TOPIC 1 (Introduction)

ATM machine ✓ES ✗CPS

Power → Microcontroller
Software → Microcontroller
Microcontroller ↔ Card reader
Microcontroller ↔ Keypad
Microcontroller ⇒ Display
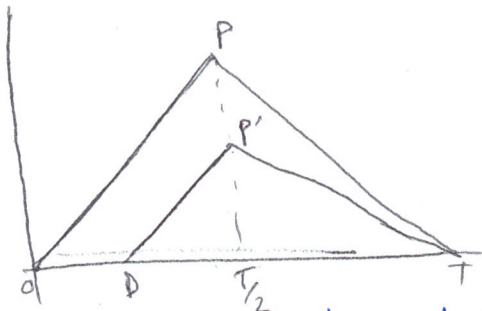Microcontroller ↔ Cash dispenser
Microcontroller ⇒ Printer
Microcontroller ↕ Camera
Microcontroller ↔ Networking hardware
Networking hardware → Server
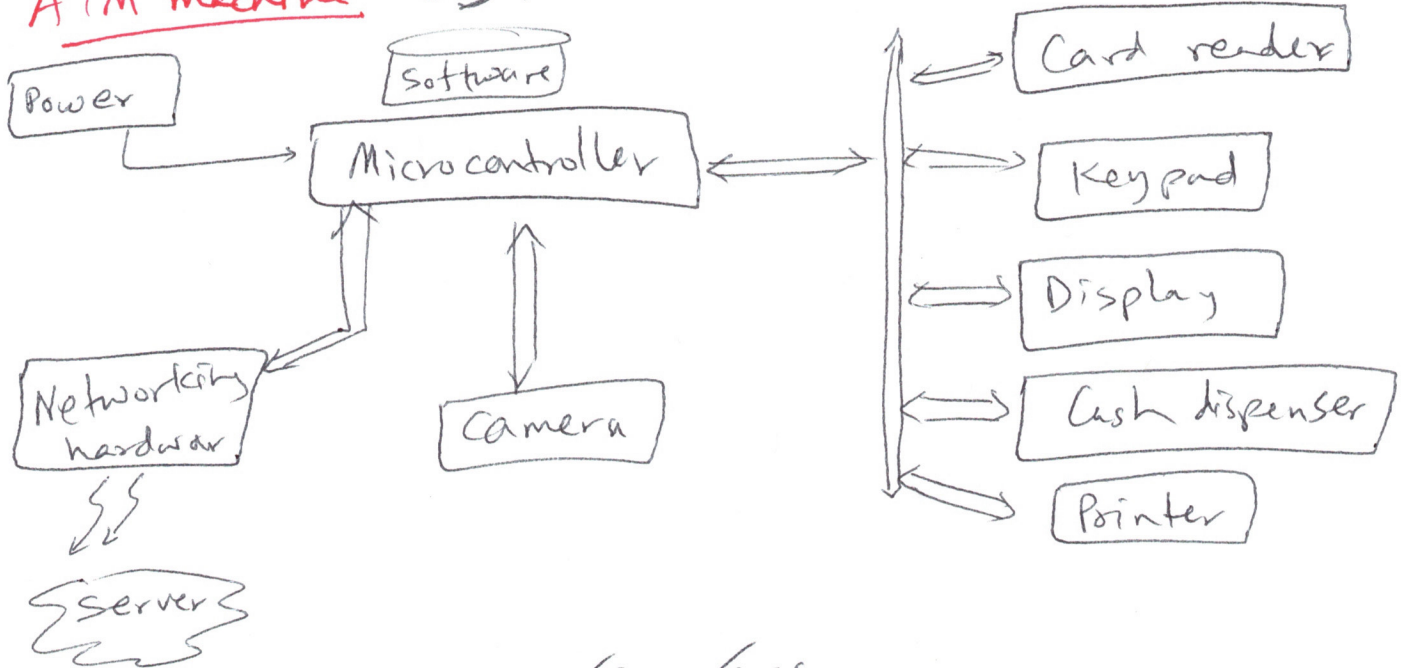
Adaptive cruise control ✓ES ✓CPS

Radar → microcontroller
Techometer → microcontroller
microcontroller → Throttle
microcontroller → Brakes
microcontroller ↓ Display
road
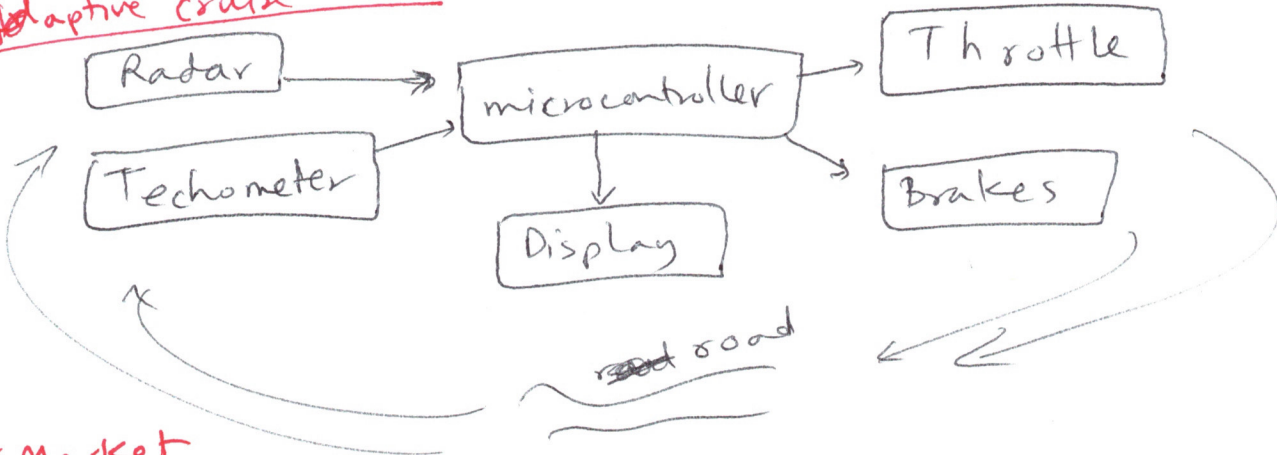
ES Market

Delayed product

$$\frac{P}{T/2} = \frac{P'}{\frac{T}{2}-D} \implies P' = \frac{2P}{T}\left(\frac{T}{2}-D\right)$$

Revenue for on-time product:

$$R = \frac{1}{2} * P * T = \frac{PT}{2}$$

Revenue for delayed product:

$$R' = \frac{1}{2} * \frac{2P}{T}\left(\frac{T}{2}-D\right)*(T-D) = \frac{P}{T}\left(\frac{T}{2}-D\right)(T-D)$$

% Revenue loss for delayed product:

$$\frac{R-R'}{R} = \frac{3TD-2D^2}{T^2} = \frac{(3T-2D)D}{T^2} * 100\%$$

Ex. 1.1 $T = 52$ months
$D = 4$ months
% Revenue loss = ?

% Revenue loss $= \dfrac{3TD - 2D^2}{T^2} * 100\%$

$= \dfrac{3*52*4 - 2*4^2}{52^2} * 100\%$

$= \dfrac{624 - 32}{2704} * 100\%$

$\approx 0.22 * 100\% = $ ~~22~~ 22%

in market $\quad$ ②
$\dfrac{T-D}{T} = \dfrac{52-4}{52} *100\%$

$= \dfrac{48}{52} * 100\%$

$= 92.3\%$
Not in market = 7.7%

Ex. 1.2 $T = 4$ yrs 4 months
$D = 10$ months
% of revenue loss ?

$T = 48 + 4 = 52$ month
% Rev. loss $= \dfrac{3*52*10 - 2*10^2}{52^2} *100\%$

$= 50\%$

$D_1 = 4$ months, $D_2 = 10$ months $\longrightarrow$ diff. = 6 months
R_1 loss = 22%, R_2 loss = 50% $\longrightarrow$ diff. = 28% loss

Ex. 1.3 $T = $ ~~6 years~~ ~~6 months~~ 4 years
% Rev. loss = 25%
max. D = ?

$T = 4*12 = 48$ months. $\quad \dfrac{3TD - 2D^2}{T^2} = \dfrac{3*48*D - 2D^2}{48^2}$
% Rev. loss = 25% = 0.25 =

$\Rightarrow D^2 - 72D + 288 = 0$

$\Rightarrow D = 4.25$ months.