WHAT IS CLAIMED IS:

1. A driving consciousness estimation device comprising:

a driver image acquisition unit configured to acquire a driver image in which a driver of a vehicle is imaged;

a travelling environment recognition unit configured to recognize a travelling environment around the vehicle;

a driving readiness estimation unit configured to estimate a driving readiness relating to a driving consciousness of the driver from a driver's reaction to the travelling environment based on the driver image and the travelling environment;

a driving task demand estimation unit configured to estimate a driving task demand;

a margin calculation unit configured to calculate a result of comparison between a value of the driving readiness and a value of the driving task demand as a margin; and

an attention awakening unit configured to execute awakening of attention for the driver relating to the driving of the vehicle,

wherein the vehicle is capable of autonomous driving by shifting between a plurality of autonomous driving levels, the levels of autonomous driving being defined according to a degree of autonomous driving,

wherein the driving readiness is a degree of height of the driving consciousness of the driver,

wherein the driving task demand is calculated based on at least one of the following:

a vehicle speed of the vehicle,

time to collision between the vehicle and a preceding vehicle, and

a curvature of a road that the vehicle is traveling,

wherein the driving task demand is a required driving readiness required from the traveling environment,

wherein, in a case where the margin is smaller than a margin threshold value, the attention awakening unit is configured to execute awakening of the attention, and

wherein the higher the executed autonomous driving level is in the vehicle, the smaller the margin threshold value used.

2. The driving consciousness estimation device according to Claim 1,

further comprising:

a manual driving possibility determination unit configured to determine whether or not the driver is in a manual driving possible situation based on the result of comparison between the driving readiness and the driving task demand when an autonomous driving electronic control unit (ECU) of the vehicle ends the autonomous driving.

3. The driving consciousness estimation device according to Claim 1,

wherein the driving readiness estimation unit is configured to calculate the number of saccades of eye balls per a predetermined time interval during a period when the driver is facing the extending direction of the road on which the vehicle is travelling based on the driver image and the travelling environment, and estimate the driving readiness based on the number of saccades.

4. The driving consciousness estimation device according to Claim 3, further comprising:

a manual driving possibility determination unit configured to determine whether or not the driver is in a manual driving possible situation based on the result of comparison between the driving readiness and the driving task demand when an autonomous driving electronic control unit (ECU) of the vehicle ends the autonomous driving.

5. A driving consciousness estimation device comprising:

a driver image acquisition unit configured to acquire a driver image in which a driver of a vehicle is imaged;

a travelling environment recognition unit configured to recognize a travelling environment around the vehicle;

a vehicle state recognition unit configured to recognize a travelling state of the vehicle;

a driving readiness estimation unit configured to estimate a driving readiness relating to a driving consciousness of the driver from a driver's reaction to the vehicle state based on the driver image and the vehicle state;

a driving task demand estimation unit configured to estimate a driving task demand;

a margin calculation unit configured to calculate a result of comparison between a value of the driving readiness and a value of the driving task demand as a margin; and

an attention awakening unit configured to execute awakening of attention for the driver relating to the driving of the vehicle,

wherein the vehicle is capable of autonomous driving by shifting between a plurality of autonomous driving levels, the levels of autonomous driving being defined according to a degree of autonomous driving,

wherein the driving readiness is a degree of height of the driving consciousness of the driver,

wherein the driving task demand is calculated based on at least one of the following:

a vehicle speed of the vehicle,

time to collision between the vehicle and a preceding vehicle, and

a curvature of a road that the vehicle is traveling,

wherein the driving task demand is a required driving readiness required from the traveling environment,

wherein, in a case where the margin is smaller than a margin threshold value, the attention awakening unit is configured to execute awakening of the attention, and

wherein the higher the executed autonomous driving level is in the vehicle, the smaller the margin threshold value used.

6. The driving consciousness estimation device according to Claim 5, further comprising:

a manual driving possibility determination unit configured to determine whether or not the driver is in a manual driving possible situation based on the result of comparison between the driving readiness and the driving task demand when an autonomous driving electronic control unit (ECU) of the vehicle ends the autonomous driving.

7. The driving consciousness estimation device according to Claim 5,

wherein the vehicle state recognition unit is configured to recognize a longitudinal acceleration of the vehicle as the vehicle state, and

wherein the driving readiness estimation unit is configured to estimate the driving readiness from a head pitch angle of the driver with respect to the longitudinal acceleration of the vehicle based on the driver image and the longitudinal acceleration of the vehicle.

8. The driving consciousness estimation device according to Claim 7, further comprising:

a manual driving possibility determination unit configured to determine whether or not the driver is in a manual driving possible situation based on the result of comparison between the driving readiness and the driving task demand when an autonomous driving electronic control unit (ECU) of the vehicle ends the autonomous driving.