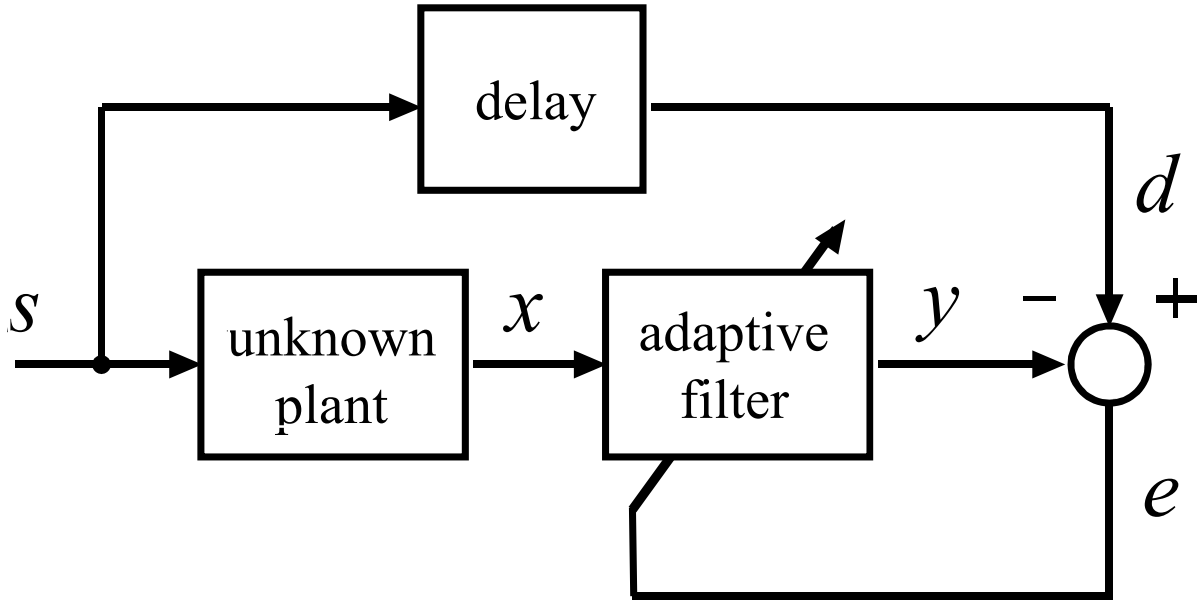
Adaptive Filters

Equalization and Noise Cancellation

c) Equalization

- Adaptive filter tries to recover delayed version of s from x.



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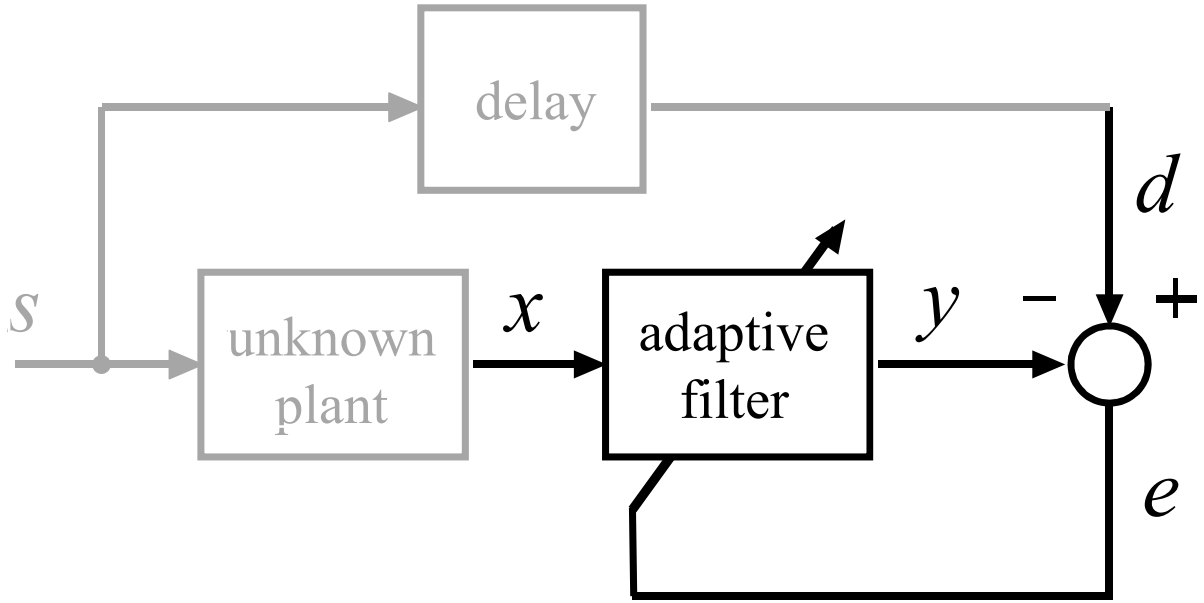
c) Equalization

- Adaptive filter tries to recover delayed version of s from x.



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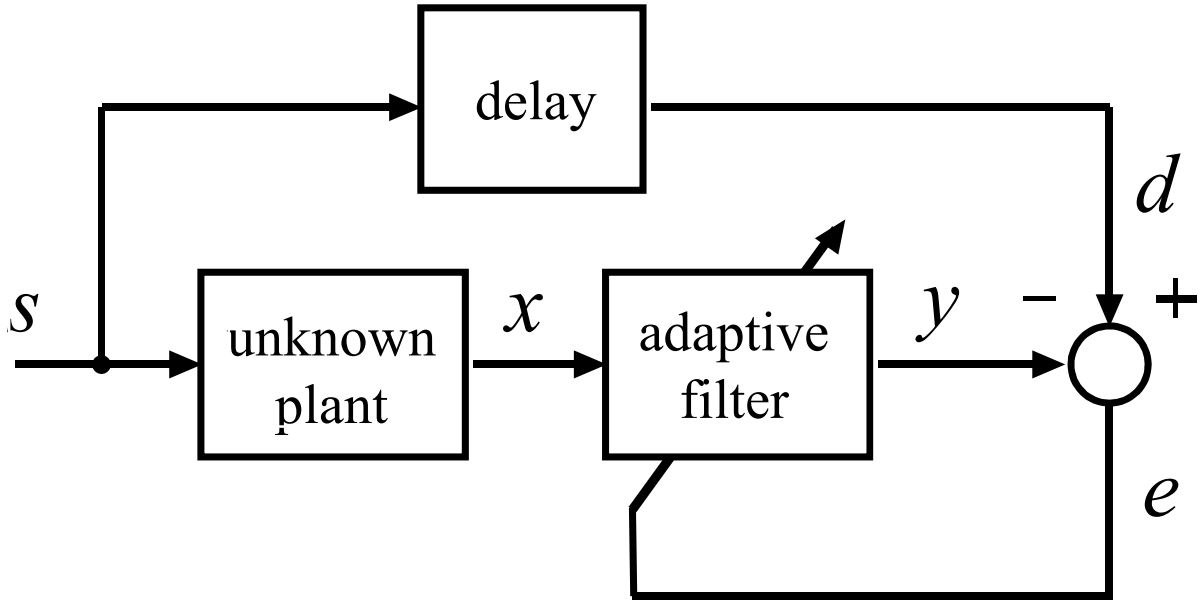
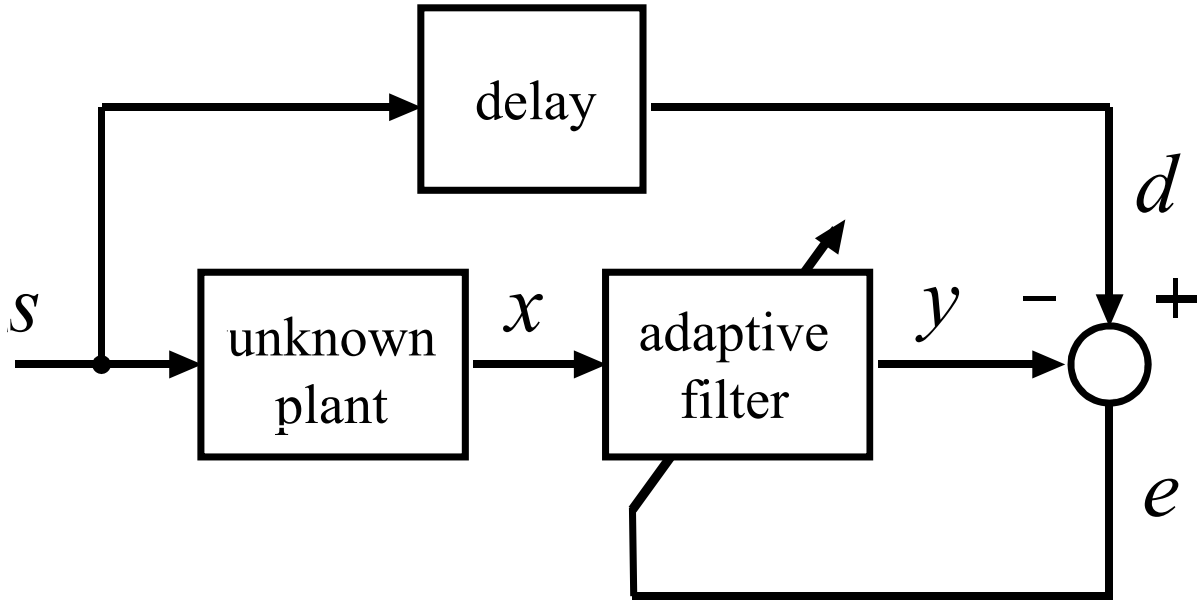
c) Equalization

- x is formed by passing s through unknown plant.



c) Equalization

- Delay is included to allow for propagation of signals through plant and filter.



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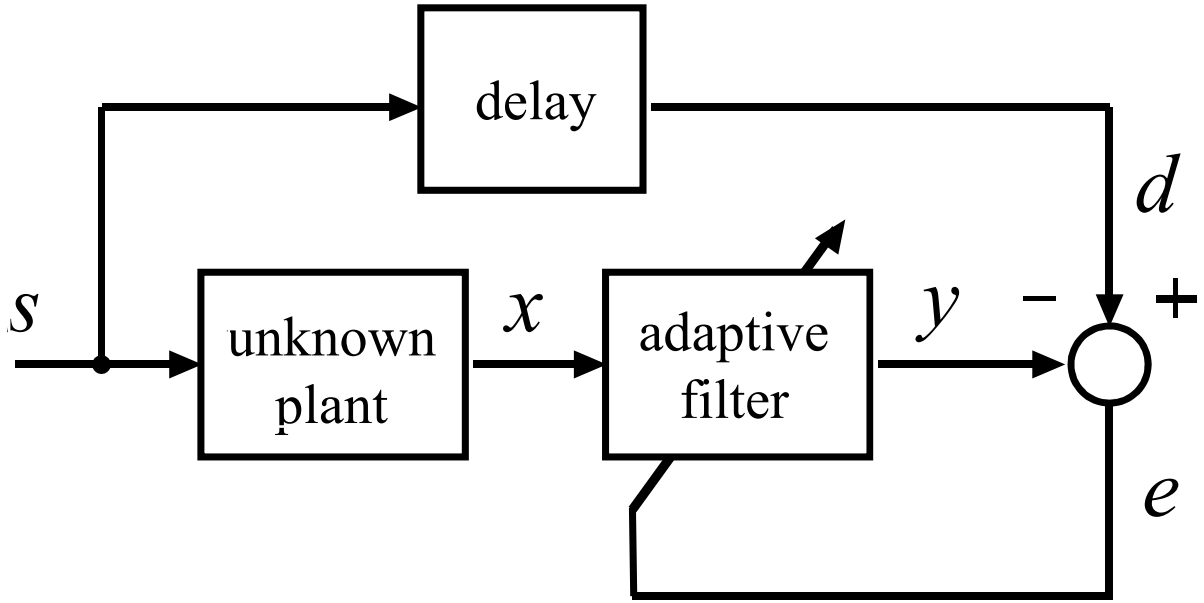
c) Equalization

- After (successful) adaptation, adaptive filter takes on inverse characteristics of plant.



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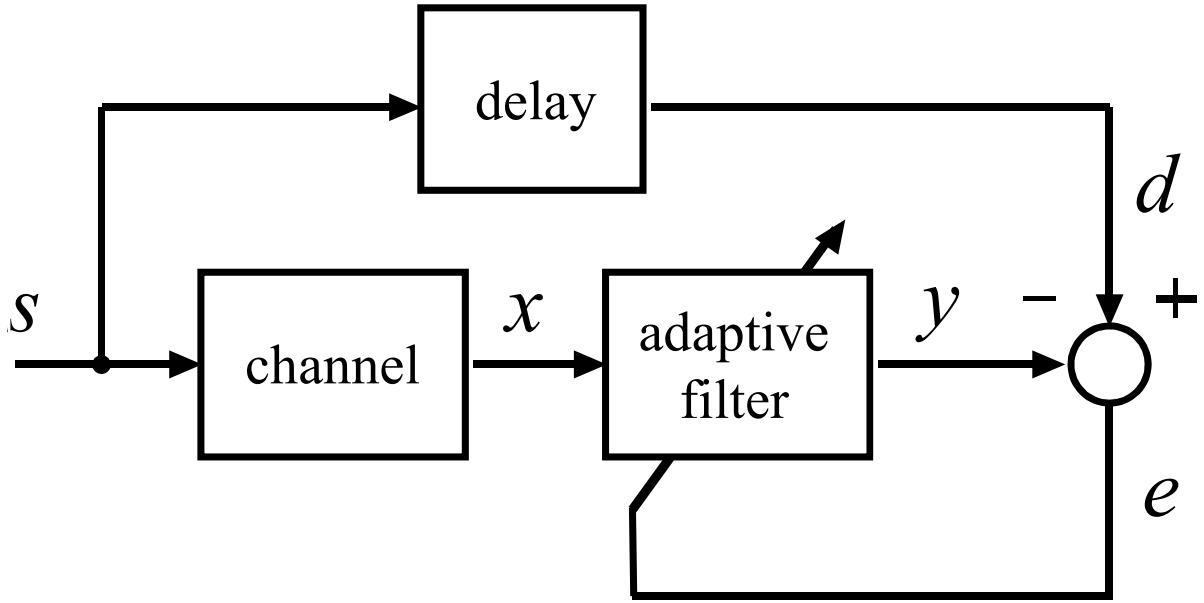
c) Equalization Application

- Unknown plant might be a communication channel.



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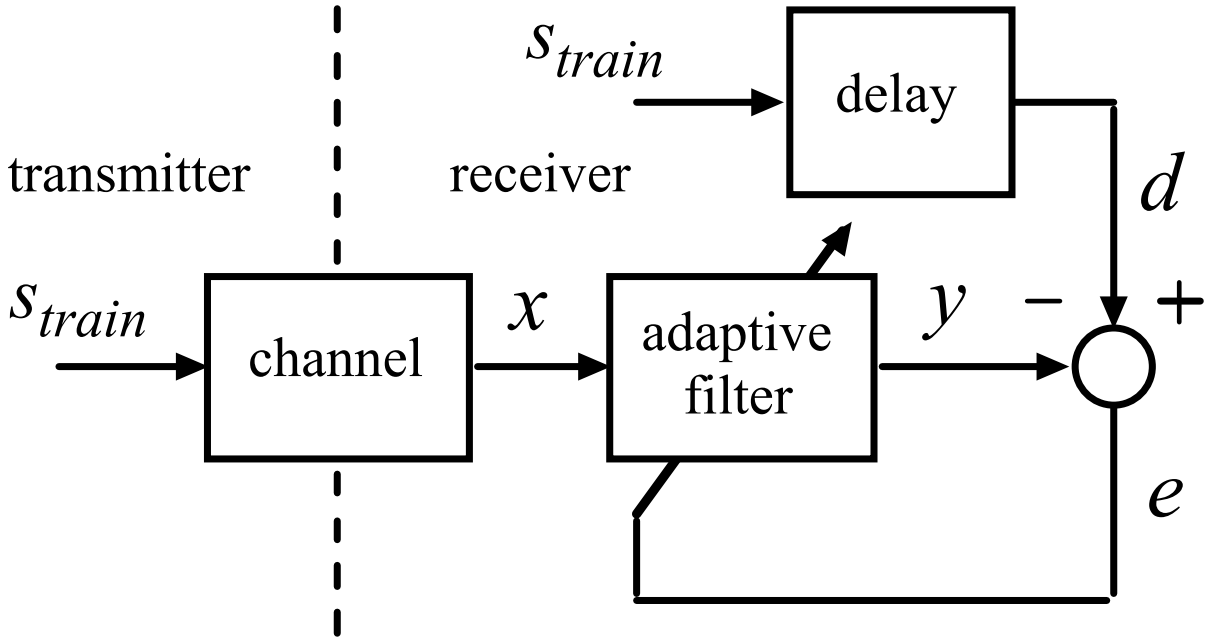
c) Equalization Application

- It is common to adjust filter at start of transmission using pre-arranged signal.



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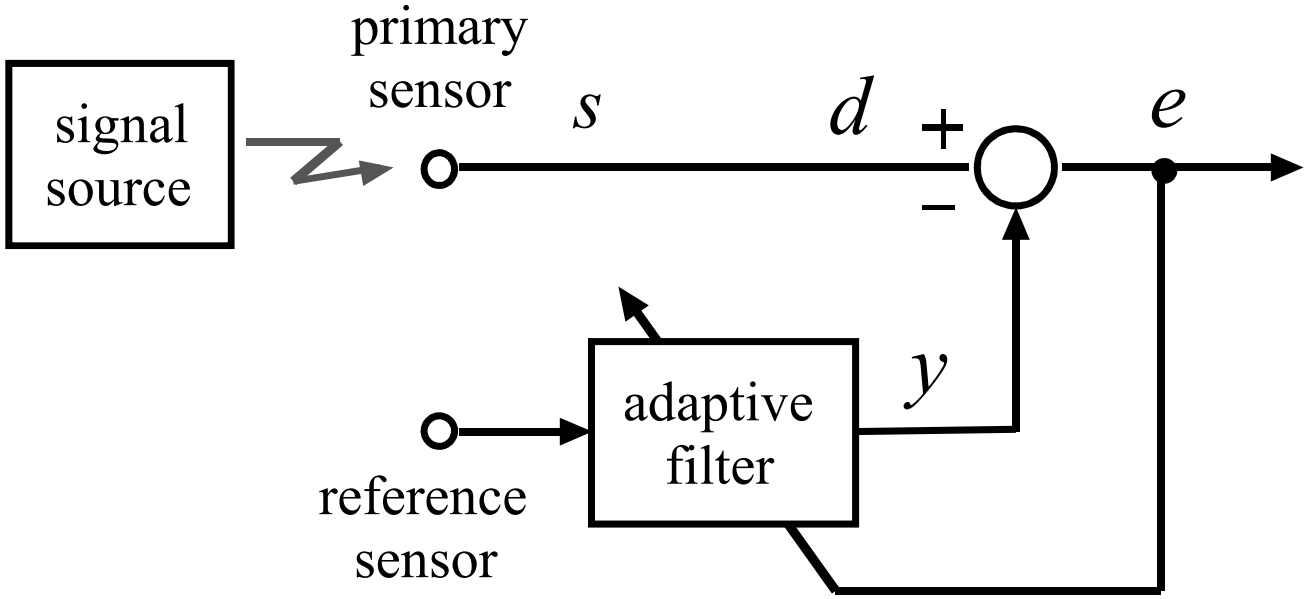
d) Noise Cancellation

- *primary sensor* picks up signal s



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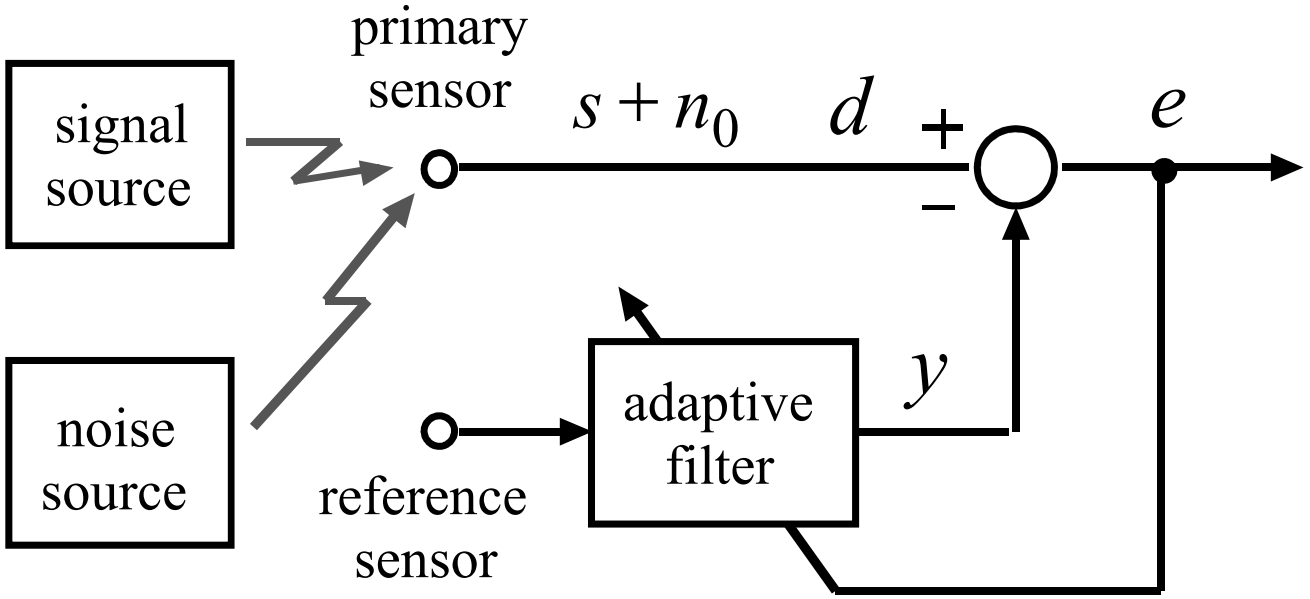
d) Noise Cancellation

- Unfortunately, this is corrupted by additive noise n_0.



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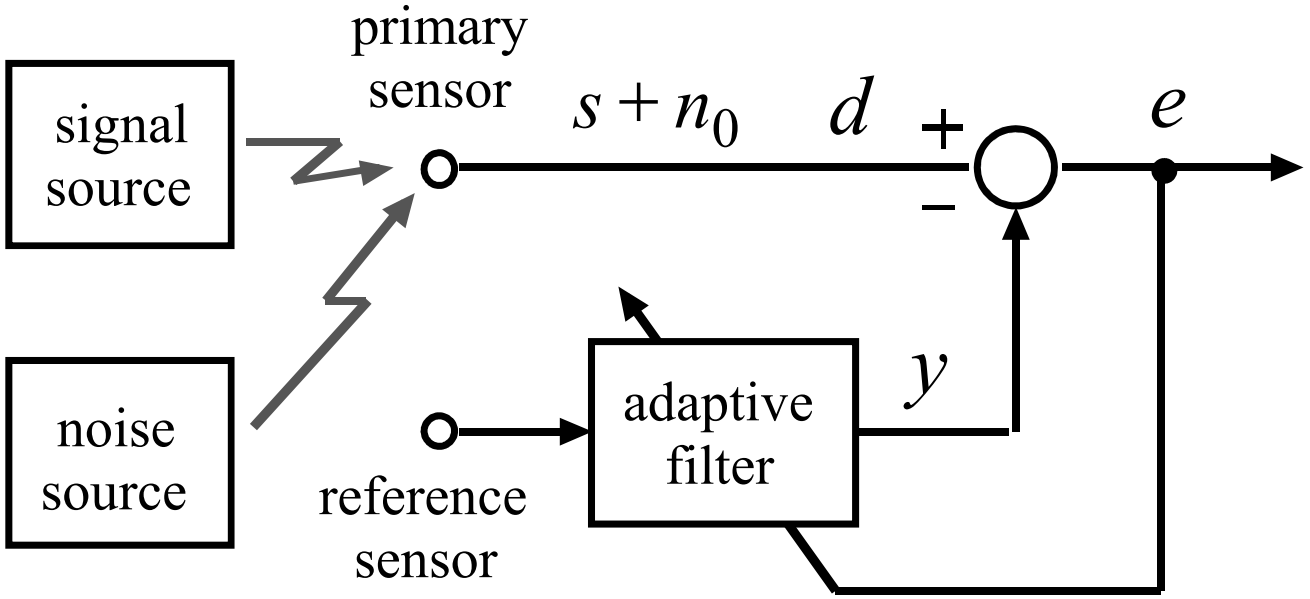
d) Noise Cancellation

- Noise canceller will attempt to subtract noise n_0 from signal at primary sensor .



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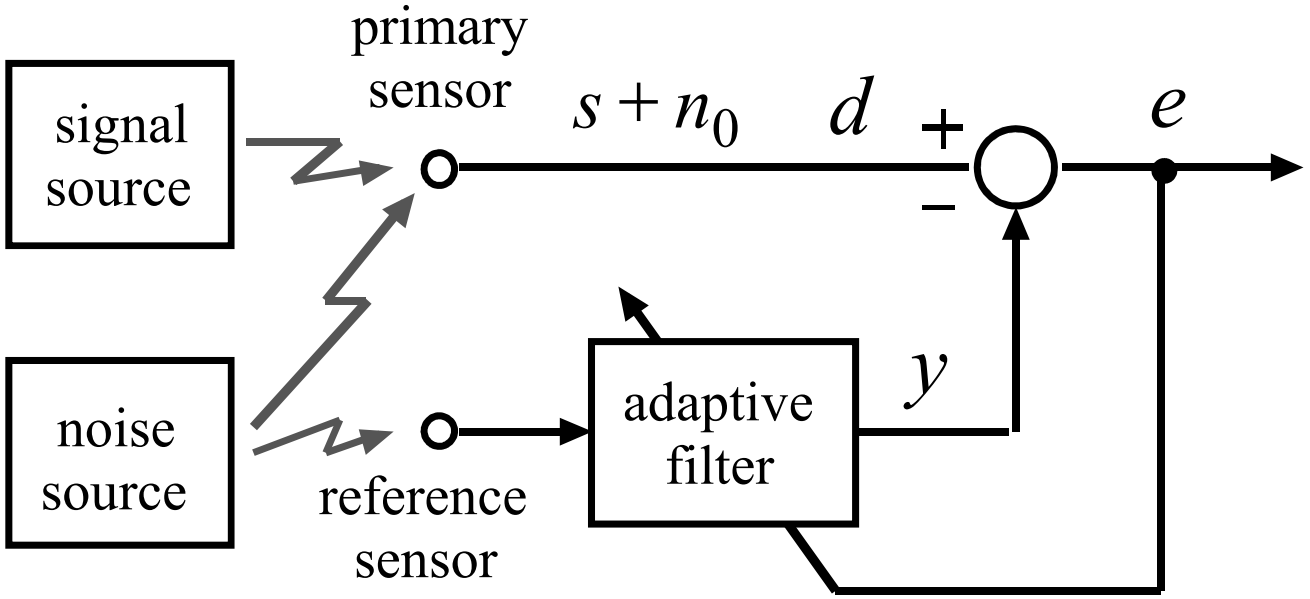
d) Noise Cancellation

- *reference sensor* positioned to pick up noise but not signal



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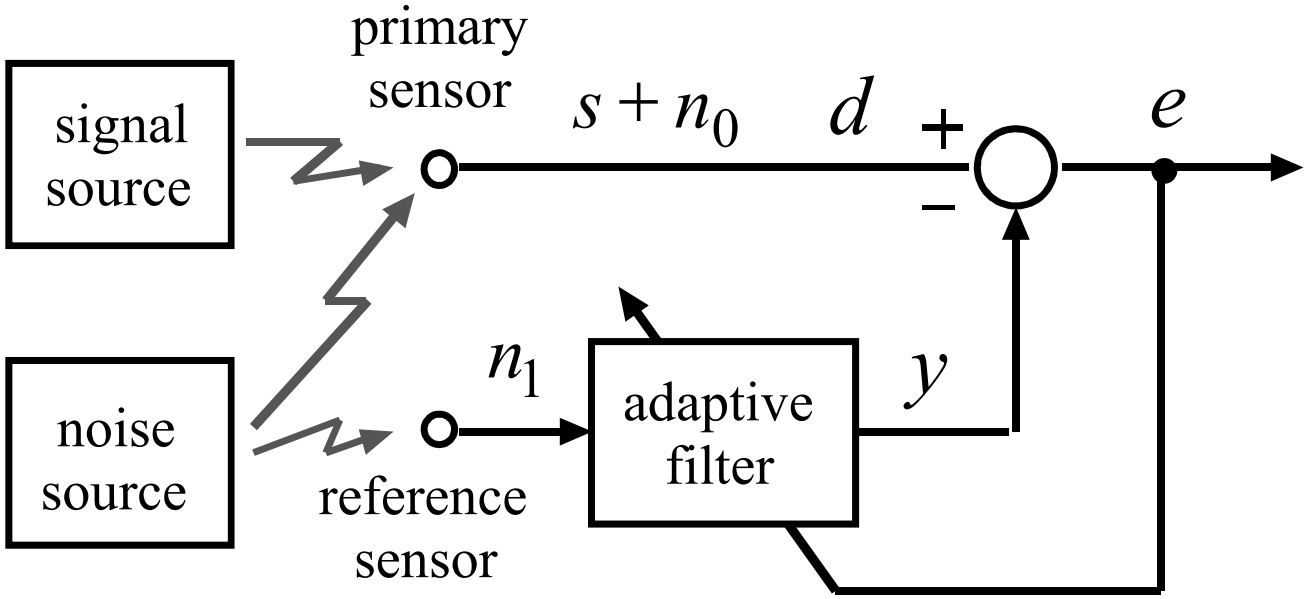
d) Noise Cancellation

- *reference sensor* positioned to pick up noise but not signal
- Reference noise n_1 is not identical to n_0.



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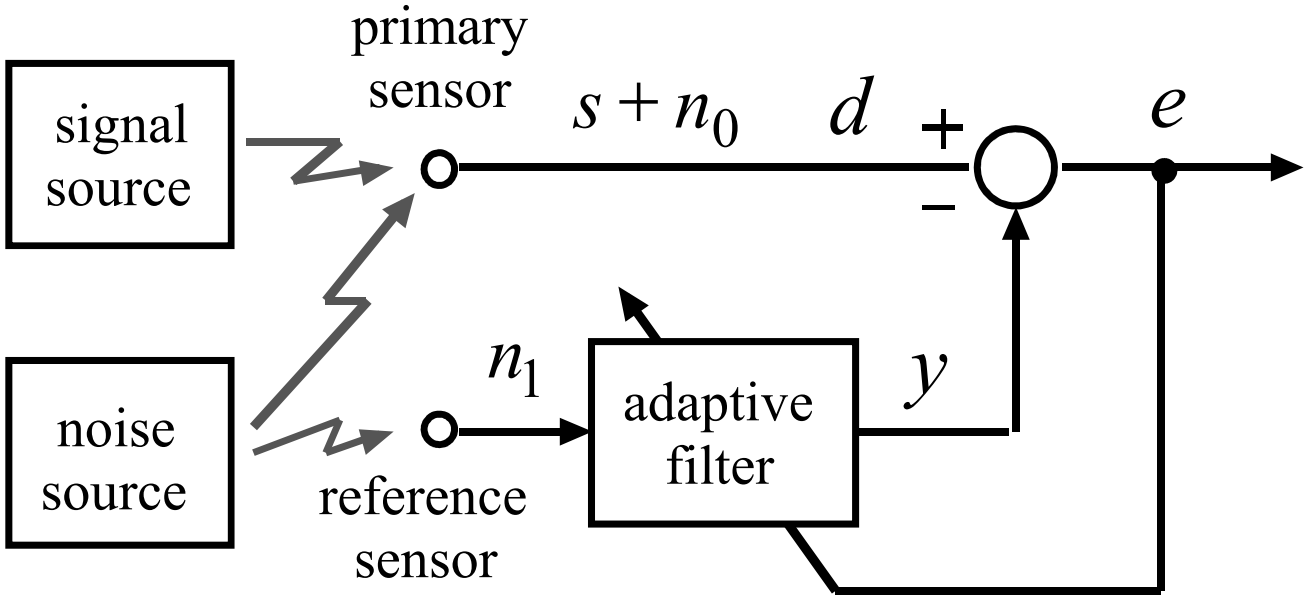
d) Noise Cancellation

- However, we will assume that n_0 and n_1 are correlated and each is uncorrelated with s.



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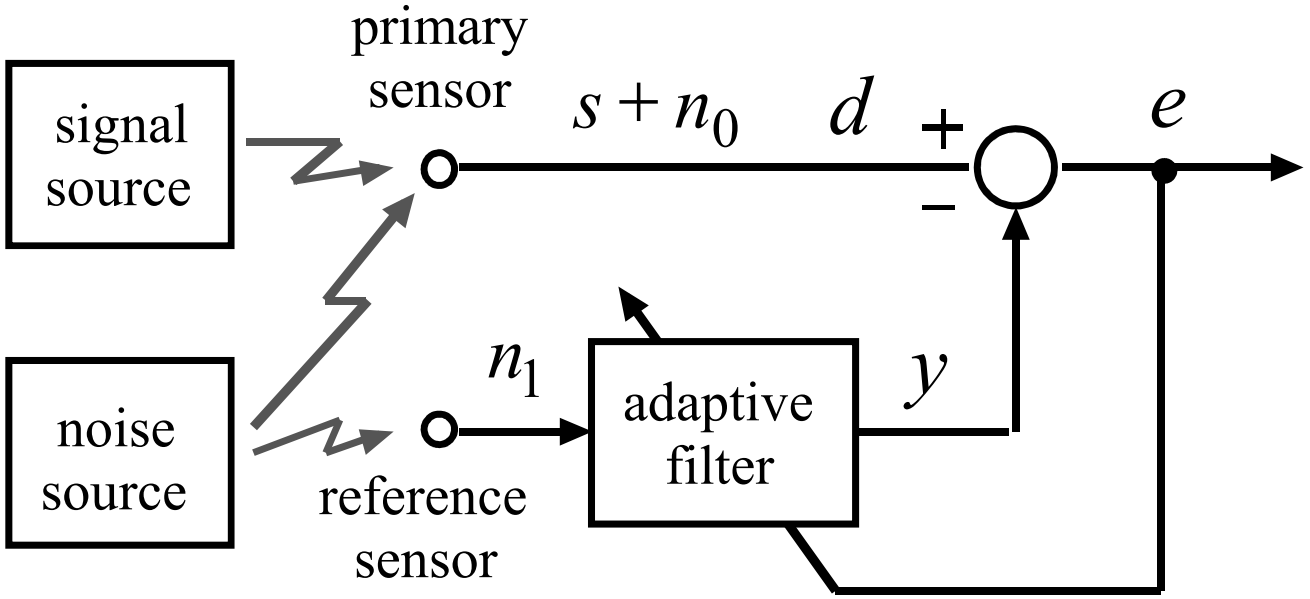
d) Noise Cancellation

- Role of adaptive filter is to estimate n_0 from n_1.



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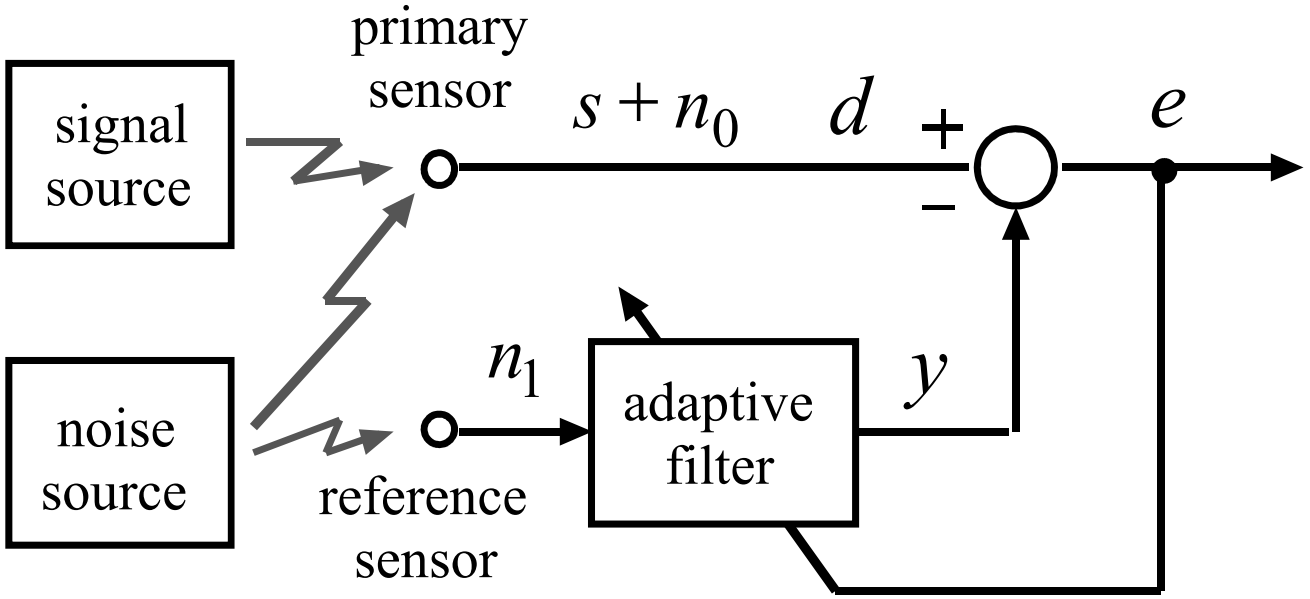
d) Noise Cancellation

- Role of adaptive filter is to estimate n_0 from n_1.
- Intuitively, this appears feasible.



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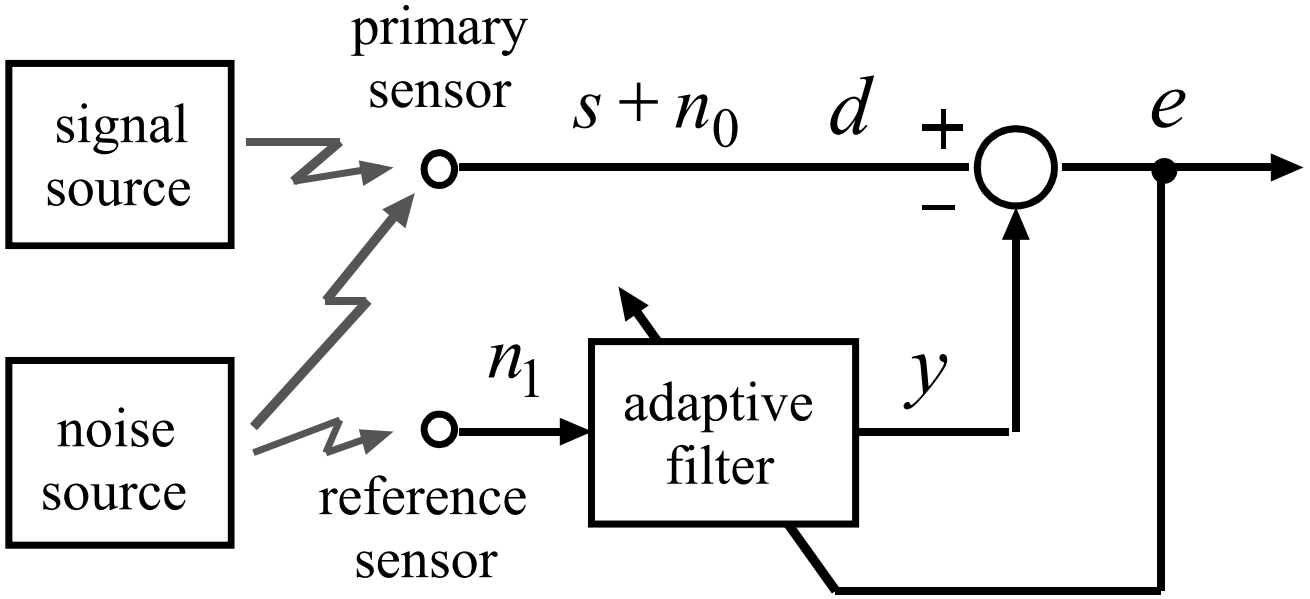
d) Noise Cancellation

- Adaptive filter seeks to minimize average power in signal e.



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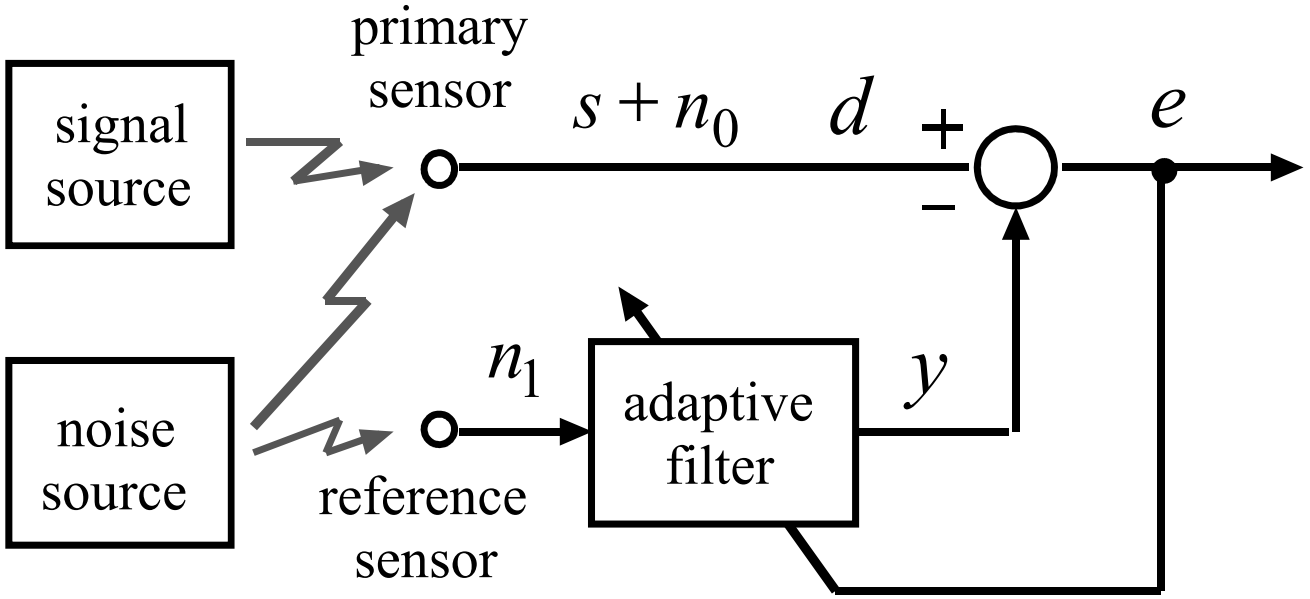
d) Noise Cancellation

- It is unreasonable to expect adaptive filter to estimate uncorrelated s from n_1.



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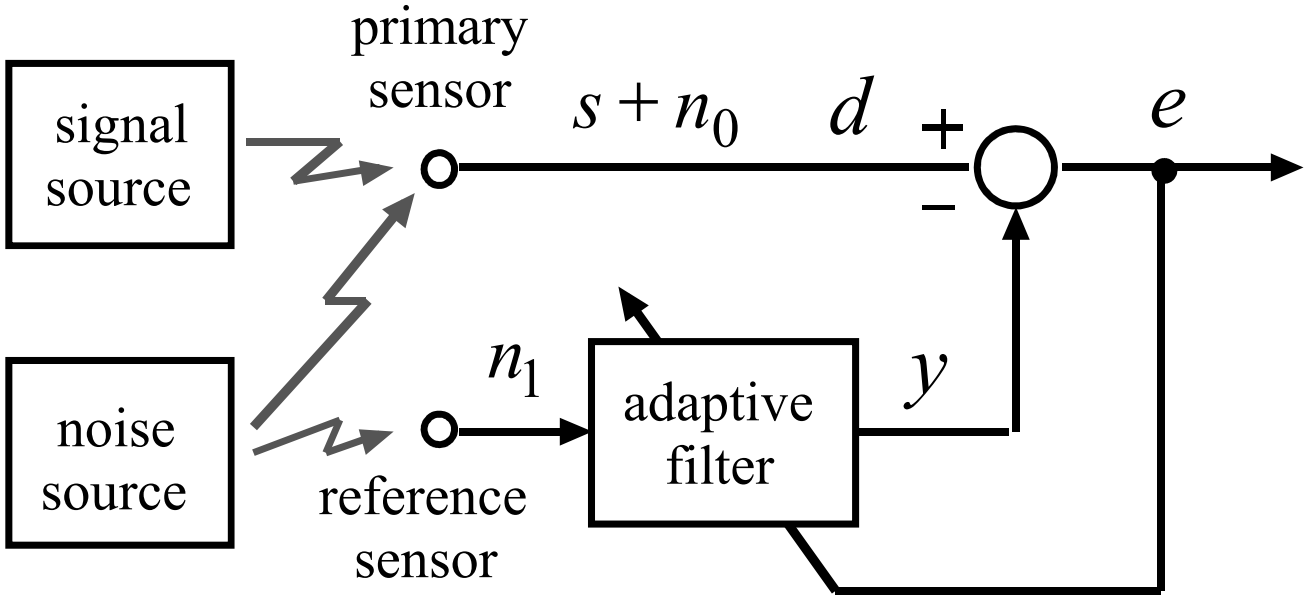
d) Noise Cancellation

- Minimizing average power in e equivalent to equaling average power in s



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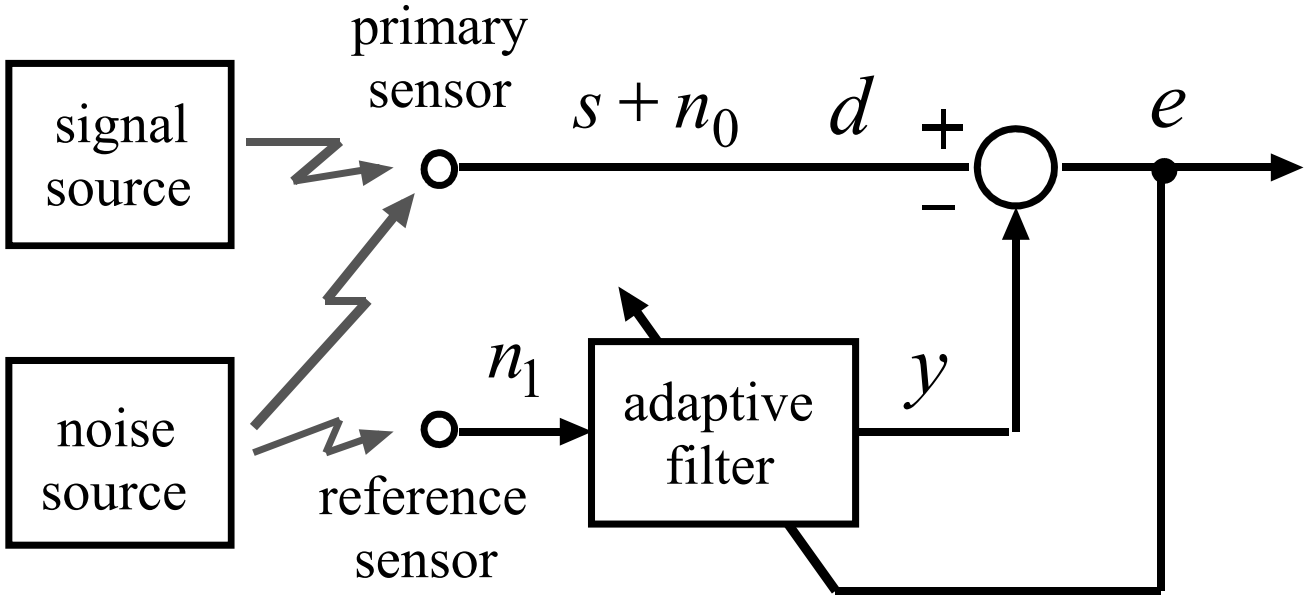
d) Noise Cancellation

- Effectively, adaptive filter learns difference in paths between noise source and sensors.



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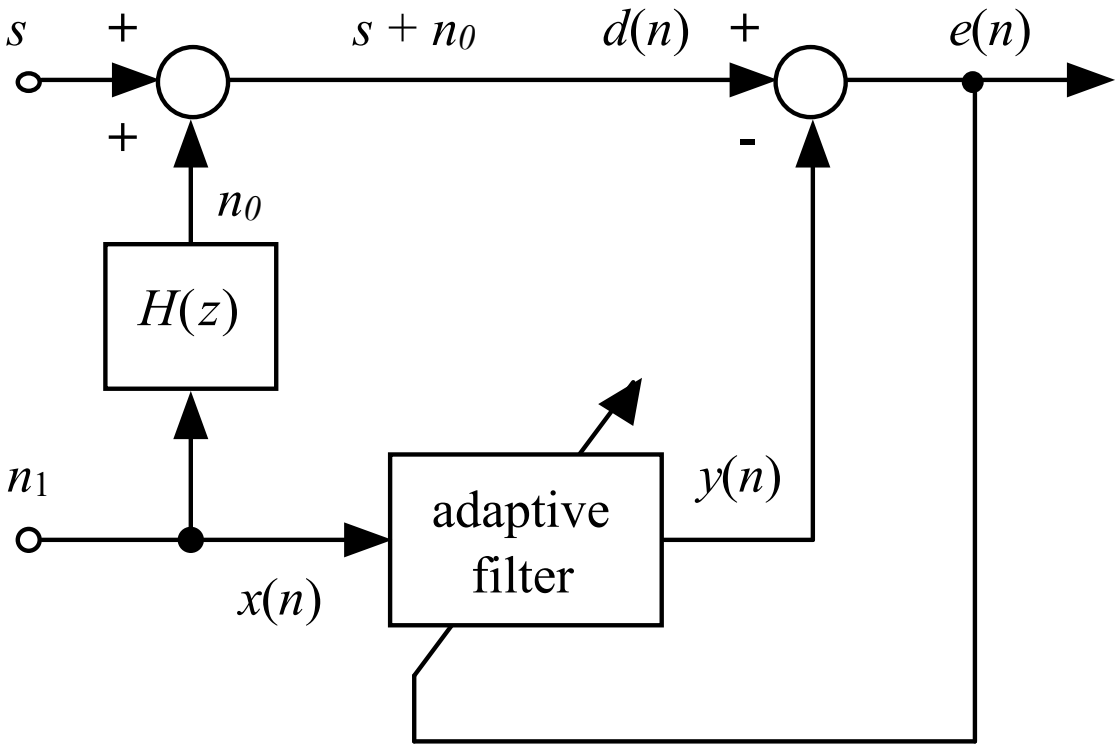
d) Noise Cancellation

- Noise cancellation application viewed as system identification problem



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d) Noise Cancellation Applications

- aircraft cockpit noise
- electrocardiography

Closed Loop Adaptive Filter Configurations

- Four basic configurations are prediction, system identification, equalization, and noise cancellation.
- Common to each is the notion of adaptive filter minimizing average power in e.
- We can understand the applications without knowing exactly *how* adaptive filter works.

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