CSE360

Semi-autonomous Accident Prevention System For Vehicle

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Introduction:

Every year the lives of approximately 1.3 million people are cut short as a result of a vehicle accident. Between 20 and 50 million more people suffer non-fatal injuries, with many incurring a disability as a result of their injury. Road traffic injuries cause considerable economic losses to individuals, their families, and to nations as a whole.[1]

Therefore, as a reliable solution of reducing road accidents, in this paper a semi-autonomous accident prevention system for ordinary vehicles is introduced. The proposed system can perform some autonomous activities (e.g. automatic combined braking, automatic turning, safety alarming, showing location, via uploading information on cloud) that can help the vehicle operator directly to protect from a probable accident.

Application Area:

The proposed system can work for road safety and security purposes of any 4 wheeled ordinary vehicle. However, with some tiny modification it can also be implemented in any 2 wheeled vehicle. It can perform automatic braking and turning when needed based on the decision of elementary image processing and distance measurement via electric actuator. The system enables the associated vehicle to connect with a cloud server where it can store some important information along with audio and video of special moments through which the owner can track the vehicle on time and can monitor the journey later and the authority can get proper information from that if unfortunately any accident occurs.

Technology And Tools:

The proposed system doesn't require too much processing power. Here the Object recognition (simple image processing) system will consume most of the processing power. The system requires a camera module which can operate both in day and night for this object recognition purpose. The system needs 3 electronic actuators for performing semi autonomous action on vehicle's brake, clutch and accelerator pedals. A stepper motor for performing necessary steering of the vehicle. The system also requires two ultrasonic sonar sensors for distance measurement of the object. An Display and LED indicator. And as an extra feature it requires a GSM module, GPS module and microphone. To control these components Raspberry PI 4 Model B is sufficient as a microprocessor. Here the most complex technology is object recognition precisely . So TensorFlow 1.9 is the best option for it as Raspbian 9 OS supports it [2]. For the cloud communication (for uploading real time location , footage and speed information) the system will use GSM [3] And GPS technology [4]. For distance measurement of the object the system will use an Ultrasonic Sonar sensor [5] that uses Ultrasonic sound technology for its functional mechanism. And the whole system will take power from the vehicle internal builtin power system.

Programming language:

The core codding of the proposed system will be done with python. Although Raspberry Pi is just a computer. It has a Raspbian OS which is based on Linux. Start with a basic *UNIX/Linux* system overview, learning some basic *UNIX/Linux* commands. It has a built-in gcc compiler. And the program can be compiled and executed as C files from the terminal [6].

But Raspbian also comes with python 2.7. And since our system has image processing architecture and python is very efficient and widely used for this segment and easy to use for Raspberry to I/O interfacing, python is recommended for this project.

Working mechanism of Sensors:

The proposed system has Ultrasonic Sonar sensor, Camera sensor, GSM module and GPS sensor. These sensors work combinely to make the perfect decision to make a semi autonomous action. The working mechanisms are:

Ultrasonic Sensor:

Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to hear. They then wait for the sound to be reflected back, calculating distance based on the time required.It basically uses the trigger pin to trigger the wave and echo pin to capture the reflected sound wave from the object. Inow the distance will be calculated based on this formula: Distance

= ½ T x C (T = Time and C = the speed of sound). At 20°C (68°F), the speed of sound is 343 meters/second (1125 feet/second), but this varies depending on temperature and humidity. Specially adapted ultrasonic sensors can also be used underwater. The speed of sound, however, is 4.3 times as fast in water as in air, so this calculation must be adjusted significantly [7].

Here for the system the Ulsonic sonar sensor will expose its ultrasound on the object in front of the vehicle for the measurement of their distance in the above mentioned procedure.

Camera Sensor :

The Image sensor accumulates the reflected light from the object in front of it via a lens. Then the light goes on a charged couple device (CCD). From there the electric pulses created according to the intensity of the light falls on CCD. Then the signal goes to the ADC (analog to digital converter). From there the digital signal goes to the digital signal processor in order to create the digital bit stream of an image [8].

Here for the system the camera will capture the raw footage of the object in front of the vehicle and send it to the Microprocessor for image processing and making autonomous decisions.

GPS sensor:

A global positioning system that is utilized for navigation and object and location detection normally operates on the fundamental tenet of radio wave exchange between the ground stations, satellites, and receivers. The trilateration mechanism of operation is preferred for this data transmission and receiving. According to the trilateral mechanism, a device or object must be inside the coverage area of at least four satellites in order to estimate its accurate location. The precision of the data processed by the GPS directly relates to the number of satellites that send and receive data to and from the item. Both two-dimensional and three-dimensional images allow for the verification of the trilateration technique. Longitudes and latitudes are used in the two-dimensional trilateration technique to pinpoint a specific location. A three-dimensional trilateration system, on the other hand, uses values for longitudes, latitudes, and height [9].

Here for the system the GPS will capture the real time location of the vehicle and send it to the MPU to show an approximate way path to the destination via google map API and the data is also used for cloud information update.

GSM module:

GSM modules are standard cellular radios that can transmit IP data and SMS on the GSM cellular network assuming the user has such service enabled (i.e., *needs* a SIM from a carrier/operator in your area).In general, these bare GSM modules are devoid of any antenna, power source, microphone, speaker, etc. These have to be connected externally. It resembles the basic components of a GSM phone.Another reasonable assumption is that the modules include one (or more) serial data ports that can be accessed by an external processor (usually RS-232 or USB) (or computer). It may include more than one serial port to isolate IP data from command messages, depending on whether the module is a 2G or 3G module. Command messages are usually from a modified AT command set (like a standard modem).

Thus, a program on an external processor and/or an application program on a computer handle the transmissions (SMS, IP data, etc.) by "controlling" the GSM module. The application determines what data is delivered, what SMS are sent, etc.; a GSM module itself has no intrinsic properties, however it may regulate transmissions to keep connections to the cellular network [10].

Here for the system the GSM module will be used for real time data transmission to the cloud and for the tracking mechanism.

Working mechanism of output device:

Stepper Motor:

The stepper motor converts a pulsing electrical current, controlled by a stepper motor driver, into precise one-step movements of this gear-like toothed component around a central shaft. Each of these stepper motor pulses moves the rotor through one precise and fixed increment of a full turn [11].

Here for the system the stepper motor will be used for vehicle turning mechanism via steering.

Electronic Actuator:

In an electric actuator an electric motor will create rotary motion as the spindle, or rotor, rotates. The motor spindle is directly coupled to a helical screw, via the drive shaft, which in turn rotates in a ball screw nut and creates linear actuator movement [12].

Here for the system the actuator will be used for the vehicle's brake, clutch and accelerator controlling mechanism via performing actuator action on braking, clutch and accelerator pad.

Display:

Display works by using liquid crystals to produce an image. The liquid crystals are embedded into the display screen, and there's some form of backlight used to illuminate them. The actual liquid crystal display is made of several layers, including a polarized filter and electrodes.

Here for the system the display will be used for showing google map based location, speed limit object distance and real time footage [13].

Buzzer and LED:

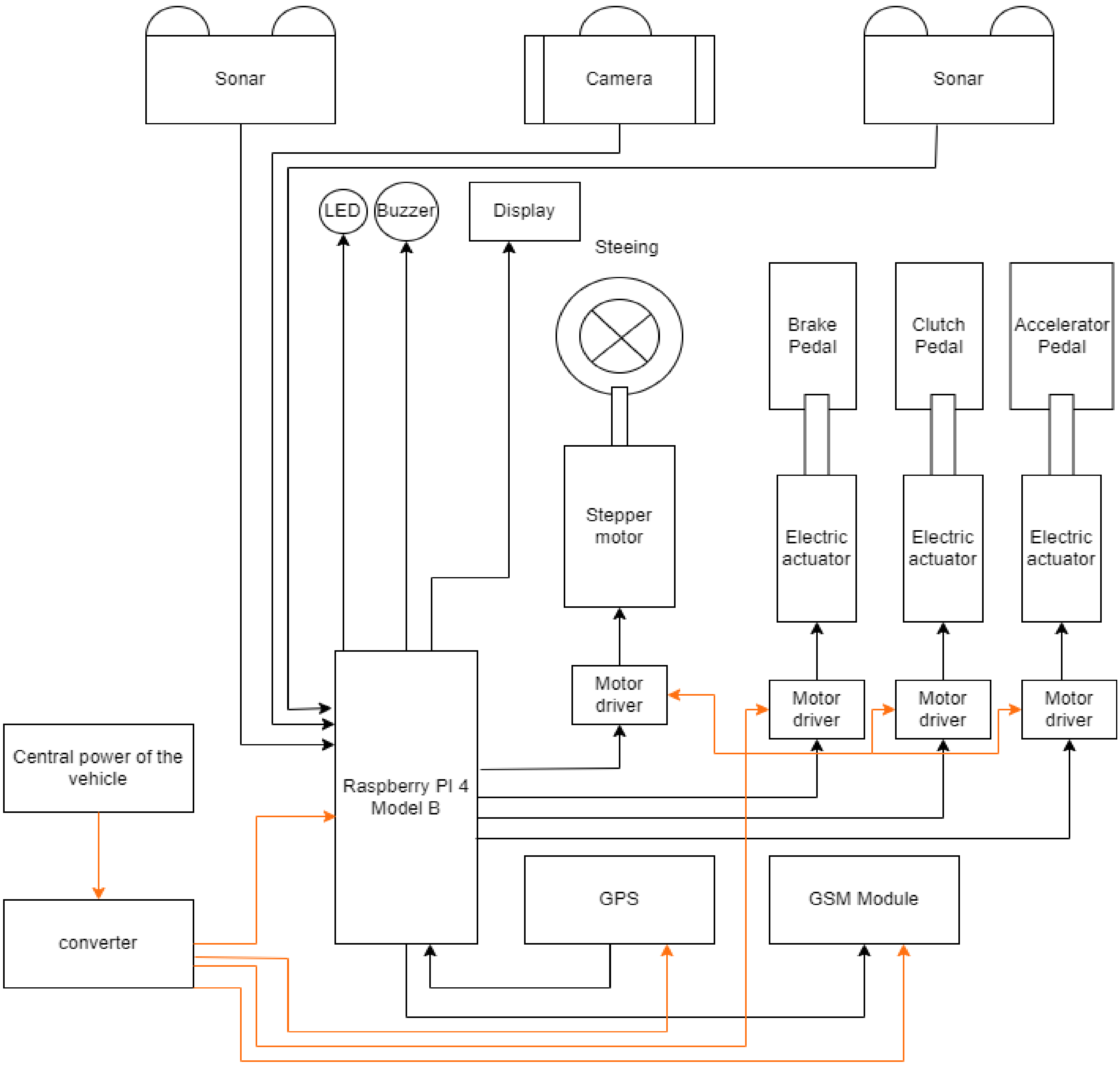
When a voltage is applied across the two electrodes, the piezoelectric material mechanically deforms due to the applied voltage. This movement of the piezo disk within the buzzer creates sound in a similar manner as the movement of the ferromagnetic disk in a magnetic buzzer or the speaker cone mentioned above.

On the other hand An LED bulb produces light by passing the electric current through a semiconducting material—the diode—which then emits photons (light) through the principle of electroluminescence [14][15].

Here for the system the LED and Buzzer will be used for notifying emergency situations to the driver.

Connection with ICs:

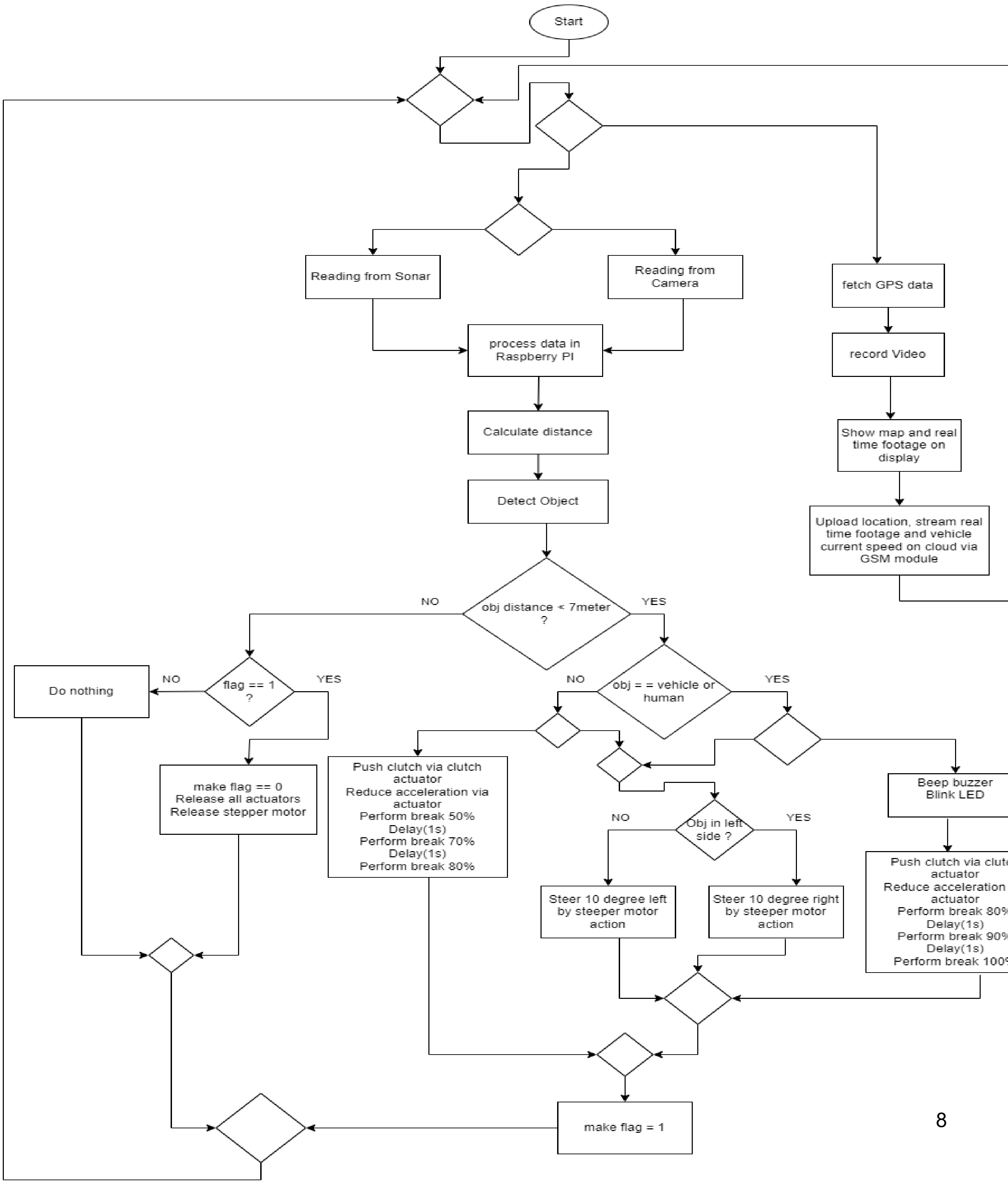
The connections of the components will be like this:



Here the GSM module will be connected to the LAN port of Raspberry Pi. The display will be connected to the HDMI port of the Raspberry Pi. The camera will be interfacing with the inbuilt camera connector of the Raspberry Pi. The GPS module will communicate via TX and RX pin.

And the LED, Buzzer, Sonar and the motor drivers for stepper and electric actuator will be connected to the GPIO interfacing pin of the Raspberry Pi board.

Data flow from sensors through ICs to I/O devices:



Estimated cost analysis:

Component	Unit price	Quantity	Cost
Raspberry Pi 4	3500/-	1	3500/-
Sonar Sensor	110/-	2	220/-
Camera Module	2000/-	1	2000/-
Display	2000/-	1	2000/-
LED	2/-	1	2/-
Motor Driver	1200/-	4	4800/-
Electrical Actuator	3000/-	3	9000/-
Buzzer	15/-	1	15/-
Stepper Motor	3000/-	1	3000/-
GSM module	1500/-	1	1500/-
GPS module	1000/-	1	1000/-
Power converter	1000/-	1	1000/-
Wire	500/-	1	500/-
Total Cost			28537/-

Total 28537 Taka will be needed to implement this model to a four wheeled vehicle. But for 2 wheeled vehicles, the cost will be reduced a lot.

Responsibilities of each member:

I have performed all of the work related to this proposed project since this is my personal proposal.

Workplan (Gantt Chart):

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Planning						
Research						
Design						
Implementation						

Conclusion:

This semi-autonomous accident avoidance system for common automobiles is introduced as a proven method of lowering traffic accidents. Accordingly, if the suggested system can be implemented flawlessly, it can carry out some autonomous tasks (such as automatic combined braking, automatic turning, safety alarming, showing location, via uploading information to the cloud) that can directly assist the vehicle operator in protecting from a potential accident.

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