ASME SETTING THE STANDARD	**Innovation Report Cover Page & Innovation Description Form** **Human Powered Vehicle Challenge** **Competition Location: Digital** **Competition Date: 03/04/2021**
This required document for all teams is to be incorporated into your Innovation Report. Please Observe Your Due Dates; see the ASME HPVC website and rules for due dates.	

University Name: KIIT University

Vehicle number: 19

Innovation title: Forward Collision Warning System

Innovation summary: We have combined the concepts of mechanics, electronics and computer science to come up with our innovation "Forward Collision Warning System" to enhance our rider's safety. In short, our innovation is a combination of hardware and software components. The main idea is to detect objects and send signals to the rider whenever an object, moving or stationary comes close to the vehicle which may result in a mishap. We have used buzzers to give auditory warning. While designing our system we have kept the charging and detection circuits separate so that the failure of one circuit will not affect the other. Our innovation will enhance the mobility as well as the safety of the vehicle by avoiding potential collision with any object.

KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY (KIIT)

Deemed to be University U/S 3 of UGC Act, 1956

TEAM KETAV

PASSION.AMBITION.DETERMINATION

ASME HPVC TEAM

PRESENTS

VULCAN

VEHICLE #19

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TABLE OF CONTENTS

IV. <u>DESIGN</u>

IV. A. <u>Is our innovation a New Idea?</u>

Most of the HPVs in India rarely have a provision for a self-sufficient collision detection system. The team has used HCSR-04 ultrasonic sensors to measure precise distance from an object/vehicle using ultrasonic waves. The team needed a reliable energy source; hence Rim Dynamo has been installed in the front fork and rear fork of the vehicle, which generates energy due to frictional force created between the wheel and dynamo, sensors and buzzers in fairing. If an obstacle is detected an algorithm is triggered and the rider is alerted with the help of buzzers placed inside the vehicle.

IV. B. <u>Need</u>

An obstacle detection and warning system can improve the mobility as well as the safety of the vehicle by avoiding a potential collision with any object. Due to a limited field of view, it is very challenging for the rider to examine the surroundings of the vehicle for probable hazards from each and every side. This Forward Collision Warning System will make the ride much safer.

IV. C. <u>Advancing the Art of HPVs</u>

The Forward Collision Warning System improves the safety of the vehicle and sets a great example for a low-cost assistance system. This innovation will allow the rider to pace themselves more effectively on racing tracks by providing crucial info around the vicinity of the vehicle. Moreover, this system will bring a revolutionary change in the safety of the human powered vehicle and will contribute to decreasing road accidents and injuries. In the near future, this innovation can be detailed further including several other possibilities.

IV. D. <u>Technology and Concept Feasibility Study</u>

The microcontroller Arduino UNO that the team has used in Forward Collision Warning System has a maximum switching frequency of 8 MHz with rise time of the output pin ATMEGA 328 of 10 ns. Based on these specifications the Ultrasonic Sensor HCSR-04 will easily detect objects which will come within the range of the safe distance from the vehicle. To furnish constant voltage to the Arduino a buck boost converter, also known as Boost converter is used which will step up and step down the voltage accordingly.

Overall, our collision warning driver assistance system is feasible as it is cost effective, easy to install and adds up to the safety of the rider.

V. <u>CONCEPT EVALUATION</u>

While riding, it is quite obvious that the rider's field of vision does not cover all the area around the vehicle, so to escalate the safety of the rider, the team needed a reliable solution to cover those blind spots. Hence, the team has used a Forward Collision Warning system for Vulcan. For object detection ultrasonic sensors have been used and the rider is given an auditory warning with the help of buzzers. Ultrasonic sensors detect objects by emitting ultrasonic sound waves, and the reflected sound is converted into electrical signals. The team has used the microcontroller, Arduino UNO, to program these sensors. The Arduino UNO is powered by a Li-ion battery which is charged using a rim dynamo using a suitable charging circuit. The obstacle detection circuit and the charging circuits have been kept separate so that in case any disruption occurs in one of the circuits, the other circuit will not be affected.

- **Components used:**

Arduino UNO, Ultrasonic sensors, Rim Dynamo, Piezo Buzzers, TP4056 charging module, Buck-boost converter, Li ion battery, capacitor.

- **Technical specifications:**

Components	**Specification**	**Quantity**
Rim dynamo	6V, 3W	2
Capacitor	10V, 1000µF	2
Full Bridge Rectifier	400V, 1A	2
Buck boost converter	Input supply voltage = DC 4~35V Output supply voltage= DC 1.25~ 25V	2
Boost converter	Input voltage = 2 ~ 24V Output voltage = 5 ~ 28V	1
TP4056 charging module	1AMP, 5V	2
Li ion battery	3.7V, 1800mAh	3
Ultrasonic sensor	5V DC, 0.02m - 4.0m(Range)	2
Piezo buzzer	5V, 3.2kHz, ≥85dB	2

- **Working:**

The Forward Collision Warning system is an integration of both hardware and software components. The hardware part consists of the system circuits and the software part deals with the programming of the Arduino UNO.

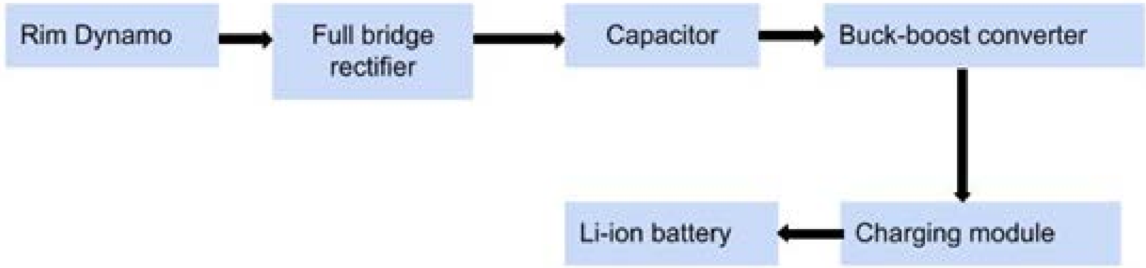

Fig. Block diagram for circuit 1

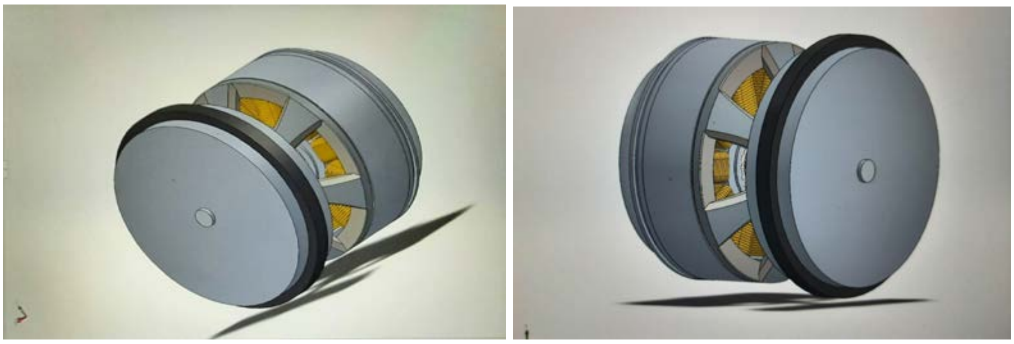

Fig. VELOGICAL Rim-Dynamo design

The 2 rim dynamos are attached to the front and rear fork of the vehicle respectively. The rim dynamo produces an emf through the process of electromagnetic induction. It has a wheel which is in contact with the rim of the wheel. As the bicycle moves, the wheel of the dynamo also rotates and turns a magnet inside the coil and as a result emf is induced in the coil. The AC voltage generated is passed through a full bridge rectifier module for converting it into DC. As rippled DC voltage is produced, a capacitor is used to smooth out the output voltage. This voltage is passed through a buck-boost converter which steps up or steps down the voltage as required to supply a constant voltage of 5V to the charging module. The charging module is used to charge the Li-ion battery.

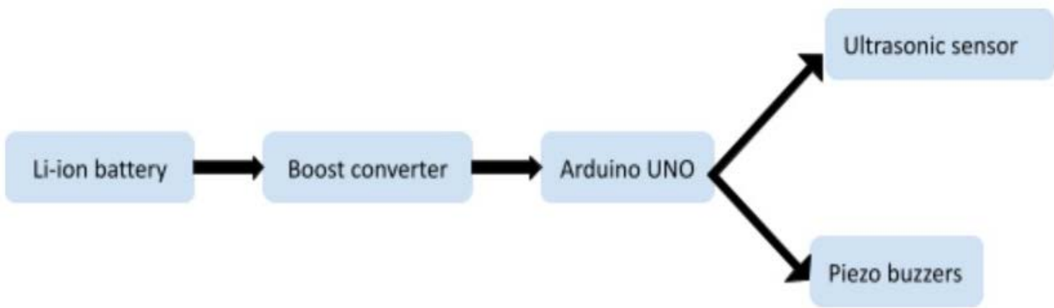

Fig. Block Diagram

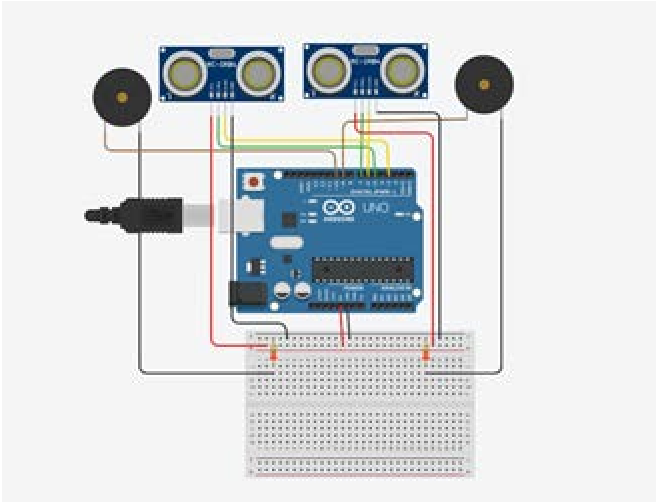

Fig. circuit 2 including Arduino, sensors & buzzers

In the second circuit, the Arduino UNO is powered up by a Li-ion battery through a boost converter. The positive terminal of the battery is connected to the IN+ and the negative terminal to the IN- of the boost converter. The boost converter is used to give a constant 5V supply to the Arduino UNO. The output terminals of the boost converter, OUT+ is connected to V_{in} pin and the OUT- to ground the Arduino. The Ultrasonic sensors and the buzzers are connected to the Arduino UNO as shown in the circuit diagram. One ultrasonic sensor and a buzzer pair is placed on either side of the fairing of Vulcan. The Arduino is programmed in such a way that along with alerting the rider of any possible obstacle, it also gives an indication from which side the obstacle is approaching.

Warning Unit: The warning unit consists of Piezo buzzers which provide reliable warning to the rider about a possible collision prior to their reaching an unsafe location. If a vehicle is detected and the distance between both vehicles is ≤ 50 cm the buzzer is triggered.

Optimum Detection Range: The two ultrasonic sensors are placed on either side of the fairing near the front part. Through CATIA design we found that if the sensors are placed at 15° from the longitudinal axis, they are covering a sensing area of 135°.

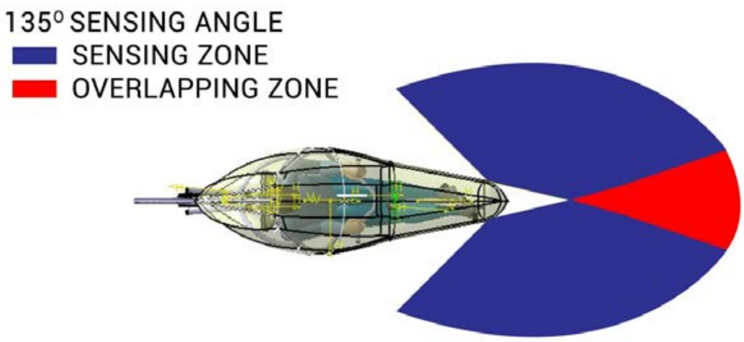

Fig: Catia design of the sensors placed

- **Code for the Collision Warning Driver Assistance System:**

```
// defines pins numbers
#define TRIGGER1 7
#define TRIGGER2 5
#define ECHO1 6
#define ECHO2 3
#define BUZZ1 9
#define BUZZ2 10
// defines variables
long duration;
int distance;
int safetyDistance;
void setup()
{
	pinMode(TRIGGER1, OUTPUT);
	pinMode(ECHO1, INPUT);
	pinMode(TRIGGER2, OUTPUT);
	pinMode(ECHO2, INPUT);
	pinMode(BUZZ1, OUTPUT);
	pinMode(BUZZ2, OUTPUT);
	Serial.begin(9600);
}
void loop()
{
	 // Clears the TRIGGER1
	digitalWrite(TRIGGER1, LOW);
	delayMicroseconds(2);
	// Sets the TRIGGER1 on HIGH state for 10 microseconds
	digitalWrite(TRIGGER1, HIGH);
	delayMicroseconds(10);
	digitalWrite(TRIGGER1, LOW);
	// Reads the ECHO1, returns the sound wave travel time in microseconds
	duration = pulseIn(ECHO1, HIGH);
	// Calculating the distance
```

```
    distance= duration*0.034/2;
    safetyDistance = distance;
    if (safetyDistance <= 50)
    {
        digitalWrite(BUZZ1, HIGH);
    }
    else
    {
        digitalWrite(BUZZ1, LOW);
    }
    // Clears the TRIGGER2
    digitalWrite(TRIGGER2, LOW);
    delayMicroseconds(2);
    // Sets the TRIGGER2 on HIGH state for 10 microseconds
    digitalWrite(TRIGGER2, HIGH);
    delayMicroseconds(10);
    digitalWrite(TRIGGER2, LOW);
    // Reads the ECHO2, returns the sound wave travel time in microseconds
    duration = pulseIn(ECHO2, HIGH);
    // Calculating the distance
    distance= duration*0.034/2;
    safetyDistance = distance;
    if (safetyDistance <= 50)
    {
        digitalWrite(BUZZ2, HIGH);
    }
    else
    {
        digitalWrite(BUZZ2, LOW);
    }
}
```

Result: The second circuit was simulated in Tinkercad and the following results were observed:

- ➔ Though the buzzers have been programmed to start giving auditory warning only if the distance is ≤ 50 cm, but both the buzzers started at 51.5 cm.
- ➔ The nearest possible distance which can be detected by the collision detection system is 2.2cm.

- **Calculations:**

Diameter of the front wheel, D = 0.508 m

Speed, v = 10 km/h

Weight of bicycle, W_1 = 20 kg

Weight of Rider, W_2 = 60 kg

Total Weight, W = 80 kg

➢ **Power Calculations:**

1. Normal Reaction on each tire, N_1 = W/2

   = 80/2 = 40 kg

   = 40 x 9.81

   = 392.4 N

2. Frictional force on each tire, F = μN_1

   = 0.3 x 392.4

   = 117.72 N

Torque Produced:

T = F x r

= 117.72 x 0.254

= 29.90 Nm

Speed Calculations, ω = V/r

= 10000/0.254 x 3600

= 10.93 rad/sec

N = (60 x 10.93)/2 x 3.142

= 104.36 RPM

Power Produced:

P = (2 x 3.142 x N x T)/60

= (2 x 3.142 x 104.36 x 29.90)/60

= 326.80 W

So, the power produced by pedalling is approx. 327 W.

- **Dynamo Specs Calculation:**

It is a 6V dynamo with maximum current capacity of 500 mA. It will produce an output of 6V even if the bicycle is moving slow at 5 km/h.

Testing output power at constant voltage

Speed (km/h)	Output Power (w)	Output Volt (v)	Output Current (A)
5	0.56	6.00	0.126
15	1.89	6.00	0.369
30	4.09	6.00	0.560

Load testing at constant resistance 18 Ω

Speed (km/h)	Output Power (w)	Output Volt (v)	Output Current (A)
5	0.45	2.45	0.115
15	1.89	5.78	0.325
30	3.21	7.23	0.435

The best hub dynamo charging system

1.7 watts – 10 km/h

3.4 watts – 15 km/h

4.8 watts – 20 km/h

7.0 watts – 25 km/h

VELOGICAL Rim-Dynamo

2 watts – 10 km/h

4 watts – 15km/h

7 watts – 20 km/h

9 watts – 25km/h

Based on several analysis and calculations like power generated by the dynamo, the team was able to ascertain the requirements of the Forward Collision Warning System and the obstacles were successfully detected by the system.

VI. LEARNINGS

Problems that we faced:

- The buzzer was louder than what was expected.
- Sometimes the ultrasonic sensors detected false alerts due to its high range of detection (100m).
- A better battery charging circuit was needed as varying dc voltage was being supplied to the charging module.

Learning from Failures:

- The sound of the buzzer was reduced to avoid any irritating noise for the rider.
- The distance was minimized from 100 cm to 50 cm to avoid false alerts in the code.
- To ensure supply of constant dc voltage to the charging module, components such as buck boost converter and capacitor were introduced to avoid any overloading or underloading in the charging module.

Negative Aspects of the Design:

- Any small damage to Arduino UNO may cause malfunctioning of the entire system.

VII. CONCLUSION

The Team's primary objective has been to enhance the rider's safety by combining the concepts of mechanics, electronics and computer science that resulted in the formulation of the Forward Collision Warning System. This system is completely self- sufficient as it uses the power generated by the dynamos to run both the charging and detection circuits. As all the components are easily available this collision warning system is highly economical. This system makes the rider feel safe, comfortable and confident to ride the vehicle. Hence, we can conclude that the system is fully safe and comfortable from the rider's perspective.

VIII. REFERENCES

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