(12) UK Patent (19)GB (11) 2554427 (13)B

(54) Title of the Invention: Method and device for detecting a trailer

(51) INT CL: **B60D 1/36** (2006.01)   **B60R 1/00** (2006.01)   **B62D 15/02** (2006.01)

(72) Inventor(s):
Bhanu Prakash Padiri
Sandeep Kuinthodu

(73) Proprietor(s):
Continental Automotive GmbH
Vahrenwalder Strasse 9, 30165 Hannover, Germany

(74) Agent and/or Address for Service:
Conti Temic microelectronic GmbH
Sieboldstrasse 19, 90411 Nürnberg, Germany

GB 2554427 B

Capturing a live video stream of the rearward scene of the vehicle —— S1

Displaying the live video stream to a user on a touch-screen —— S2

Recognizing a user input via the touch-screen —— S3

Detecting a trailer in the live video stream based on the user input —— S4

Camera calibration parameters ⇢ Providing trailer assistant functions —— S5

Tracking of the trailer using template matching

Extracting the height and width of the trailer
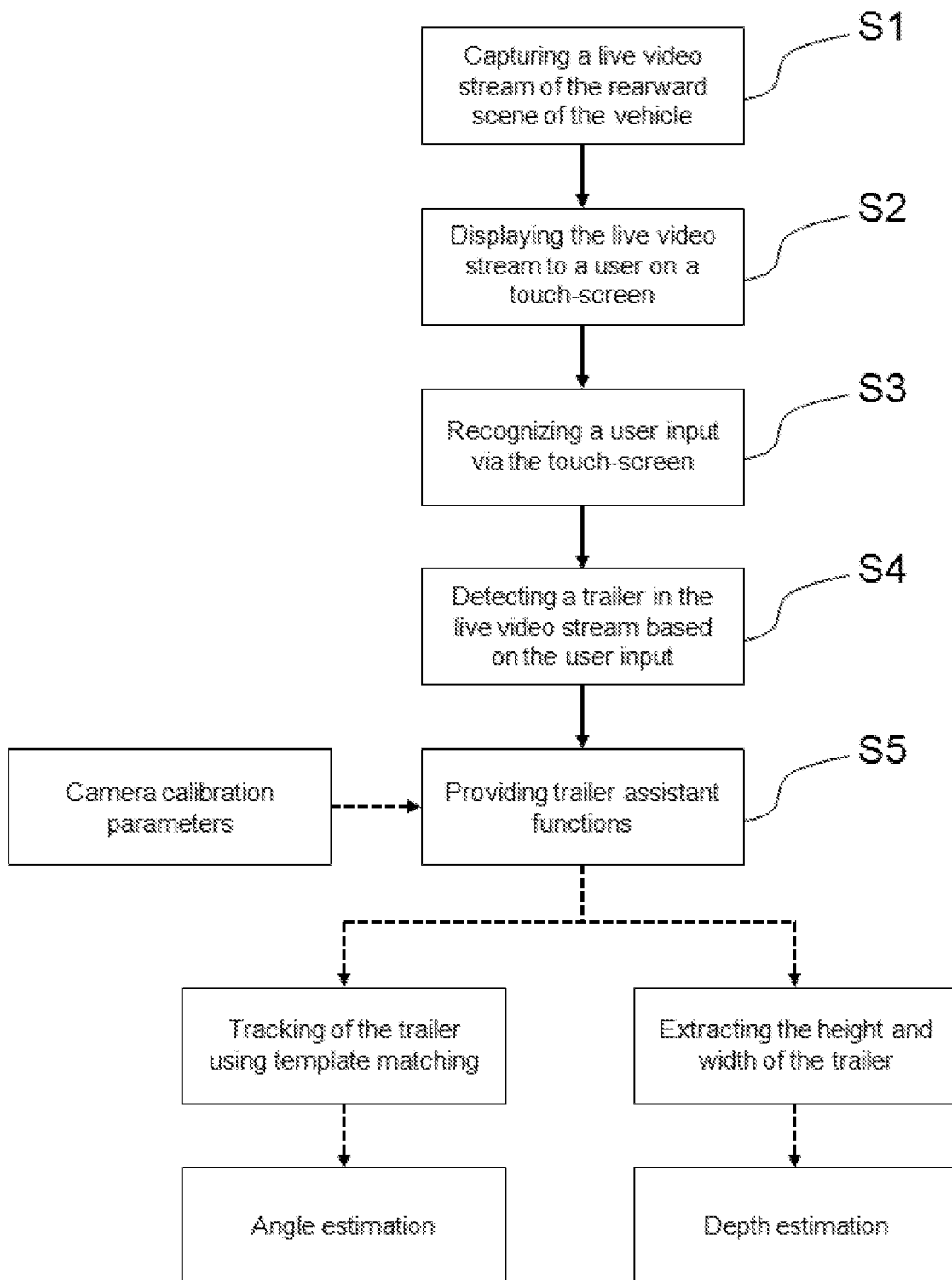
Angle estimation
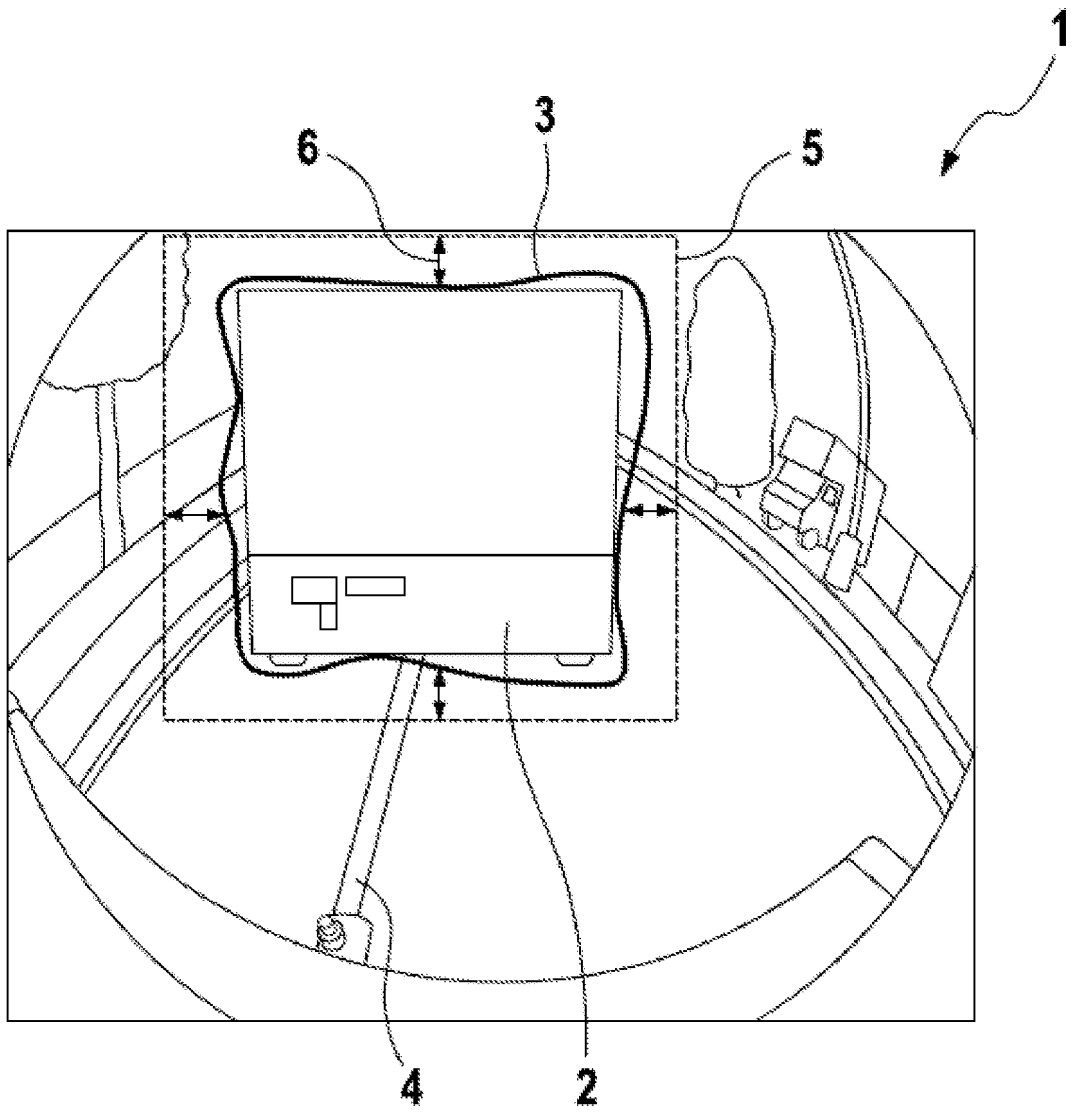
Depth estimation

Fig. 1

Fig. 2

METHOD AND DEVICE FOR DETECTING A TRAILER

The present invention relates to a method for a driver assistant system of a vehicle for detecting a trailer.

5

The prior art already discloses different camera-based driver assistant systems, also called advanced driver assistance systems, offering different trailer assistant functions, in particular comprising a camera-based detection of the trailer and its dimensions and/or a camera-based detection of the angle between the trailer and the vehicle. Based on this, functions like assisted or automated trailer backing and assisted or automated trailer hitching can be offered.

US 2015/321697 A1 discloses a trailer assistance system comprising a trailer angle detection with a rearward facing camera disposed at a rearward portion of a vehicle equipped with the trailer assist system. The rearward facing camera is operable to capture image data representative of the scene rearward of the equipped vehicle. When a trailer is near and/or attached to the equipped vehicle and is rearward of the equipped vehicle, a processor is operable to process the captured image data and, responsive at least in part to such processing, is operable to determine an angle of the trailer relative to a longitudinal axis of the equipped vehicle. Based on this, a display for the driver of the vehicle may be provided indicative of a determined rearward trajectory of the trailer to assist the driver in reversing the vehicle. Also a degree of swing or sway of the trailer can be determined while the vehicle is pulling the trailer in a forward direction, wherein an alert signal is given to alert the driver once the swing or sway is greater than a threshold level.

US 2014/160276 A1 discloses a vehicular vision system comprising a camera which is disposed at a vehicle and having a rearward field of view. The vision system, responsive at least in part to image processing of image data captured by the camera, is operable to determine a trailer angle of a trailer that is towed by the vehicle, to determine a path of the trailer responsive to a steering angle of the vehicle and to display information for viewing by the driver to assist the driver in driving the vehicle with the trailer. The displayed information can be a road in the direction of travel of the vehicle with an overlaying steering path, e.g. to indicate to the driver of the vehicle a steering path for the vehicle to drive the trailer into a desired location.

WO 2014/174028 A1 discloses a system for monitoring available space to maneuver a vehicle to align a tow hitch mounted to the vehicle with a trailer coupling mounted to a trailer. The system comprises an imaging system disposed on the vehicle to generate image data and a processor configured to analyze said image data to determine if there is sufficient space available to maneuver the vehicle to align the tow hitch with the trailer coupling. The processor is further configured to generate a steering guidance signal for steering the vehicle to align the tow hitch with the trailer coupling.

The common concept among the known camera-based trailer assistance systems is the detection of the trailer, which is either already coupled to the vehicle or which is to be hitched to the vehicle, by means of image processing of images captured by a vehicle-mounted camera having a rearward field of view.

Thus, image processing algorithms for the detection of a
trailer are well known, in particular from the above mentioned
prior art. Examples of suitable algorithms are edge detection,
pattern recognition, pattern matching or the detection of tar-
5   gets or markers especially disposed for this purpose on the
trailer, e.g. at specified positions.

However, a fundamental problem of the known systems is the
computational complexity of the image processing algorithms
10   for processing the captured images and for detecting the
trailer and the relevant parameters, like the dimensions of
the trailer and/or the angle between the trailer and the vehi-
cle. This comprises but is not limited to the accurate detec-
tion and estimation of the depth of the trailer, in particular
15   from the real world images of a monocular camera.

It is, therefore, an object of the present invention to pro-
vide an improved method and device for detecting a trailer by
means of camera.
20
This object is solved by the subject matter of the independent
claims. Further improvements are the subject matter of the de-
pendent claims.

25   According to a first aspect of the present invention a method
for detecting a trailer is provided, in particular for being
implemented in a driver assistant system of a vehicle, and in
particular for an assistance system providing one or multiple
trailer assistance functions. The method comprises the steps:
30   capturing at least one image with at least one camera which is
mounted to the vehicle and which has a rearward field of view;
displaying the at least one image to a user on a touch-screen;

recognizing a user input via the touch-screen and detecting at least a portion of the trailer by means of image processing of the at least one image, wherein the image processing of the image is based on the user input.

5

According to the present invention, a region of interest is determined in the at least one image based on the user input and the trailer is detected by means of image processing of the at least one image based on the determined region of in-

10   terest. Thus, the image processing effort for the detection of the trailer is reduced to a defined image region.

According to the present invention, the user input comprises selecting a region in the images via the touch-screen and the

15   region of interest is determined based on the selected region. The region of interest may be for example a region in the image corresponding to the region being selected by the user in the image. Alternatively or in addition, the region of inter-est may have a certain offset to the region which has been se-

20   lected by the user in the image.

According to another preferred embodiment of the present in-vention, the user input comprises selecting a point in the im-ages via the touch-screen and the region of interest is deter-

25   mined based on the selected point.

According to another preferred embodiment of the present in-vention, the user input is requested by means of an appropri-ate notification.

30

According to another preferred embodiment of the present invention, the user input is requested if a trailer function of the driver assistant system is activated.

5 According to another preferred embodiment of the present invention, the user input is requested if a trailer function of the driver assistant system is activated and if no trailer or if multiple trailers are detected by means of image processing, wherein the image processing is not based on a previous user input.

A significant advantage of the present invention, in particular according to the aspects and embodiments disclosed in the foregoing embodiments, is that the computational complexity of the camera-based detection of a trailer can substantially be reduced by the consideration, or respectively by the support, of the user input. It is particularly possible to determine prior to the image processing for detection the trailer a region of interest in the camera images and to process only the determined region of interest with the respective image processing algorithm for the detection of the trailer and, for instance, for computing the height and width of the trailer and/or the tow bar length and/or the angle between the trailer and the vehicle. As many cars are already equipped with touch-based user interfaces in the dashboard, the present invention may be implemented in many cars without additional hardware.

More particular, the present invention can be applied for the detection of trailers of any shape and may avoid using computationally complex algorithms for selecting a region of interest and for determining the trailer boundary in the camera images.

The present invention may also support the respective driver assistance system in selecting the right trailer, i.e. the trailer which is to be hitched to the vehicle, in case if there are many trailers in the respective detection area, i.e. in a parking space, and thus present in the camera images.

Preferably, by using the present invention, it is no longer necessary to use any synthetic features on the trailer, like targets or makers, in particular for detecting the trailer and/or for estimation the dimensions and yaw angle of the trailer.

The present invention is also advantageous in conditions with bad visibility, e.g. bad light or bad weather conditions.

According to the preferred embodiments, the present invention offers the driver the opportunity to use the rear view camera information to draw pattern around the trailer on the touch-screen and the pattern is processed to find the pattern height and width. The pattern can be fine tuned using image processing algorithms to find the exact dimensions of the trailer. This information can be used to calculate the yaw angle and the depth at which the trailer is hitched or to be hitched to the vehicle (tow support/tow assist). This may assist the driver to hitch the vehicle to the trailer without any artificial feature.

According to a second aspect of the present invention a computer program product is provided. The computer program product comprises a computer readable storage medium having computer executable code stored thereon which, when executed by a

processor, executes the method according to the first aspect
of the present invention and its preferred embodiments.

According to a third aspect of the present invention a device

5   for a vehicle is provided, in particular a driver assistant
system. The device is configured for detecting a trailer and
comprises at least one camera to be mounted to the vehicle
with a rearward field of view, an electronic control unit to
be mounted to the vehicle and to be connected with the at

10   least one camera and with a touch-screen, wherein the elec-
tronic control unit comprises a processor and a computer pro-
gram product according to the second aspect of the invention.

According to a fourth aspect of the present invention a vehi-

15   cle is provided which comprises a device according to the
third aspect of the invention.

The present invention will be described in the following by a
preferred embodiment based on the accompanying drawings.

20

In the following description, details are provided to describe
an embodiment of the present specification. It shall be appar-
ent to one skilled in the art, however, that other embodiments
of the invention may be practiced without such details.

25

Fig. 1   shows a flowchart of a method for detecting a
               trailer according to an embodiment;

Fig. 2   shows an exemplary displayed image according to an

30   embodiment.

Fig. 1 shows a flow-chart of a preferred embodiment of the method according to first aspect of the present invention, which may be implemented as a computer program product accord-ing the second aspect of the invention within a device accord-

5   ing to the third aspect of the invention, in particular in terms of computer executable code stored on a computer program product, which, when executed by a processor, executes the method according to Fig. 1.

10   The embodiment according to Fig. 1 comprises multiple process steps S1-S5.

The method according to the present invention can be used, for instance, as a part of a driver assistant system of a vehicle,

15   in particular for a driver assistant system providing the driver of the vehicle one or multiple assistance functions in conjunction with a trailer. Such functions may be functions which are already known from the prior art, e.g. functions as described in the introductory part of the description. The

20   method may further be implemented as a program within a driver assistant system and may, for instance, be started upon re-quest, e.g. upon manual activation of a trailer function by a user, and/or upon automatic activation, e.g. upon detection that a trailer is coupled to the vehicle and/or that a reverse

25   gear of the vehicle is set.

In step S1 of the embodiment, shown in Fig. 1, at least one image is captured with at least one camera which is mounted to the vehicle and which has a rearward field of view. Such cam-

30   era may be a rear camera mounted exterior or interior to a rear portion of the vehicle. In a particular embodiment the image may also be a composite image which provides a view of

the rearward scene of the vehicle and which may be assembled
by image processing means from the images of multiple cameras.
Such multiple cameras may be, for instance, cameras of a so-
called surround view camera system. According to Fig. 1, the
5   at least one image is a live video stream of the rearward sce-
ne of the vehicle surroundings, i.e. consecutive image frames
captured by one or multiple cameras having at least partially
a rearward field of view.

10 In step 2 of the embodiment, shown in Fig. 1, the at least one
image is displayed to a user on a touch-screen. The user to
whom the at least one image is displayed may be the vehicle
driver or respectively the vehicle owner. According to Fig. 1,
the displayed image is a live video stream at least of the
15 rearward scene of the vehicle. The touch-screen may be a
touch-screen which is arranged in the interior of the vehicle,
e.g. integrated into the dashboard. Alternatively or in addi-
tion, the touch-screen may be a touch-screen of a mobile
and/or handheld device, e.g. a mobile phone, a tablet or the
20 like. Accordingly, the image may be displayed to the user ei-
ther inside the vehicle, in particular for assisting the user
in maneuvering the vehicle with a trailer or in coupling the
vehicle with a trailer while the user is inside the vehicle,
or the image may be displayed to the user on a mobile device,
25 in particular for remote controlled trailer function, e.g. re-
mote controlled maneuvering of the vehicle with a trailer or
remote controlled coupling of the vehicle with a trailer.

In step 3 of the embodiment, shown in Fig. 1, a user input via
30 the touch-screen is recognized. According to a preferred em-
bodiment, such user input may be a selection of a region with-
in the displayed image by the user via the touch-screen. More

specifically, such a selection of a region may be a drawing of
an outline around the trailer by the user, i.e. a drawing of a
pattern on the touch-screen around an image portion where the
trailer is present. This is exemplarily illustrated in Fig. 2.

5

Fig. 2 shows an image 1 of a rearward scene of a vehicle,
wherein a trailer 2 is coupled to the vehicle. In Particular,
the image which is shown in Fig. 2 may be an image 1 which is
displayed to the user on the touch-screen according to step 2.

10   Fig. 2 further illustrates a pattern 3 around the outer con-
tour of the trailer, which may be drawn by the user on the
touch-screen. The pattern 3 may, for instance also comprise a
line along the trailer axis 4 or an outline around the trailer
axis 4.

15

According to another preferred embodiment, the input 3 may al-
so be a selection of a point within the displayed image 1 by
the user via the touch-screen. More specifically, such a se-
lection of a point may be a marking or indication of a point
in the displayed image 1 by the user where the trailer 2 is

20

present, i.e. indicating a location or point in the image 1 on
the touch-screen where a portion of the trailer 2 is present.

According to a preferred embodiment of the invention, the user

25   input 3 may be requested by means of an appropriate notifica-
tion, e.g. by a visible notification on the touch-screen
and/or an audible notification, in particular as a further
step before the recognition of the user input 3. Such re-
quest/notification may be given, for instance, each time when

30   the method is performed or upon start or activation, manually
or automatically, of a trailer function. Alternatively or in
addition the request/notification may only be given under spe-

cific circumstances or certain conditions. Such circumstances
or conditions may arise, for instance, if it is detected that
a trailer 2 is coupled to the vehicle, if a trailer function
is activated, manually or automatically, but no trailer 2 is
or can be detected in the image 1 and/or if a trailer function
is activated, manually or automatically, but multiple trailers
are detected in the image 1.

In step 4 of the embodiment, shown in Fig. 1, the trailer or
at least a portion of the trailer is detected by means of im-
age processing in the live video stream based on the user in-
put. The detected trailer portion can be, for instance, the
outer contour of the trailer and/or the coupling of the trail-
er. Image processing methods for driver assistant systems for
detecting a trailer or for detecting portions of a trailer are
well known, for instance, from the prior art mentioned in the
introductory part of the description. The present invention
improves such trailer detection by image processing, in par-
ticular in certain circumstances like bad visual conditions.

According to a preferred embodiment of the invention a region
of interest 5 is determined in the at least one image 1 based
on the user input 3 and the trailer 2 is detected by means of
image processing of the at least one image 1 based on the de-
termined region of interest 5.

More specifically, if the user input 3 comprises the selection
of a region 3 in the at least one image 1 by the user via the
touch-screen, then the region of interest 5 is preferably de-
termined based on the selected region 3. For instance, the im-
age may be processed only within the selected region 3, in
particular by means of image processing algorithms for trailer

detection. Alternatively, a certain tolerance range 6 or deviation may be applied to the selected region 3 and the image 1 may be processed only within the image area 5 thus obtained. Alternatively or in addition the selected region 3 may be adjusted to a certain shape, e.g. a rectangle or square, and the image may be processed only within the adjusted image area.

If the user input 3 comprises the selection of a point in the image 1 the region of interest is preferably determined based on the selected point in the image 1. For instance, a region of interest having a specified shape and specified dimensions may be defined around the selected point within the image 1 and the image may be processed only within the image area thus obtained. Alternatively or in addition, the outline or outer counter of the trailer may only be searched around the selected point.

Once the trailer or at least a portion of the trailer is detected, in the following step S5, different trailer functions can be provided. Such trailer functions are commonly known. Some of them have been described in the introductory part of the description. It shall be apparent to a person skilled in the art, that the present invention may be used in combination with any existing or future camera based trailer assistant functions, in particular implemented in a driver assistant system of a vehicle.

As illustrated in Fig. 1, trailer assistant functions may comprise, but are not limited to, a tracking of the trailer using template matching, an estimation of the angle between the trailer and the vehicle, an extraction of the height and width of the trailer and an estimation of the depth of the trailer.

For providing such trailer functions further input parameters may be provided to the system, e.g. camera calibration parameters.

5

Claims

1. A method for a driver assistant system for detecting a
   trailer (2), comprising:
   - (S1) capturing at least one image (1) with at least one
   camera being mounted to a vehicle and having a rearward
   field of view;
   - (S2) displaying the at least one image (1) to a user on
   a touch-screen;
   - (S3) recognizing a user input (3) via the touch-screen,
   wherein the user input (3) comprises selecting a region
   (3) in the at least one image (1) via the touch-screen;
   - determining a region of interest in the at least one
   image (1) based on the selected region (3), wherein the
   region of interest has an offset to the selected region
   (3);
   - (S4) detecting at least a portion of the trailer (2) by
   means of image processing of the at least one image (1)
   based on the determined region of interest (5), wherein
   image processing comprises computing the height and width
   of the trailer.

2. The method according to one of the preceding claims,
   wherein
   - the user input (3) is requested by means of an appropri-
   ate notification.

3. The method according to claim 2, wherein
   - the user input (3) is requested if a trailer function of
   the driver assistant system is activated.

4. The method according to claim 2 or 3, wherein

- the user input (3) is requested if a trailer function of
the driver assistant system is activated and if no trailer
(2) is detected in the at least one image (1) by means of
image processing not being based on a user input (3).

5

5. A computer program product with a computer readable stor-
age medium having computer executable code stored thereon
which, when executed by a processor, executes the method
according to one of the preceding claims.

10

6. A device for a vehicle for detecting a trailer (2), in
particular a driver assistant system, comprising:
- at least one camera to be mounted to the vehicle with a
rearward field of view, and
- an electronic control unit to be mounted to the vehicle
and to be connected with the at least one camera and with
a touch-screen, wherein
- the electronic control unit comprises a processor and a
computer program product according to claim 5.

20

7. Vehicle comprising a device according to claim 6.