Dav Pankhur's bathroom door automation project

Design document

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Overview

This project will automate a sliding door to a bathroom. The door will be driven by a bidirectional DC motor and can be locked when fully closed. Control will be by a combination of infra-red non-contact hand-operated sensors, kick buttons mounted low on walls, and PIR (passive infra-red) motion detectors. LEDs and/or lamps will provide state indication.

All of the control logic will be implemented on a circuit board using gate and other ICs from the CD4000 range. Outputs will be driven with MOSFETs and/or relays. All I/O devices, and power, will plug into this board. The next sections cover the connections to this circuit board: power, inputs, and outputs.

Control Board Connections

Power

The whole system will operate on 12V DC. This is because the installation has a battery-backed 12V DC system, the door motor is also 12V DC, and other components of the system can run from 12V or a 5V supply that will be derived from the 12V supply.

Power connections on the control board:

- One 2-pin connector for 12V DC input. The supply must be able to provide enough current to run the solenoid lock, and to simultaneously run the door motor comfortably without dipping during motor start-up or stall.
- Connectors for various input devices will include power pins carrying 12V DC and/or 5V DC (derived from the 12V rail by a regulator on the main board).

One or more emergency kill switches may be connected in series with the 12V DC supply to the board so that the system can be powered down and the motor can be moved manually in case of failure of any part of the system.

Inputs

Inputs to the control board come from sensors of various kinds that are used to allow user control, and to monitor the system. As described in the section on Power, some input connectors include a pin carrying a positive power supply rail for use by the sensor.

Input connectors on the control board used for user control:

BASIN_HAND_CLOSE:

Identification: red colour; “CLOSE" marking
Function: close and lock the door; illuminate the “occupied” sign
Location: shoulder height, on the right of the basin in bathroom (see plan view)
Sensor type: hand-operated non-contact infra-red proximity detector
Power: +5V/0V to sensor (100mA)
Signal: Logic-level output; 0V idle; +5V when hand proximity is detected
Connector: 3-pin: +5V, SIGNAL, 0V

BASIN_HAND_OPEN:

Identification: green colour; “OPEN” marking
Function: unlock and open the door; deactivate the “occupied” sign
Everything else same as BASIN_HAND_CLOSE

TOILET_KICK_CLOSE:

Identification: red colour; “CLOSE” marking
Function: close and lock the door; illuminate the “occupied” sign
Location: ankle height on bathroom wall next to toilet, so that it can be press by foot if user is on the toilet (see plan view)
Sensor: heavy duty spring-loaded pushbutton
Power: not required
Signal: contact closes momentarily (while button is pressed)
Connector: 2-pin: CONTACT, 0V

ROOM_KICK_CLOSE:

Identification: red colour; “CLOSE” marking
Function: close and lock the door; illuminate the “occupied” sign
Location: ankle height on bathroom wall near door (see plan view)
Everything else same as TOILET_KICK_CLOSE

ROOM_KICK_OPEN

Identification: green colour; “OPEN” marking
Function: unlock and open the door; deactivate the “occupied” sign

Location: ankle height on bathroom wall near door (further away from door than ROOM_KICK_CLOSE)
Everything else same as TOILET_KICK_CLOSE

HALL_KICK_CLOSE:
Identification: red colour; “CLOSE” marking
Function: close and lock the door; illuminate the “occupied” sign
Location: ankle height on hallway wall (see plan view)
Everything else same as TOILET_KICK_CLOSE

HALL_KICK_OPEN:
Identification: green colour; “OPEN” marking
Function: unlock and open the door; deactivate the “occupied” sign
Location: ankle height on hallway wall (see plan view)
Signal: contact closes momentarily (while button is pressed) and only if LIMIT_CLOSE is open (thus this button has no effect while the door is closed).
Everything else same as TOILET_KICK_CLOSE

HALL_MOTION_DETECTOR:
Identification: White 6 LED ceiling mounted light with PIR sensor.
Function: detect person walking in hall, and open door if room is not occupied.
Location: ceiling of hallway leading to bathroom, about 2m from the bathroom door.
Sensor: passive infra-red motion detector; range ~3 metres
Power: +5V/0V to sensor
Signal: Signal high or??? contact closes for 20 seconds when motion is detected.
**KH: Dav, you added here: “and only if LIMIT_CLOSE is open (thus this switch has no effect while the door is closed)”. That logic will be implemented on the control board, right? If the room is occupied, the control board will ignore movement in the hallway. This is part of the logic definition, not part of the signal definition - the motion detector will still generate the signal regardless of whether the bathroom is occupied or not, right? Also, are you sure that the motion detector’s output is a contact, and that it needs 5V power?
Connector: 3-pin: +5V, SIGNAL, 0V
**DP: sorry your right, logic doesnt go here. I’ll take it out. regarding the digital output, this sensor is actually a fully functional led light which happens to have a motion PIR sensor. Instead of have another separate PIR module, i am re-using this PIR led light’s output, which is the 3v powering the 6 led lights… what do you think?

Input connectors on the control board used for monitoring purposes:

LIMIT_OPEN:
Function: detect when the bathroom door has reached the fully open position
Sensor: Lever switch pressed by edge of door
Power: none

Signal: dry contact; normally closed; opens when door reaches end of travel
Connector: 2-pin: CONTACT, 0V

LIMIT_CLOSED:

Function: detect when the bathroom door has reached the fully closed position
Everything else same as LIMIT_OPEN

Outputs

MOTOR:

12V DC high-current output to door motor. Two terminals identified as “A” and “B”.
Open mode: A = +12V; B = 0V: motor OPENS the door, spins clockwise
Close mode: A = 0V; B = +12V: motor CLOSES the door, spins counter-clockwise
Off mode: A,B both 0V: motor does not run.
The control board will include logic to prevent immediate reversal of the voltage, as this would cause excessive current consumption.
The control board will include protection against inductive voltages from the motor but a snubber circuit (resistor and capacitor in series) should also be connected across the motor at its terminals to reduce electromagnetic interference.
We may support running the motor at low speed by reducing the supply voltage, to avoid hitting the door limits with a bang.
Motor starting current (max): 200mA
Motor stall current (max): 600mA
http://www.ebay.com/itm/320959604660
**KH: Dav, thanks for the link. You mentioned you were going to use a bigger motor in future, right? Have you chosen one?
Kirs, I might, but this one seems strong enough and if it works then it wont need changing.

LOCK:

12V DC medium-current output to lock lever. Two terminals identified as “+” and “0V”.
When 12V DC appears, the lock will activate.
The lock will be activated while the door is closing; in this case, the door’s lock hole plate will click into the lock solenoid pin when it reaches the fully closed position.
(If the lock is activated after the door has reached fully closed, and might have bounced back slightly, the lock would probably still work, because the slope on the lock pin would pull the door fully closed. But the control logic will activate the lock before the door reaches fully closed, so this won’t be an issue.)

OCCUPIED_SIGN

5V DC medium-current output to the “occupied” sign (LED light) in the hallway to indicate that the bathroom is in use. Two terminals identified as “+” and “0V”. When 5V DC

appears, the sign will illuminate. The sign may not read “Occupied” but it will have that function.

Definition of control logic

**DP: how does this section try to communicate?? I’m assuming it describes the logic, but via what format?
KH: Sorry Dav. I should have started something. I think it’s easiest to start from the motor control and work backwards to the user interface.

Motor and Lock control logic

********kh work in progress here

User activates input: BASIN_HAND_CLOSE (by waving hand in front of the sensor).
BASIN_HAND_CLOSE activates the LOCK and at the same time activates the MOTOR with Close mode and also activating the OCCUPIED_SIGN.
Once the door edge touches the LIMIT_CLOSE switch, the MOTOR deactivates (Off mode).

Inputs: TOILET_KICK_CLOSE, ROOM_KICK_CLOSE and HALL_KICK_CLOSE triggers the same logic as BASIN_HAND_CLOSE.

User activates input: BASIN_HAND_OPEN (by waving hand in front of the sensor).
BASIN_HAND_OPEN deactivates the LOCK before activating the MOTOR with Open mode and also deactivating the OCCUPIED_SIGN.
Once the door edge touches the LIMIT_OPEN switch, the MOTOR deactivates (Off mode).

Inputs: ROOM_KICK_OPEN triggers the same logic as BASIN_HAND_OPEN.

User activates input: HALL_KICK_OPEN (by pressing the pusbutton with their leg).
HALL_KICK_OPEN only works if LIMIT_CLOSE is closed. If so, it deactivates the LOCK before activating the MOTOR with Open mode and also deactivating the OCCUPIED_SIGN.
Once the door edge touches the LIMIT_OPEN switch, the MOTOR deactivates (Off mode).

Inputs: HALL_MOTION_DETECTION triggers the same logic as HALL_KICK_OPEN.

User activates input: KILL_SWITCH (by pressing the pushbutton).
KILL_SWITCH deactivates the MOTOR, the LOCK and the OCCUPID_SIGN. This allows for manual push and pull movement of the door.

Components

(Quantities are mostly wrong at the moment)

1x TE Connectivity RUEF300 Polyswitch PTC resettable fuse 3A/6A
http://www.digikey.com/product-detail/en/D55663-000/D55663-000-ND/1045777 USD 0.42

1x Fairchild FJN3302R NPN BRT/RET 10k+10k 50V 100mA TO-92-JAP
http://www.digikey.com/product-detail/en/FJN3302RTA/FJN3302RTACT-ND/4213840 USD 0.22

1x Fairchild FJN4302R PNP BRT/RET 10k+10k 50V 100mA TO-92-JAP
http://www.digikey.com/product-detail/en/FJN4302RTA/FJN4302RTACT-ND/4743946 USD 0.22

1x Fairchild FQPF27P06 MOSFET P-channel 17A 60V TO-220FP
http://www.digikey.com/product-detail/en/FQPF27P06/FQPF27P06FS-ND/1055106 USD 1.17

1x Infineon TLE5206-2S Full bridge motor driver
http://www.digikey.com/product-detail/en/TLE5206-2S/TLE5206-2S-ND/1283081 USD 7.02
***DP what is the motor driver for? i was hoping to keep the system very simple, so that it could be easily repaired if required, but if its really needed then i guess its needed… i thought the motor would spin at the rated rpm and then stop once power is cut, yeah?

References

http://www.electronicspoint.com/threads/.268928