Hardware Design and Implementation of Object Detection System Using Image Processing

Dr.Anasraj R, Jithin P R

Abstract: In this paper, the detection of an object is considered by using a computer controlled Cam-vehicle. The object detection system is developed with two main components; (i) a Cam-vehicle and (ii) an Image Processing Circuit. A Cam-vehicle is constructed containing a webcam to obtain random videos/images and a motor controlling circuit to control the locomotion of the vehicle. The Image Processing Circuit is used to carry out the processing of a video data. An exact image of the object, to be identified, is fed into the database as the reference image [4]. Each snapshot of the Mother image is verified with the reference image. The existence of the desired object can be concluded if any of the snapshots provides an optimum accuracy. The cam-vehicle is then automatically signaled to alarm by the computer and subsequently, the object is approached by the cam-vehicle.

Keywords: Cam- Vehicle, Microcontroller**,** Image Processing**,** RF-Module

I.   INTRODUCTION

In this world of diversity, humans are surrounded by a variety of objects. Objects may differ in size, shape, colour and various other physical features. So, it is always cumbersome to locate a particular object with a particular characteristic. The whole process of locating and detecting any desired object is identified in this proposed work. It is done just by obtaining a mother image of all the objects in a given region and then by processing the mother image. In this context, a CAM-VEHICLE was developed based on image processing with the help of MATLAB.

The main objective of this paper is to fabricate a working model of Computer Automated Object Detection System. For the simplicity of control and to make it more user-friendly, a graphical user interface is developed[1-3]. To reduce human effort, motion detection program is incorporated. The live monitoring of the area increases the reliability of the device[5]

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The characteristic feature of the model is setting up a high resolution camera.

The objectives are attained by the following methods. Firstly, the proposed structure mechanism of obtaining the image and its matching was drawn and designed. The vehicle mechanism is fabricated in an engineering workspace. A suitable circuit is made to control motors and interface the IC with computer. Circuits for motor driving and power supply were also added with it. Embedded C codes were written to program the IC ATMEGA8 in order to make IC compatible with the signals from computer through USB and also control the motors corresponding to the control signals.. The organization of this paper is such that it elaborates the working and hardware components and software part.

II.   BASIC COMPONENTS OF THE OBJECT IDENTIFICATION SYSTEM

The basic components are microcontrollers, motor driver ICs, RF module and wireless camera. The ATmega8 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, ATMEGA8 IC is used.

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of

1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter. The RF module is often used along with a pair of encoder/decoder.

The wireless audio video camera is used to get the visuals of the surroundings and to transmit the video to the control room. The specifications of wireless camera are Voltage: DC +9V, Current: 200mA/300mA, Power consumption<=400mW, Output power: 50 mW/ 250 mW/ 300 mW, Deliver distance: 200-300m, Frequency control: 0.9GHz/1.2 GHz, Sensitivity: +18dB, Transmission signal: video, sound, Minimum illumination: 3 LUX

III. OBJECT DETECTION SYSTEM BLOCK DIAGRAM

The block diagram of the proposed object detection system is shown below. The identification system consists of a Cam-vehicle and an Image Processing Circuit (IPC).
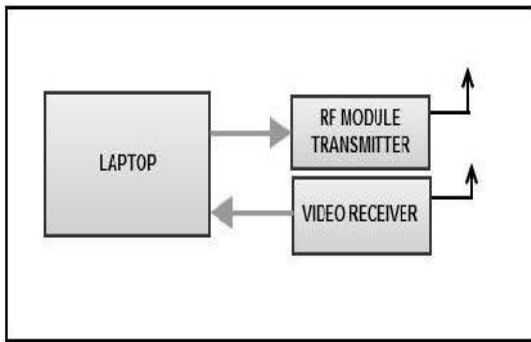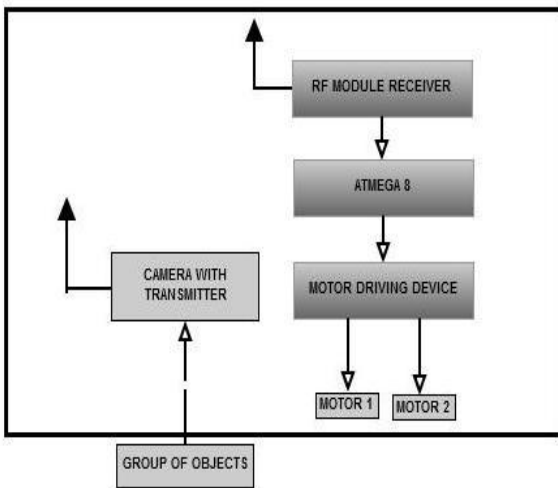

. Fig.1. IPC Block Diagram.

Fig. 2.Cam-VehicleBlock Diagram.

The Cam-vehicle contains a camera and a motor controlling circuit for its locomotion. The Cam-vehicle is sub-divided into a motor system, a webcam-cum- transmitter and a RF-receiver. The Motor system consists of two 12V dc motors. These motors are used for the free motion of the cam-vehicle.

A microcontroller ATMEGA8 is used in controlling the motors' rotation. A webcam is used to obtain the complete visuals of the region of objects. Such a visual is called Mother Image. The webcam-transmitter transmits the mother image from the webcam to the Image Processing Circuit. A RF-receiver is used to receive acknowledgment signals from the image processing circuit.
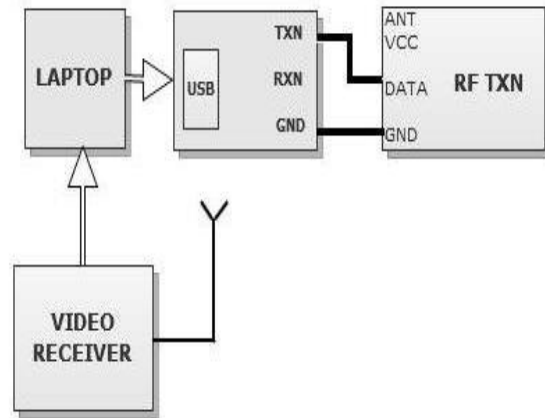

Fig.3. Detailed Block Diagram of IPC

The Cam-vehicle assembly consists of microcontroller, motor driver IC and the driving motors. Two 9V D.C motors are used in the rotation of the rear wheels of the Cam-vehicle. The motor system is connected to a motor driver IC (L293D). Signals to these motors are sent through a microcontroller (ATMEGA 8). Camera is used for visualizing the target of objects. Camera is connected to computer for display. The Image Processing Circuit is used to carry out the processing of a video data feed. Image acquisition toolbox is available in MATLAB for this purpose. Image Acquisition Toolbox enables in acquiring images and video from cameras and frame grabbers directly into MATLAB

The Image Processing Circuit is sub-divided into Video-receiver, laptop and a RF-transmitter. The video-receiver receives the Mother video sent from the Cam-vehicle. The video is divided into many snapshots (still images) by the MATLAB software. An image of the desired object has been already fed into the database as the reference image. Each snapshot of the Mother image is verified with the reference image by MATLAB optical tools. The snapshot accounting to the maximum accuracy concludes that the desired object does exist. The cam-vehicle would be automatically signaled to alarm by the laptop through the RF-transmitter and subsequently, the cam-vehicle stops.
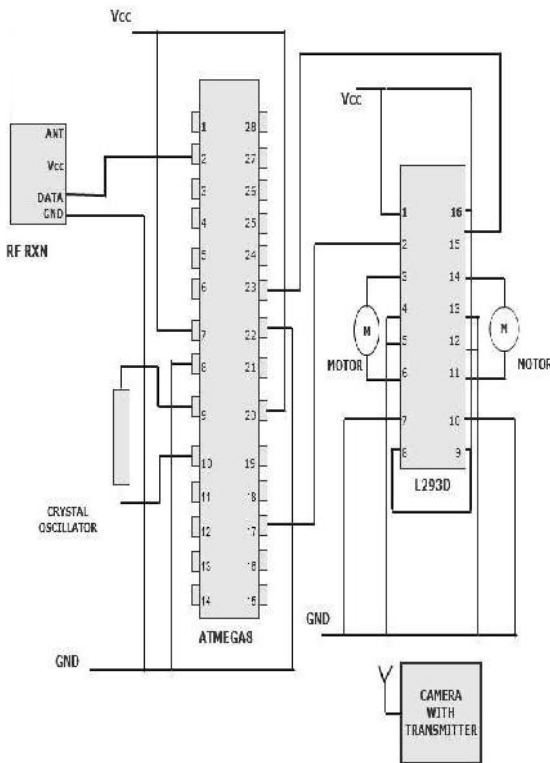
Fig. 4.Detailed Cam-vehicle Block Diagram

Object detection is a process of confirming the presence of an object in a given surroundings. This detection can be achieved by both mechanical and electronic methods. The principal methods by which position of an object can be electronically identified are optical detection and acoustical detection. Infrared light or laser technology may be used for optical detection. Once detected, an electronic signal can activate an alarm or a camera that can capture an image or video of the moving object. More complex algorithms are necessary to detect motion when the camera itself is moving, or when the motion of a specific object must be detected in the field.

IV. WORKING OF THE OBJECT DETECTION SYSTEM

An exact image of the desired object is fed into the database as the reference image. A mother video is captured using the camera. The wireless camera sends the video of the target of objects continuously to the video receiver and it can be viewed in a laptop. The received video is put into MATLAB for motion detection.

The mother video is sub-divided into various snapshots. Each snapshot is then matched with the reference image. The sub-image accounting to the maximum accuracy concludes that the desired object does exist. This information is passed to RF circuits with the help of Computer interfacing and encoder unit and the signal is transmitted. In the receiver side, decoder decodes the information and the motor drive microcontroller drives the motor and hence the Cam-vehicle. The main task of the software was to read the still images

recorded from the camera and then process these images to detect motions and take necessary actions accordingly.

To access camera in MATLAB an object is required. A video input object represents the connection between MATLAB and a video acquisition device at a high level. For faster access of camera manual triggering is used. The threshold value is also set in this stage. The threshold can also set by the user according to the environment it can be adjusted. Also a reference frame is captured and stored for future reference.

After setup stage the image acquisition starts. This process reads images from the laptop and save them in a format suitable for the motion detection algorithm. The image acquisition toolbox is a collection of functions that extend the capability of MATLAB. The toolbox supports a wide range of image acquisition operations, including acquiring images through many types of image acquisition devices, such as frame grabbers and USB PC cameras, also viewing a preview of the live video displayed on monitor and reading the image data into the MATLAB workspace directly.

This algorithm is based on differencing technique. It is mathematically represented using the following equation: $D(t) = |\text{current image} - \text{previous image}|$ the resultant matrix consists of difference between the 2 images. In this algorithm, the maximum value of this matrix is compared with threshold value.

The RF Receiver receives the signals transmitted from the Laptop. The transmitted data is in serial form. The decoder IC associated with it converts the serial data in to parallel data .The parallel data then fed to microcontroller at receiver side. The microcontroller checks the input data with its program and produces and output according to the program. The output of the microcontroller is fed to the motor drivers. These provide necessary amplification to run the program. Thus the motor is rotated accordingly. The block diagram of the components in the Cam-vehicle is shown in Fig 5.

The chip L293D is designed to control two dc motors. There are two input pins and two output pins for each motor. When both the inputs are low or high, the motor halts. When first output is high and the second output low, the motor runs in forward. Conversely, when first output is low and second output is high ,then the motor runs in reverse direction.

When both motors are in halt condition, then the Cam-vehicle comes to rest. When both motors are in forward direction,the Cam-vehicle moves in forward direction.Similarly, when both are in reverse direction,the Cam-vehicle moves in backward direction.When the motor A moves forward and motor B reverse,the Cam-vehicle turns to left direction and when the motor B moves forward and motor A reverse, the Cam-vehicle turns to right direction.Forward direction,the Cam vehicle moves in forward Direction.Similarly, When both are in reverse direction.The cam vehicle moves in backward direction When the motor A moves forward and motor B reverse,the Cam-vehicle turns to left direction and when th motor B moves forward and motor A reverse, the Cam-vehicle turns to right direction.
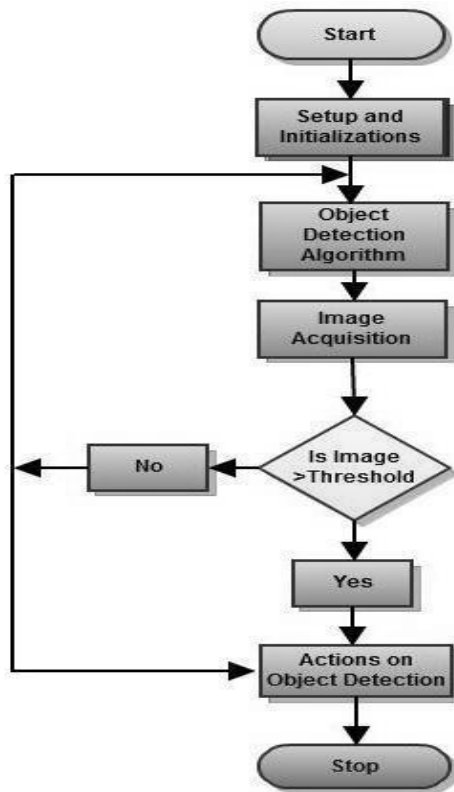
Fig.5. Object detection Program Flow Diagram

V. HARDWARE IMPLEMENTATION

In this Object Detection System, the fundamental operational steps are:-

1. Capture: The data (image/video) is captured, digitized and entered into a database.

2. Extraction: The data is divided into different snapshots. A separate template is created for each snapshot using this measurable unique data.

3. Comparison: Each template is compared with a reference template (image of the object to be detected).

4. Match/Non-Match: The new template matches the reference template or it does not.

5. Acknowledgment: If this template matches with the referrence template, a "STOP" signal is alrmed to the Cam Vehicle. If not, the Cam vehicle repeats the process for the next set of data.

VI. CONCLUSION

A working model of an object identification system is developed. The device is highly portable and can be used in any place, even where human interference is prohibited. The entire system provides an easy identification without much human effort. The motion detection software works more accurately when it is used in indoors and reduces human effort. The camera interfacing and control software provides an easy platform for its control. The device can be used as simply to identify a particular object out of a disordered or a clustered set of diverse objects. The device could be handy in high security areas and in those areas where human trespassing is restricted. The device could be considered useful in live monitoring also. The chief applications for such detection are (a) detection of unauthorized entry, (b) detection of cessation of occupancy of an area to extinguish lighting and (c) detection of a moving object which triggers a camera to record subsequent events. The object detector is thus a linchpin of electronic security systems, but is also a valuable tool in preventing the illumination of unoccupied spaces. A simple algorithm for object detection by a fixed camera compares the current image with a reference image and simply counts the number of different pixels. Since images will naturally differ due to factors such as CCD dark currents, pre-processing is useful to reduce the number of false positive alarms. The original device can be modified with a flying mechanism so varying that it can propogate faster in air as compared to its land motion. This could be additionally lighting, camera flicker, and advantageous in patrolling, warfront areas etc. By updating the program and sensing method,operation can be made automatic.

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