Student Information

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Specifications

1. When the office_button signal in any office is on or blinking, it will stay so until the robot reaches that office and its lid opens up.
LTL formula:
$G((\texttt{office1.office\_button} = \texttt{on} \vee \texttt{office1.office\_button} = \texttt{blink}) \supset ((\texttt{office1.office\_button} = \texttt{on} \vee \texttt{office1.office\_button} = \texttt{blink}) U ((\texttt{robot.location} = \texttt{at1}) \wedge (\texttt{robot.lid} = \texttt{open}))) \vee G(\texttt{office1.office\_button} = \texttt{on} \vee \texttt{office1.office\_button} = \texttt{blink})) \wedge$
$G((\texttt{office2.office\_button} = \texttt{on} \vee \texttt{office2.office\_button} = \texttt{blink}) \supset ((\texttt{office2.office\_button} = \texttt{on} \vee \texttt{office2.office\_button} = \texttt{blink}) U ((\texttt{robot.location} = \texttt{at2}) \wedge (\texttt{robot.lid} = \texttt{open}))) \vee G(\texttt{office2.office\_button} = \texttt{on} \vee \texttt{office2.office\_button} = \texttt{blink})) \wedge$
$G((\texttt{office3.office\_button} = \texttt{on} \vee \texttt{office3.office\_button} = \texttt{blink}) \supset ((\texttt{office3.office\_button} = \texttt{on} \vee \texttt{office3.office\_button} = \texttt{blink}) U ((\texttt{robot.location} = \texttt{at3}) \wedge (\texttt{robot.lid} = \texttt{open}))) \vee G(\texttt{office3.office\_button} = \texttt{on} \vee \texttt{office3.office\_button} = \texttt{blink}))$

2. When the lid on the robot opens within any office, it stays open for at least three time units.
LTL formula:
$G((\texttt{robot.lid} = \texttt{close} \wedge X(\texttt{robot.lid} = \texttt{open} \wedge (\texttt{robot.location} = \texttt{at1} \vee \texttt{robot.location} = \texttt{at2} \vee \texttt{robot.location} = \texttt{at3}))) \supset X(\texttt{robot.lid} = \texttt{open} \wedge X(\texttt{robot.lid} = \texttt{open} \wedge X(\texttt{robot.lid} = \texttt{open}))))$

3. If office_button is not off, it will be blinking when the robot is moving and it will be on when the robot is stopped.
LTL formula:
$G((\texttt{office1.office\_button} \neq \texttt{off}) \supset ((\texttt{office1.office\_button} = \texttt{blink} \wedge \texttt{robot.moving}) \vee (\texttt{office1.office\_button} = \texttt{on} \wedge \neg \texttt{robot.moving}))) \wedge$
$G((\texttt{office2.office\_button} \neg \texttt{off}) \supset ((\texttt{office2.office\_button} = \texttt{blink} \wedge \texttt{robot.moving}) \vee (\texttt{office2.office\_button} = \texttt{on} \wedge \neg \texttt{robot.moving}))) \wedge$
$G((\texttt{office3.office\_button} \neq \texttt{off}) \supset ((\texttt{office3.office\_button} = \texttt{blink} \wedge \texttt{robot.moving}) \vee (\texttt{office3.office\_button} = \texttt{on} \wedge \neg \texttt{robot.moving})))$

4. If the lid is open on the robot, it must stay open until the sensor has been false for at least two time units. The lid can close after one time unit following this condition.
LTL Formula:
$G((\texttt{robot.lid} = \texttt{close} \wedge X(\texttt{robot.lid} = \texttt{open})) \supset ((X(\neg \texttt{robot.sensor} \wedge X(\neg \texttt{robot.sensor}))) R (X(\texttt{robot.lid} = \texttt{open} \wedge X(\texttt{robot.lid} = \texttt{open} \wedge X(\texttt{robot.lid} = \texttt{open}))))))$

5. When the lid is open, the sensor will eventually be false for two consecutive time units.
LTL Formula:
$G((\texttt{robot.lid} = \texttt{open}) \supset F(\neg \texttt{robot.sensor} \wedge X(\neg \texttt{robot.sensor})))$

6. If the robot is requested from within an office, it will eventually reach that office.
LTL Formula:
$G(\texttt{office1.robot\_button} \supset F(\texttt{robot.location} = \texttt{at1})) \wedge G(\texttt{office2.robot\_button} \supset F(\texttt{robot.location} = \texttt{at2})) \wedge G(\texttt{office3.robot\_button} \supset F(\texttt{robot.location} = \texttt{at3}))$

7. When the robot lid is open, the robot must not move and both buttons for that office must be off.
   LTL Formula:
   $G((\texttt{robot.lid} = \texttt{open} \wedge \texttt{robot.location} = \texttt{at1}) \supset (\neg\texttt{robot.moving} \wedge \neg\texttt{office1.robot\_button} \wedge \texttt{office1.office\_button} = \texttt{off})) \wedge$
   $G((\texttt{robot.lid} = \texttt{open} \wedge \texttt{robot.location} = \texttt{at2}) \supset (\neg\texttt{robot.moving} \wedge \neg\texttt{office2.robot\_button} \wedge \texttt{office2.office\_button} = \texttt{off})) \wedge$
   $G((\texttt{robot.lid} = \texttt{open} \wedge \texttt{robot.location} = \texttt{at3}) \supset (\neg\texttt{robot.moving} \wedge \neg\texttt{office3.robot\_button} \wedge \texttt{office3.office\_button} = \texttt{off}))$

8. The robot must not move at the first time unit after the lid is closed.
   LTL Formula:
   $G((\texttt{robot.lid} = \texttt{open} \wedge X(\texttt{robot.lid} = \texttt{close})) \supset X(\neg\texttt{robot.moving}))$

9. It takes the robot two or three time units to move between offices (i.e. after one time unit of moving it will be between offices and within one or two extra time units, it will be in front of the next office.)
   LTL Formula:
   $G((\texttt{robot.location} = \texttt{at1} \wedge \texttt{robot.moving}) \supset ((X(\texttt{robot.location} = \texttt{btw12} \wedge X(\texttt{robot.location} = \texttt{at2}))) \vee (X(\texttt{robot.location} = \texttt{btw12} \wedge X(\texttt{robot.location} = \texttt{btw12} \wedge X(\texttt{robot.location} = \texttt{at2})))))) \wedge$
   $G((\texttt{robot.location} = \texttt{at2} \wedge \texttt{robot.moving}) \supset (((X(\texttt{robot.location} = \texttt{btw12} \wedge X(\texttt{robot.location} = \texttt{at1}))) \vee (X(\texttt{robot.location} = \texttt{btw12} \wedge X(\texttt{robot.location} = \texttt{btw12} \wedge X(\texttt{robot.location} = \texttt{at1}))))) \vee (((X(\texttt{robot.location} = \texttt{btw23} \wedge X(\texttt{robot.location} = \texttt{at3}))) \vee (X(\texttt{robot.location} = \texttt{btw23} \wedge X(\texttt{robot.location} = \texttt{btw23} \wedge X(\texttt{robot.location} = \texttt{at3})))))))) \wedge$
   $G((\texttt{robot.location} = \texttt{at3} \wedge \texttt{robot.moving}) \supset ((X(\texttt{robot.location} = \texttt{btw23} \wedge X(\texttt{robot.location} = \texttt{at2}))) \vee (X(\texttt{robot.location} = \texttt{btw23} \wedge X(\texttt{robot.location} = \texttt{btw23} \wedge X(\texttt{robot.location} = \texttt{at2}))))))$

10. People can put mail in the robot compartment (making the value of the sensor true) only when the lid is open.
    LTL Formula:
    $G(\texttt{robot.sensor} \supset \texttt{robot.lid} = \texttt{open})$

11. If there are no requests from any other office, the robot should not move.
    CTL Formula:
    $A[(\neg\texttt{robot.moving}) U (\texttt{office1.robot\_button} \vee \texttt{office2.robot\_button} \vee \texttt{office3.robot\_button})]$

12. The robot cannot change direction between offices.
    CTL Formula:
    $AG((\texttt{robot.location} = \texttt{btw12} \wedge \texttt{robot.direction} = \texttt{forward}) \supset AX(\texttt{robot.location} = \texttt{at2} \vee (\texttt{robot.location} = \texttt{btw12} \wedge AX(\texttt{robot.location} = \texttt{at2})))) \wedge$
    $AG((\texttt{robot.location} = \texttt{btw12} \wedge \texttt{robot.direction} = \texttt{backward}) \supset AX(\texttt{robot.location} = \texttt{at1} \vee (\texttt{robot.location} = \texttt{btw12} \wedge AX(\texttt{robot.location} = \texttt{at1})))) \wedge$
    $AG((\texttt{robot.location} = \texttt{btw23} \wedge \texttt{robot.direction} = \texttt{forward}) \supset AX(\texttt{robot.location} = \texttt{at3} \vee (\texttt{robot.location} = \texttt{btw23} \wedge AX(\texttt{robot.location} = \texttt{at3})))) \wedge$
    $AG((\texttt{robot.location} = \texttt{btw23} \wedge \texttt{robot.direction} = \texttt{backward}) \supset AX(\texttt{robot.location} = \texttt{at2} \vee (\texttt{robot.location} = \texttt{btw23} \wedge AX(\texttt{robot.location} = \texttt{at2}))))$

13. If the robot is in front of the second office and there are requests from both the first and third offices, the robot will continue moving in its current direction.

CTL Formula:
$AG((\texttt{robot.location} = \texttt{at2} \wedge \texttt{office1.robot\_button} \wedge \texttt{office3.robot\_button} \wedge \texttt{robot.moving}) \supset ((\texttt{robot.direction} = \texttt{forward} \supset AX(\texttt{robot.location} = \texttt{btw23})) \wedge (\texttt{robot.direction} = \texttt{backward} \supset AX(\texttt{robot.location} = \texttt{btw12}))))$

14. If the robot is in front of a requested office, it will not leave this office before the lid is open.
CTL Formula:
$AG(\texttt{office1.robot\_button} \supset AF(\texttt{robot.location} = \texttt{at1} \wedge A[\texttt{robot.location} = \texttt{at1} U \texttt{robot.lid} = \texttt{open}])) \wedge$
$AG(\texttt{office2.robot\_button} \supset AF(\texttt{robot.location} = \texttt{at2} \wedge A[\texttt{robot.location} = \texttt{at2} U \texttt{robot.lid} = \texttt{open}])) \wedge$
$AG(\texttt{office3.robot\_button} \supset AF(\texttt{robot.location} = \texttt{at3} \wedge A[\texttt{robot.location} = \texttt{at3} U \texttt{robot.lid} = \texttt{open}]))$

15. It is possible that there are requests for the first and third offices at the same time and the robot chooses to go to the third office first.
CTL Formula:
$EF(\texttt{office1.robot\_button} \wedge \texttt{office3.robot\_button} \wedge E[\texttt{robot.location} \neq \texttt{at1} U \texttt{robot.location} = \texttt{at3}])$

16. It is possible that there are requests for the first and third offices at the same time and the robot chooses to go to the first office first.
CTL Formula:
$EF(\texttt{office1.robot\_button} \wedge \texttt{office3.robot\_button} \wedge E[\texttt{robot.location} \neq \texttt{at3} U \texttt{robot.location} = \texttt{at1}])$

Additional Specifications

1. The robot cannot skip any office with a request, i.e., the robot must stop at an office with a request when it is in front of that office and it cannot move before opening its lid.
LTL Formula:
$G((\texttt{office1.robot\_button} \wedge X(\texttt{robot.location} = \texttt{at1})) \supset X(\neg \texttt{robot.moving} U \texttt{robot.lid} = \texttt{open})) \wedge$
$G((\texttt{office2.robot\_button} \wedge X(\texttt{robot.location} = \texttt{at2})) \supset X(\neg \texttt{robot.moving} U \texttt{robot.lid} = \texttt{open})) \wedge$
$G((\texttt{office3.robot\_button} \wedge X(\texttt{robot.location} = \texttt{at3})) \supset X(\neg \texttt{robot.moving} U \texttt{robot.lid} = \texttt{open}))$

2. The robot must always be moving when it is in between offices.
CTL Formula:
$AG((\texttt{robot.location} = \texttt{btw12} \vee \texttt{robot.location} = \texttt{btw23}) \supset \texttt{robot.moving})$

3. The robot button is off if and only if the office button is off.
CTL Formula:
$AG((\neg \texttt{office1.robot\_button} \supset \texttt{office1.office\_button} = \texttt{off}) \wedge (\texttt{office1.office\_button} = \texttt{off} \supset \neg \texttt{office1.robot\_button})) \wedge$
$AG((\neg \texttt{office2.robot\_button} \supset \texttt{office2.office\_button} = \texttt{off}) \wedge (\texttt{office2.office\_button} = \texttt{off} \supset \neg \texttt{office2.robot\_button})) \wedge$
$AG((\neg \texttt{office3.robot\_button} \supset \texttt{office3.office\_button} = \texttt{off}) \wedge (\texttt{office3.office\_button} = \texttt{off} \supset \neg \texttt{office3.robot\_button}))$