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|  | A picture containing food  Description automatically generated |
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| Adaptive Vehicle  Lighting Control |
| For Smarter Vehicle |
|  |
| KPIT Technologies Ltd. |



“Connecting cars with technology for a smarter, better, and safer world.”

Project By:

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**Project Vision**



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# State of the Art

# Introduction:

# 4W1H

### What is adaptive vehicle lighting control system ?

Adaptive vehicle lighting control system uses electronic sensors to detect the speed of the car, how far the driver has turned the steering wheel, foggy and rainy weather, distance of car from any other cars travelling in the opposite direction, presence of light intensity outside. Proposed system uses these sensors data to automatically turn on or off the fog light, tail light as well as headlight. It controls the high beam and low beam operations of headlight depending on the street light present, distance of cars travelling in opposite direction and forward light. Also, it controls the direction of headlight depending on the steering position. The lights turn their beams around each bend in the road, giving a better view of what's ahead. Depending on difference situation and requirements system controls the intensity of each light.

### Where it can be used ?

Adaptive vehicle lighting system can be used in car where required sensors can be implemented and control lights automatically. System is most suitable for automatic cars as they are designed to reduce the driver’s control and intended to make features automatic.

### How it works?

System can be implemented by connecting various required sensors in car. When auto mode is selected for controlling light sensors data is used for controlling all lights of car. LDR is connected to detect the darkness. Sensor detects the position of the steering which turns the headlight of car in left or right direction by specified angle. Also, system takes the sensor data for street light present, distance of other vehicles travelling in opposite direction, any human or animal on road or obstacle, forward light to decide the switching of high beam and low beam of the headlight. Humidity sensors detects the intensity of fog present in air and according to the input system actuates the fog light with 30%, 60% or 100% intensity. When auto mode is on and there is darkness system turns on the tail lights.

### Why is it implemented ?

Standard headlights shine straight ahead, no matter what direction the car is moving. When going around curves, they illuminate the side of the road more than the road itself. Adaptive headlights react to the steering, speed and elevation of the car and automatically adjust to illuminate the road ahead. When the car turns right, the headlights angle to the right. Turn the car left, the headlights angle to the left. This is important not only for the driver of the car with adaptive headlights, but for other drivers on the road as well. Headlight intensity of vehicles poses a great danger during night travel. The drivers of most vehicles use high bright beam while driving at night. The glare of oncoming headlights can cause serious visibility problems. This causes inconvenience for the person travelling from the opposite direction. To avoid such incidents system is implemented to switch the high beam and low beam appropriately.

Fog usually increases the chances of accidents. So whenever driving in fog to reduce hazards, fog lights must be used. Tail lights are useful for indicating the vehicles or people on the road presence of the moving car. As each car lights plays an essential role in driving and indications for safety, using these lights appropriately is very important for safety of driver and others. As system controls all lights automatically, it reduces the efforts of driver as well as probability of accidents. It ensures the safety driving with improved driving experience.

### When does adaptive lighting control system come into play?

When car engine is on, Auto control mode is selected and darkness is detected by LDR system activates to control lights automatically

# SWOT Analysis

|  |  |
| --- | --- |
| Strengths:   * Prevent injuries and property damage due to accidents * Save driver’s time. * System is unaffected by most weather conditions * Cost effective | Weaknesses:   * In extreme conditions, heavy dirt and grime on the ultrasonic sensors reduce their effectiveness but can be easily remedied by wiping clean the sensors |
| Opportunities:   * Small camera can be mounted in a protected area on the rear of the car. | Threats:   * Very heavy rain or snowfall can cause the ultrasonic sensor to indicate that an object appears closer than it really is. |

# Applications

* This system can be used in any vehicle for controlling different lights stated.
* Subsystems can be modified to control the lights in home or industry

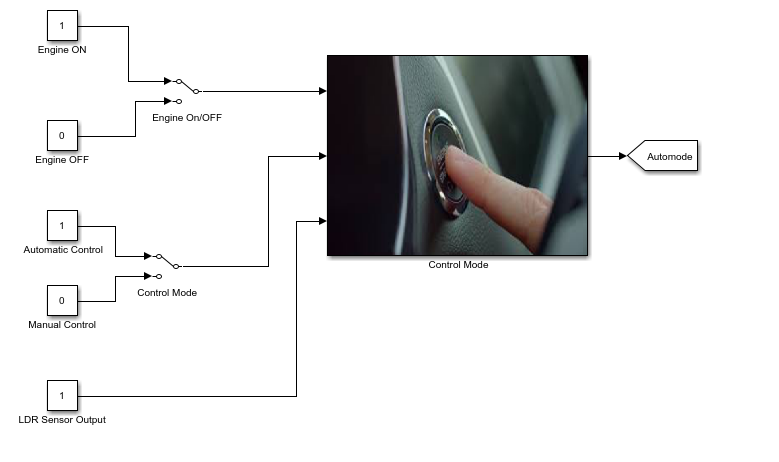
# Stakeholder’s Requirements

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| --- | --- | --- |
| Feature | Stakeholder’s  Requirement | System Requirement |
| 1. Automatic headlight control | Headlight should adjust its direction, intensity. High beam and low beam of headlight must switch on or off as per operating conditions | Distance sensor  Light sensor  Controller  Steering position sensor  DC Motor |
| 1. Automatic Fog light control | When fog is detected while driving fog light must turn on with required intensity for clear vision | Humidity sensor  Controller |
| 1. Tail light control | When there is darkness tail light must be on | LDR sensor  Controller |

# C. MATLAB Modeling and Simulation:

1. Subsystems:

a. Auto/Manual Control Mode:



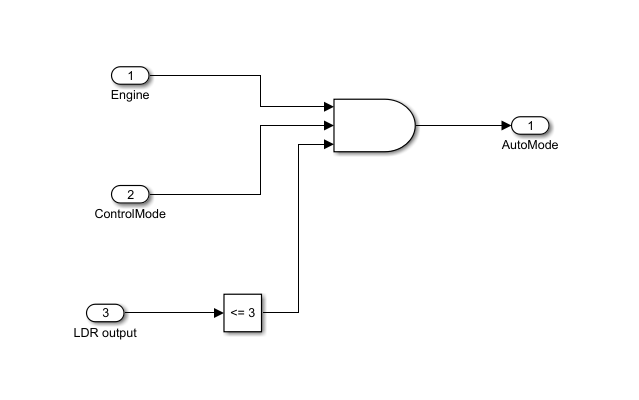
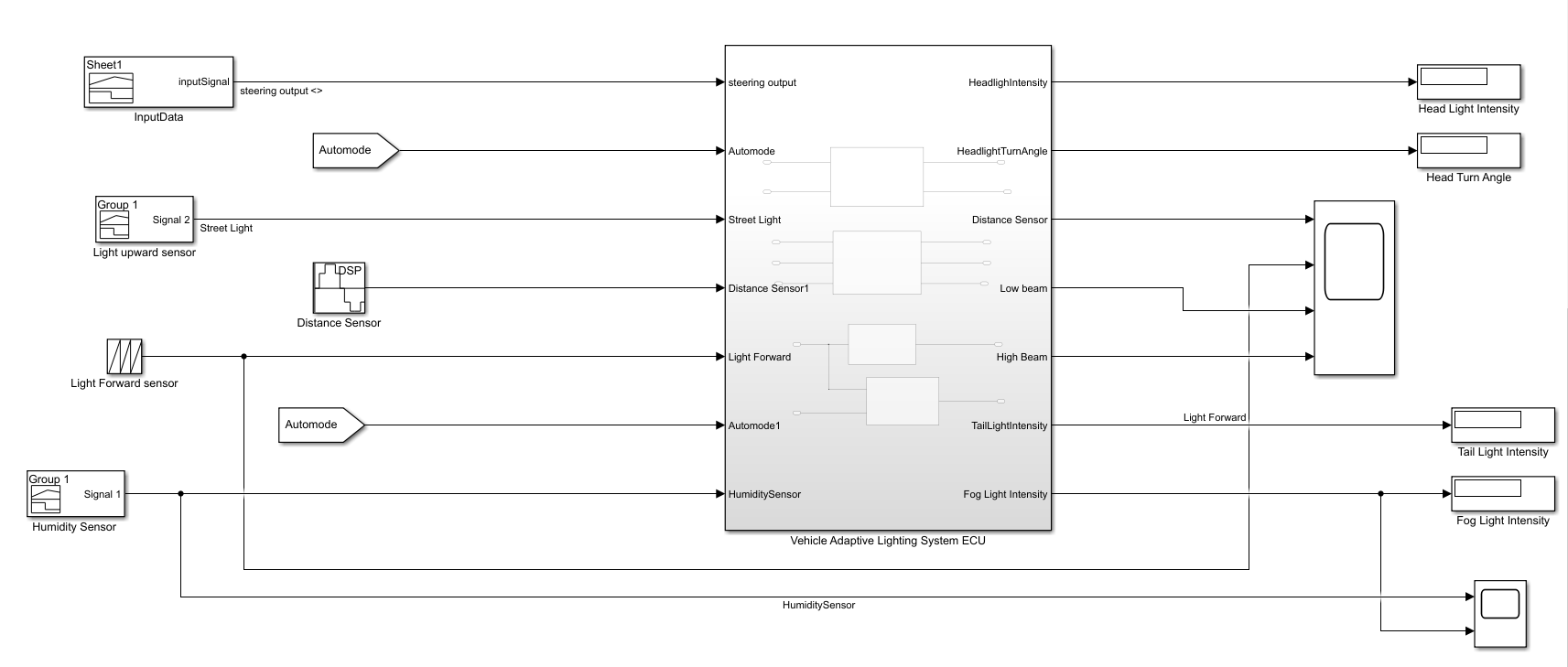


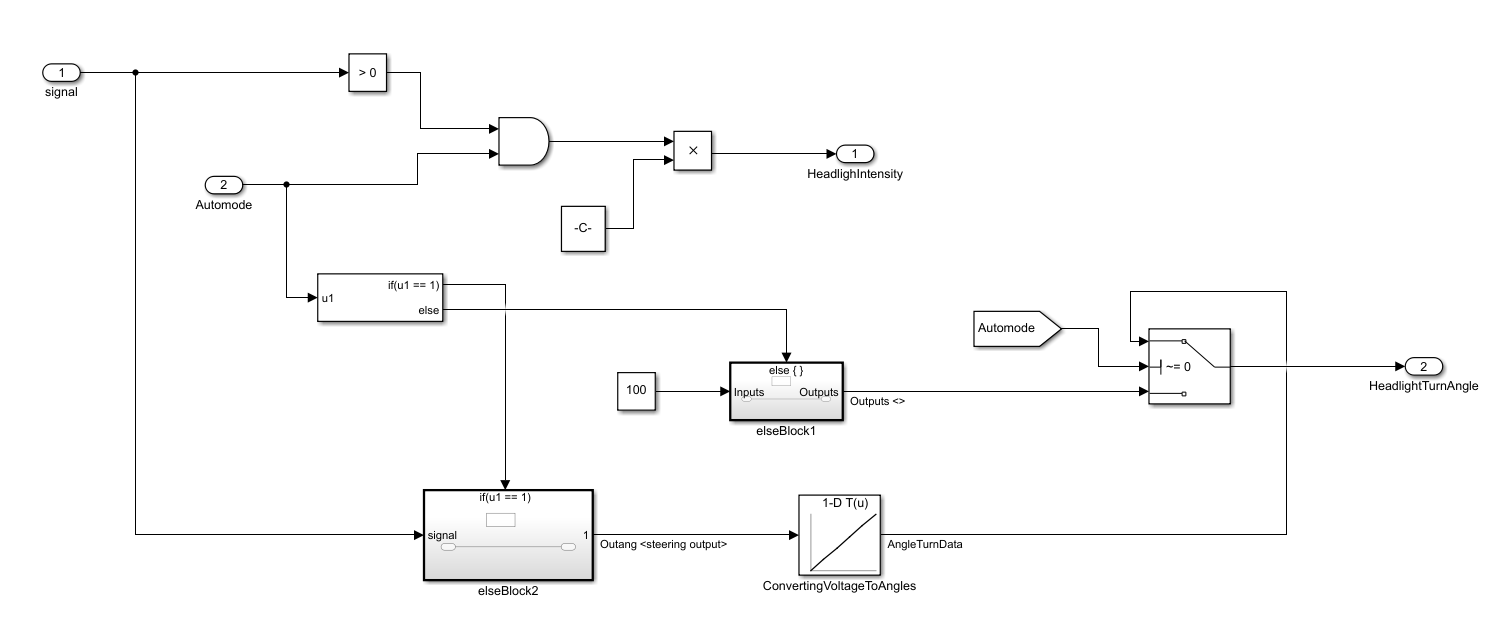
Fig. MATLAB model

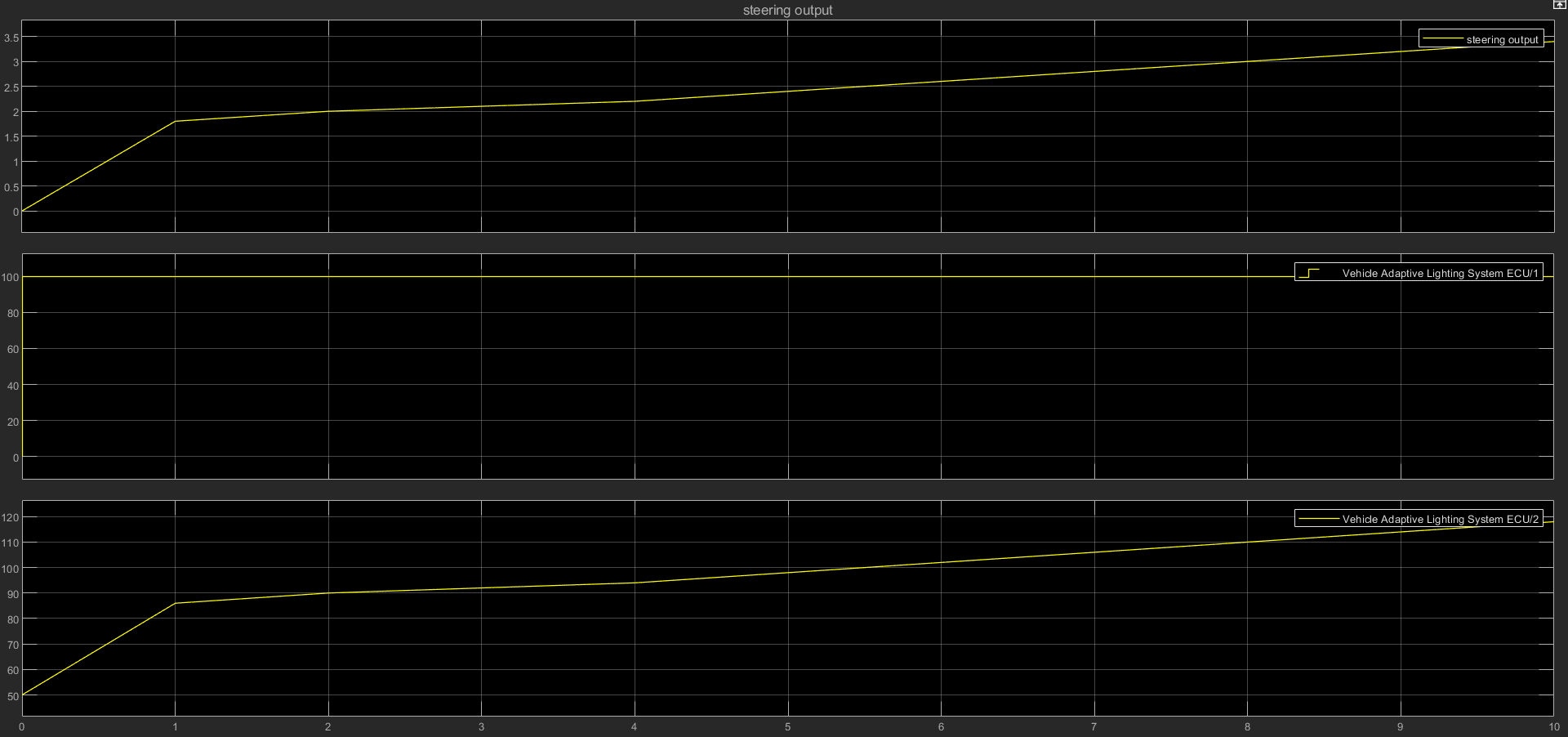
b. Integrated ECU control unit:



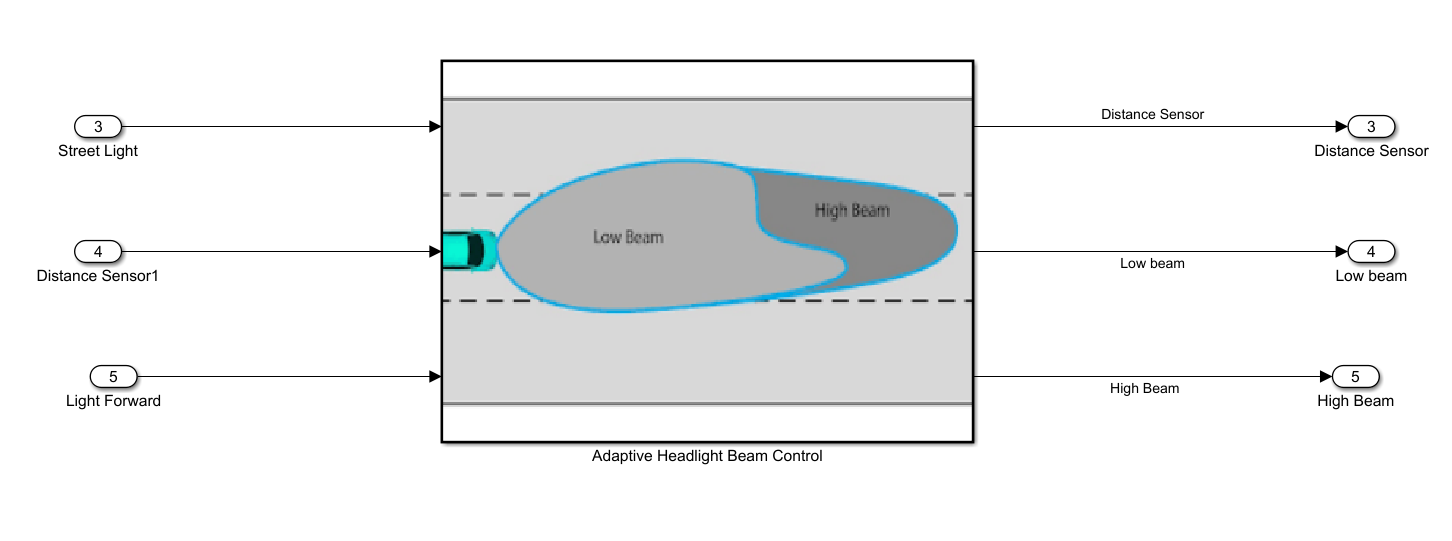
c. Headlight direction control system

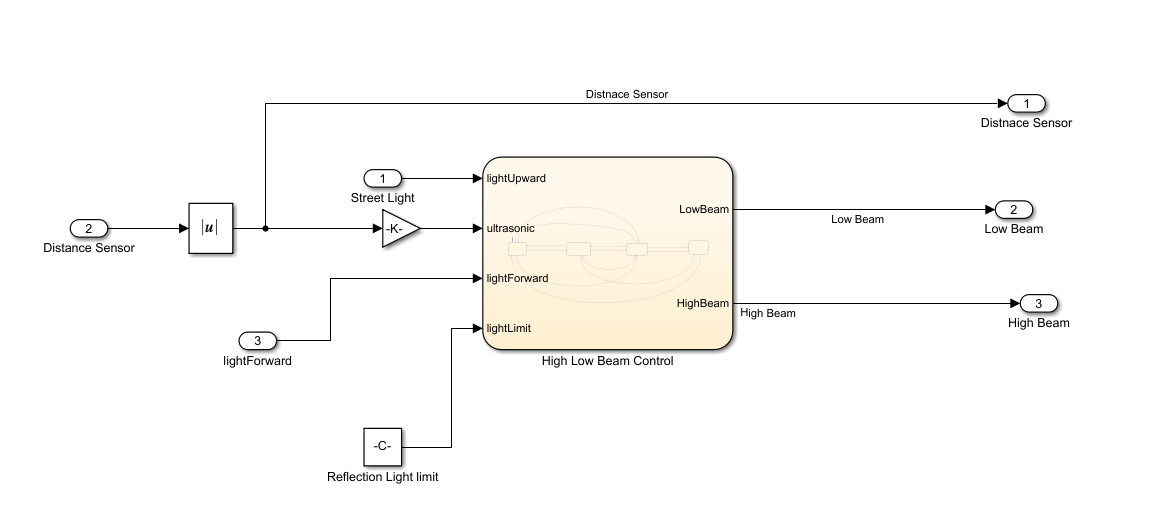


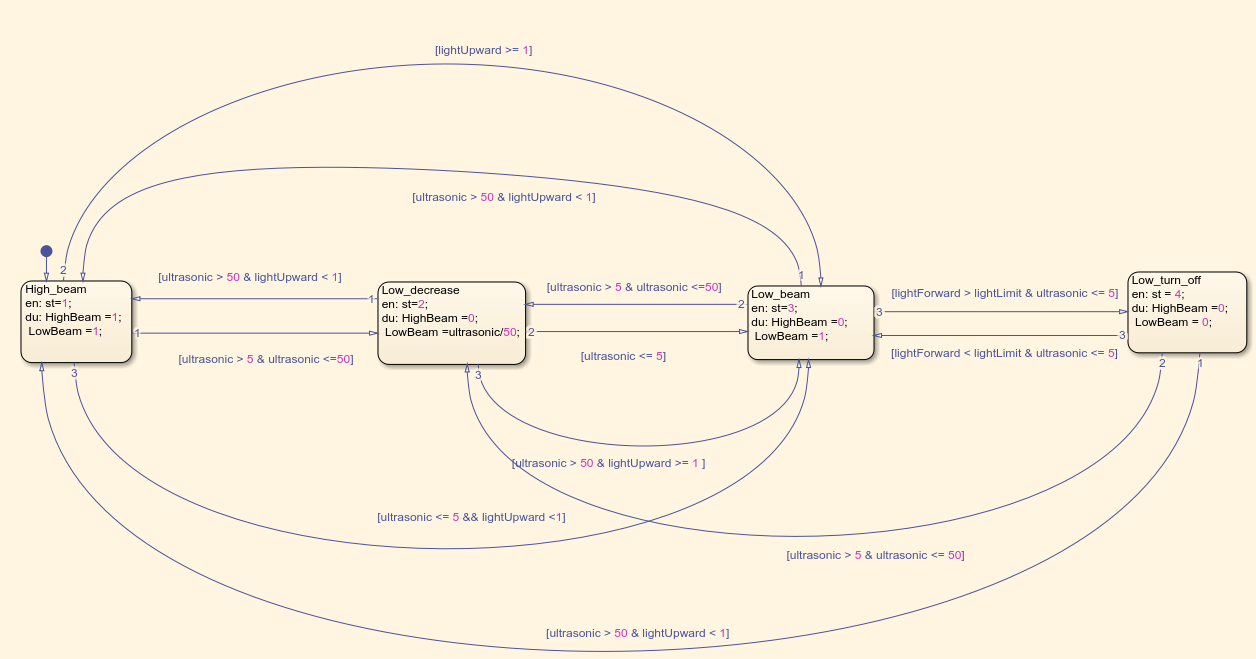
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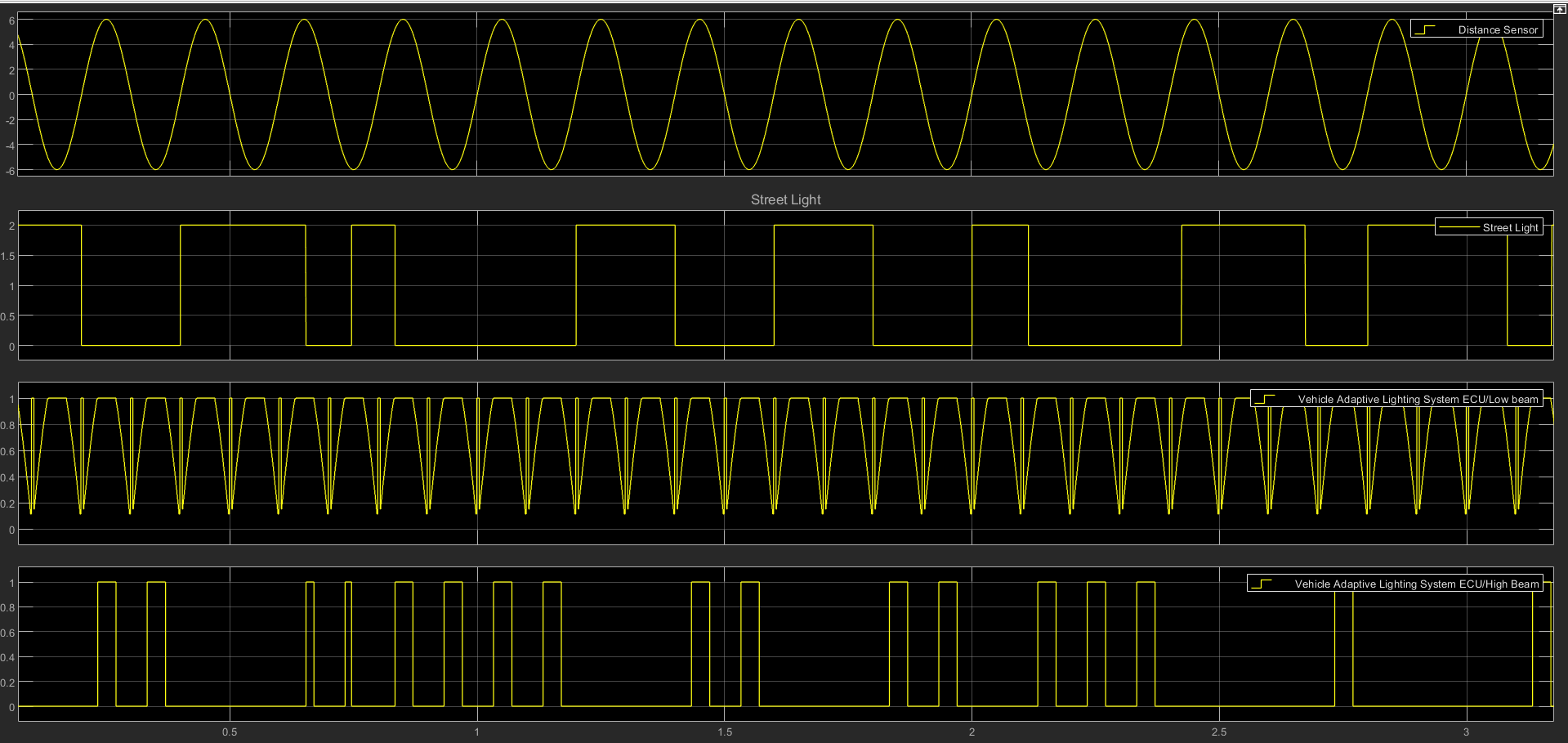
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## d. Adaptive headlight beam control

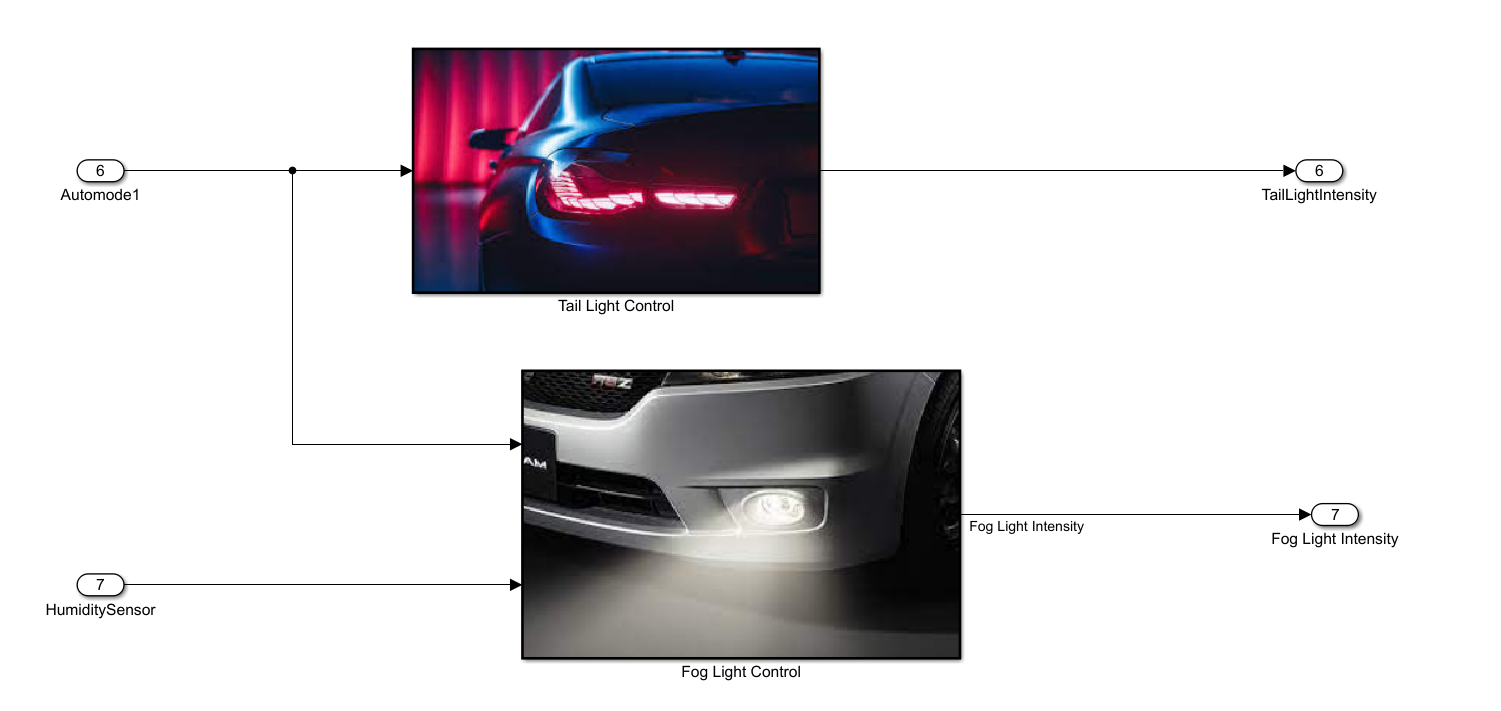


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## e. Fog light and tail light control



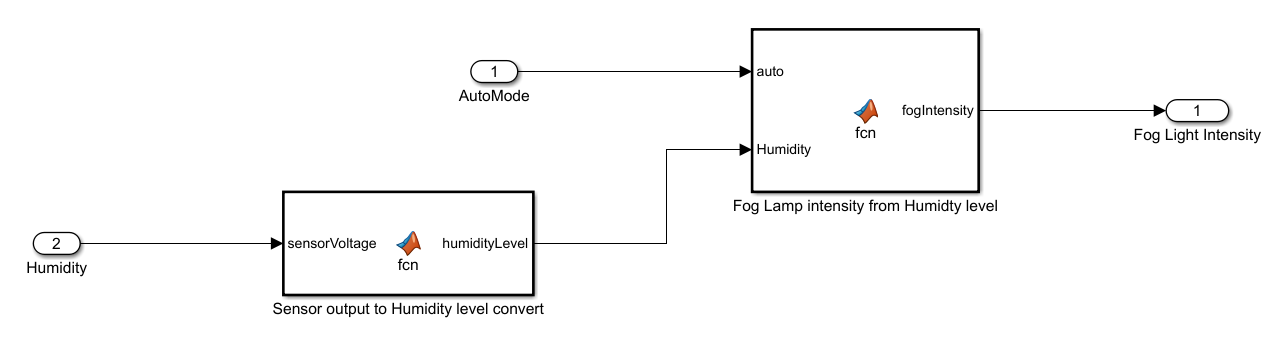
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Fig. Fog light MATLAB model

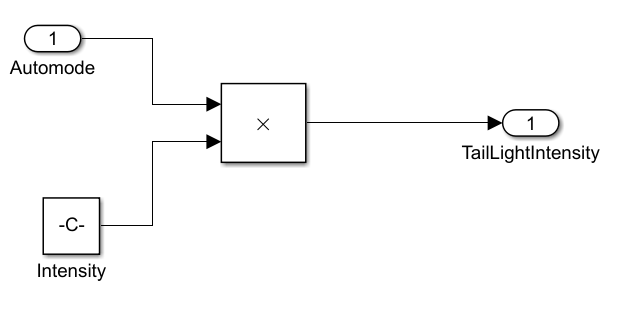
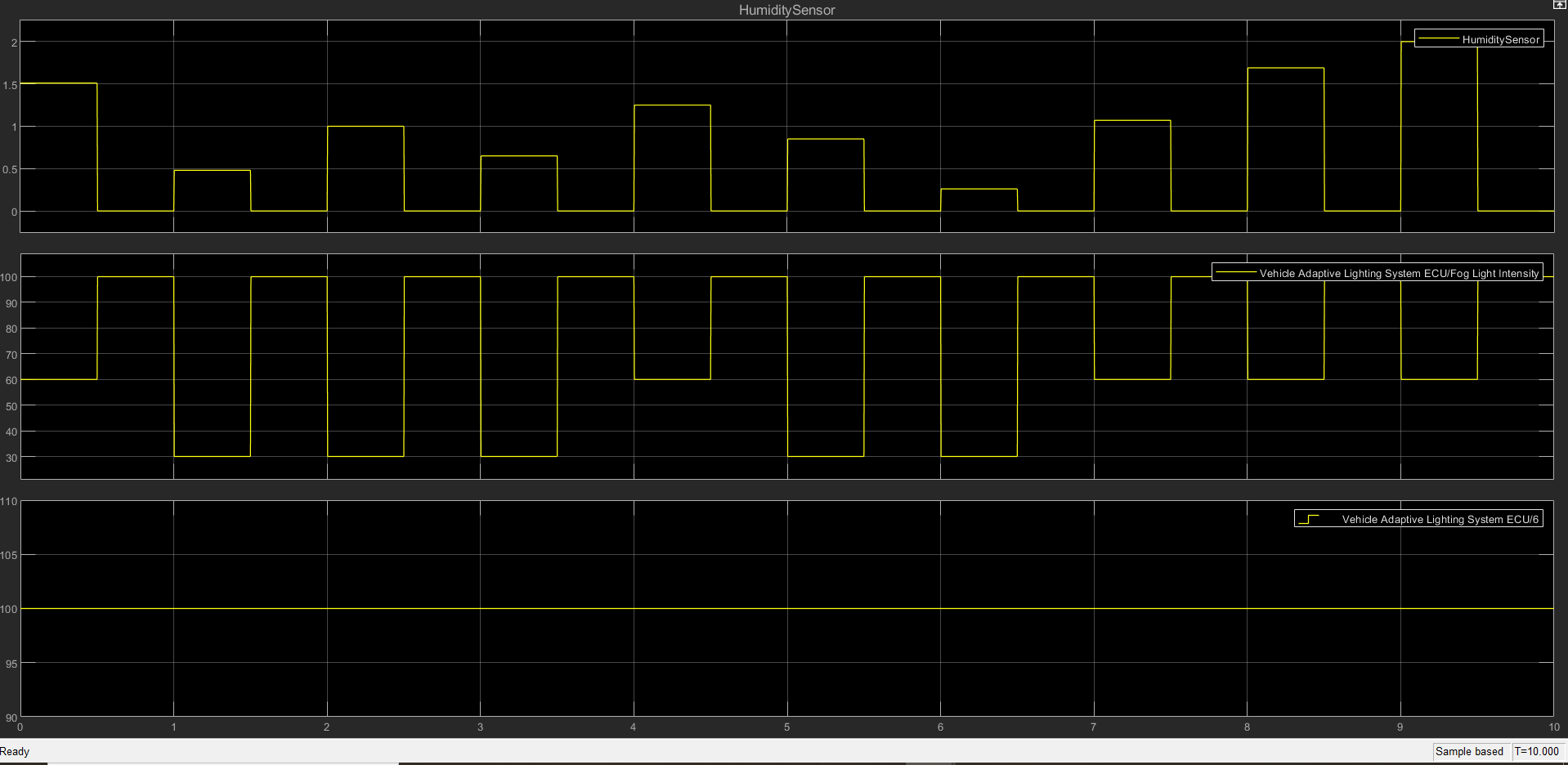


Fig. Tail light MATLAB model



**D. MATLAB and Simulink Skills Implemented**

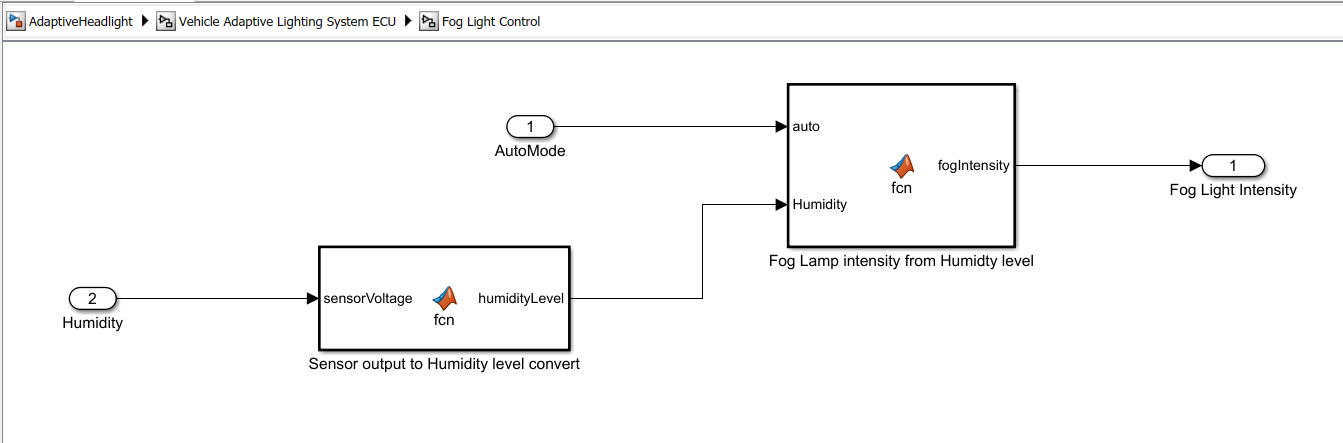
## 1. Data Inspector

* Input signals such as Humidity sensor output, steering position data, street light, forward light, distance sensor data signals are logged for monitoring the working of system.
* Output signals such as Fog light intensity, Headlight turn angle, low beam, high beam status signals, tail light intensity signals logged for analysis of system working as per the input signal conditions.
* System simulated under various conditions and output signals between different runs are compared.

## 

## 2. MATLAB Function Block

* MATLAB function implemented for Fog light control subsystem which takes the humidity sensor data as input argument and returns the corresponding humidity level low, medium or high.
* This humidity level is given as input to another function to decide the intensity of the fog light as per fog density as 30%, 60% or 100%.



## Signal Builder

* Random signal for representing different steering positions generated using signal builders to test system for various inputs
* Light upward sensor signal generated using signal builder by modifying the square wave to check random presence of external light
* Humidity sensor output signal generated using signal builder to check system behavior for different values of humidity ranging from 0 to 3

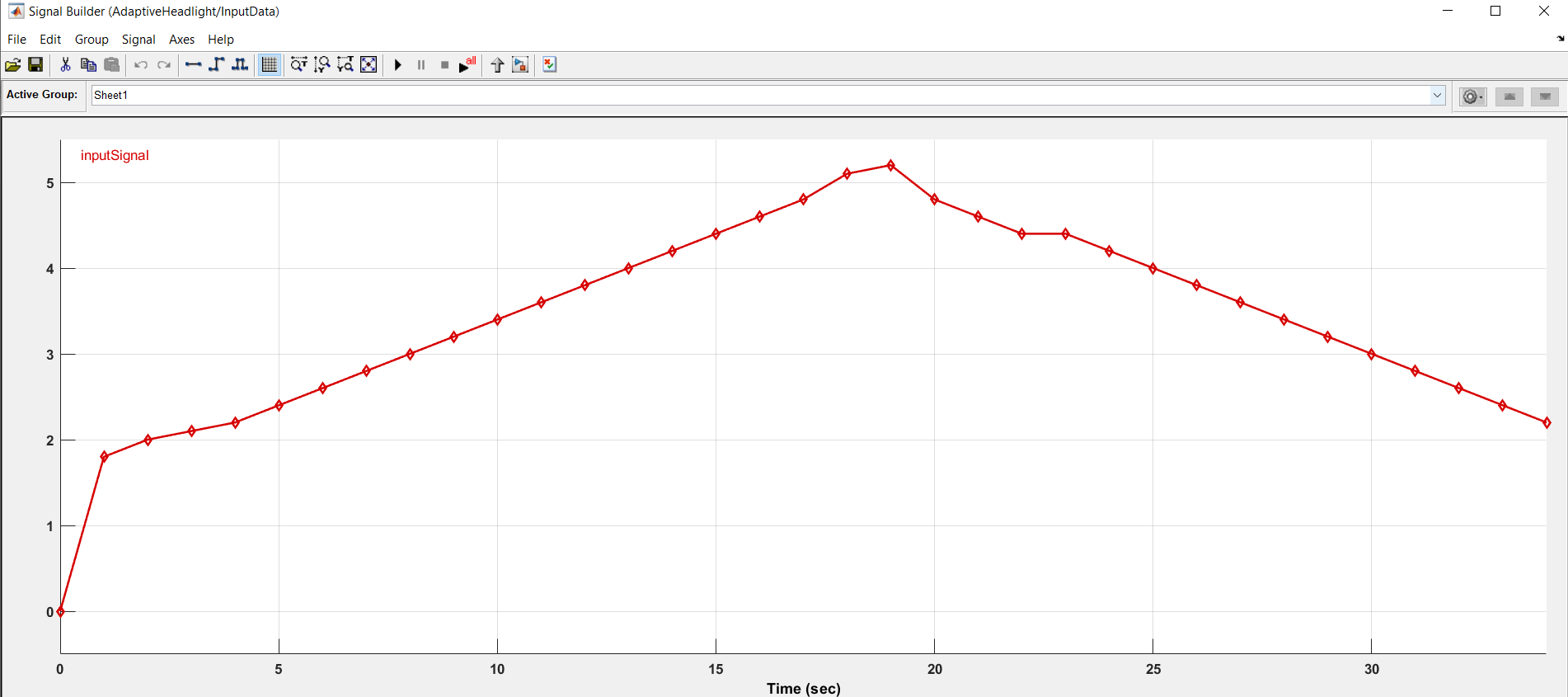


Fig. Steering Position signal

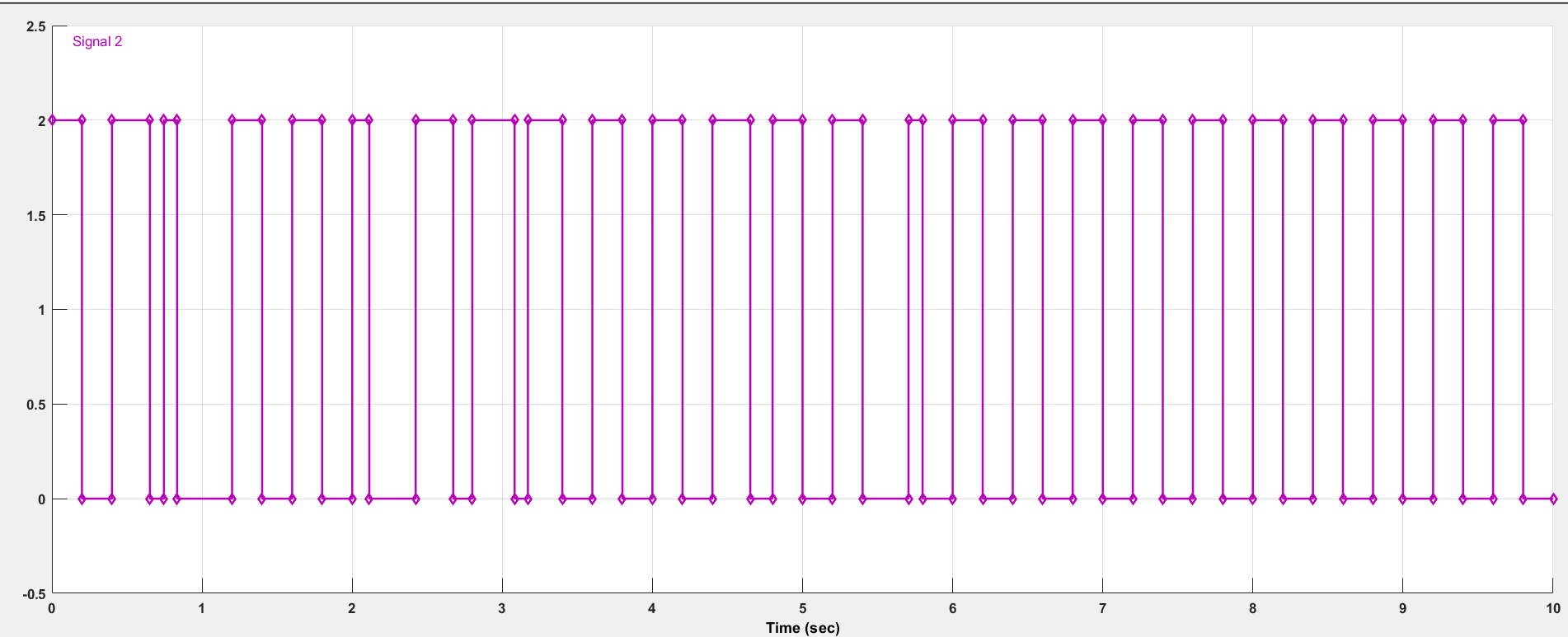


Fig. Upward light signal

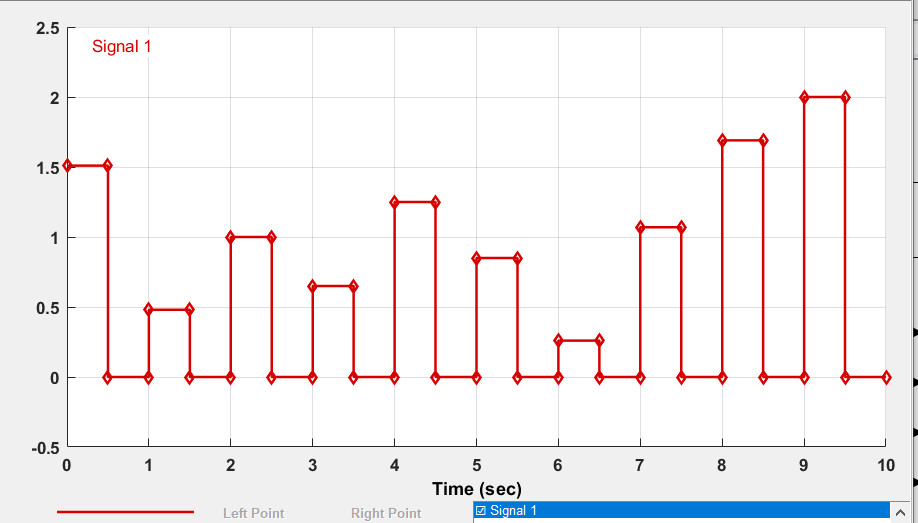


Fig. Humidity Sensor data output

## Look Up Table

* Look up table used for giving the headlight turn angle values corresponding to the steering position.
* Steering position given as breakpoint and Turning angle as Table data

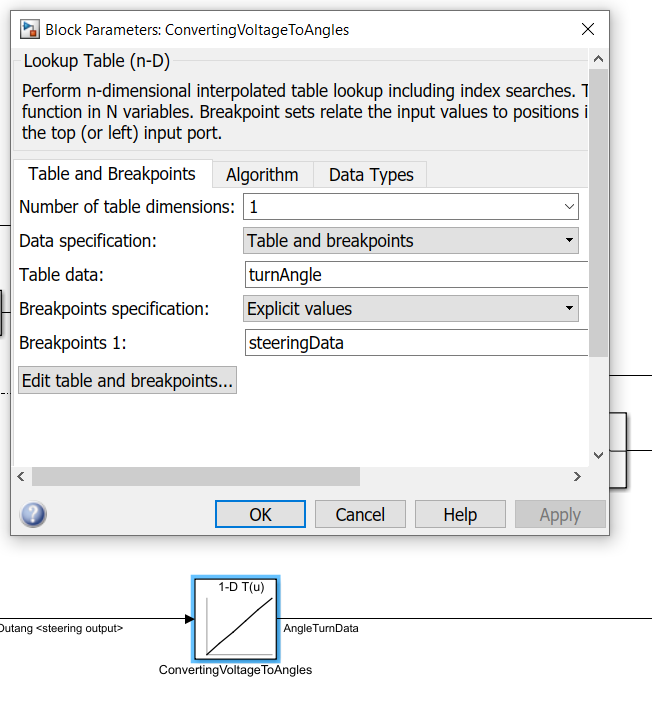


Fig. Look up table used in system

## Callbacks

* Callback functions such as PostLoadFunc used for automatic initialization of parameter values and closeFunc used for saving all files and closing the file after simulation

## Solver Strategy

Variable step solver is used for adaptive lighting control system. Simulation max step size selected is 0.001 for smooth waves. Simulation performed for 10 sec.

## Data Dictionary

* Data dictionary is used for giving the default values and defined parameter values for flexibility of checking the system for different data set

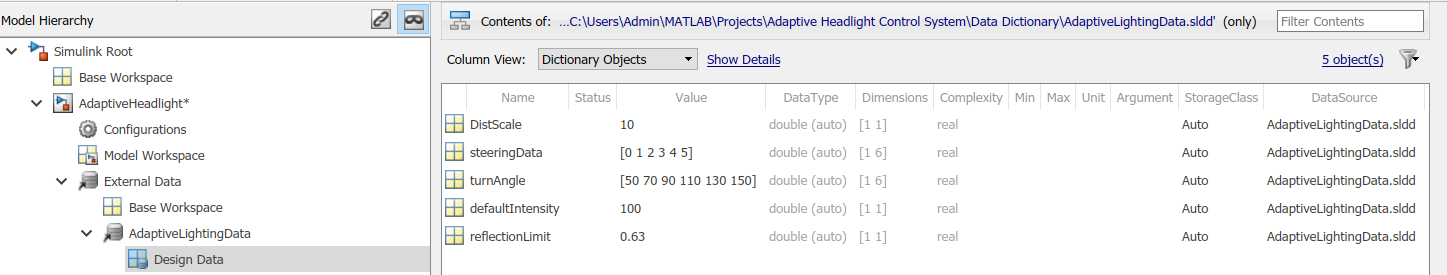


Fig. Data Dictionary

## State chart

* Statechart containing 4 states created for controlling switching of High beam and low beam depending on various sensor inputs

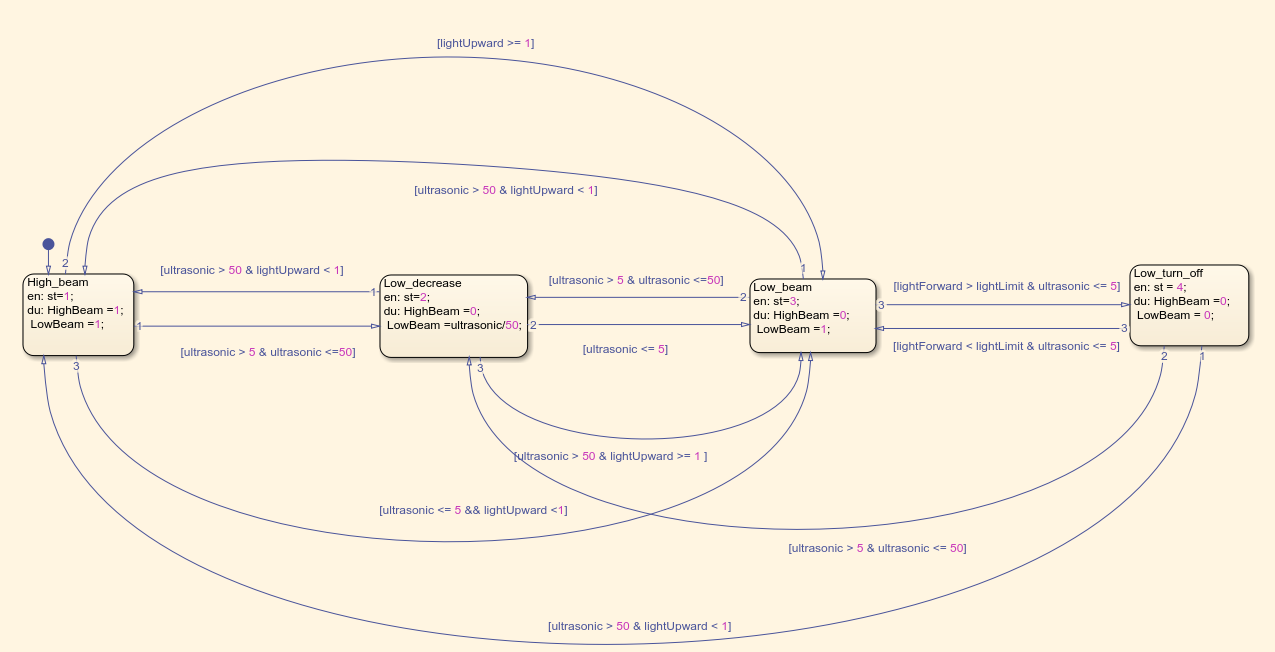


Fig. State chart Implemented

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