IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Automated Robotic Electric Vehicle Charging Machine with Digital Payment

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ABSTRACT

Day by day the demand for hybrid and electric vehicles are increasing. It became necessary to develop an innovative and human friendly charging infrastructure for steady charging. Today charging of electric vehicle is done by. In future there will be autonomous car, the charging of the car should also be automated. This paper deals with robotic electric vehicle charging machine with digital payment. It explains the pros of automated charging system and its necessity in the coming future. The next part explains the systems which are in presently available in market. The last part deals with the proposed system and it future scope and modifications.

Keywords: electric, vehicles, charging, Automatic, station

I. INTRODUCTION

Even though the number of electric vehicles is very less compared to IC engine vehicles, the charging process is time consuming and costly as man power is required. Lot of money and effort is invested to develop an autonomous and customer friendly charging system. There are lot of advantages for contactless method of charging. Marketability of automated robotic charging system is being looked into, by the manufacturers. There are many issues like complex vehicle adaption, energy losses, environmental impacts on flora and fauna, electromagnetic radiations need to be solved. Driving long distances with short intervals of charging is necessary to make travelling in electric vehicle more enchanting and user-friendly. In inductive system, high charging ability and low power transmission performance are not feasible. Fast charging or quick charging or DC quick charging is done with conductive process. Next option is battery switch stations, which replace the discharged battery with charged one. Due to the difficulty in integration of grid to vehicle and also of high cost, battery switch option is not implemented.

The Figure 1 highlights number of kilometers / hour loading capacity that the electric vehicle can cover based on the energy consumption and different loading methods [1, 2, 3]. The losses due to discharging and charging are not considered in the comparison. When comparing low and fast charging technologies, the charging time can be reduced significantly for fast charging system for the load up to 170 KW.

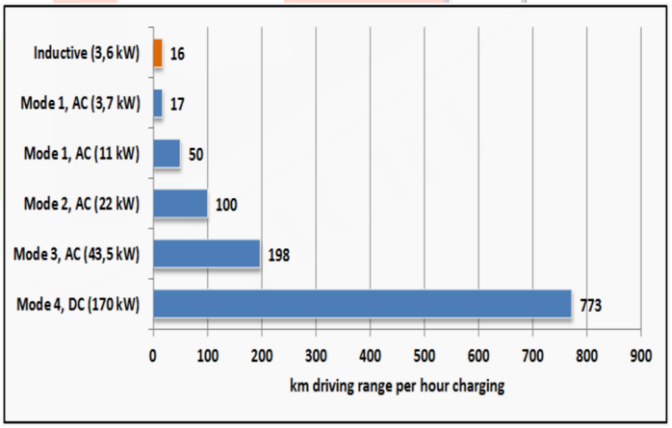

Figure 1: Charging Capacity by Charging Method

The people face difficulty for charging their electric vehicle when the cable becomes unhandy, and hard. This happens when the diameter of cable size increases. The increase in cable occur when powerful direct current is used for charging [4]. The automated conductive charging process is attractive and customer friendly because of this possibility to load vehicles. New opportunities are offered Autonomous vehicles along with automatic charging systems provides new opportunities [5].

. PROPOSED SYSTEM

The proposal is able to charge any electric car independent of socket position, brand type and model. Any type of modifications and complex vehicle adaptions are not required. With a single robot, it is possible to charge multiple vehicles. Here, we are using cheap and simple robot charging machine without camera system for locating the charging port and also well incorporated an autonomous digital payment system.

A. MATERIALS

- Servo motor:MG995
- Node MCU:ESP8266
- Battery charge protection for Li-ion:TP4056
- Ultrasonic sensor module:Hc-Sr04
- IR Sensor
- 3D Printed Robotic ARM
- Relay:5V 10A
- Toy Car: RC
- DC Power Supply:7.5V,2A

B. METHODOLOGY

Electric / Hybrid Plug IN vehicle enters the charging station; Here we are using an RC Toy car as the vehicle. We also arranged a stopper on the floor, so that the vehicle tyre should park exactly by hitting on the stopper. This arrangement helps the robotic hand enough data to locate the charger port position.

We have introduced a mobile application for our project. The charging station can be completely controlled by this mobile application. When the driver enters the charging station, it automatically detects the vehicle and the charging station can detect the type and model of vehicle. We have used ultrasonic sensor to measure the distance between the vehicle and the charging station. The app interface is very user friendly. It can be easily controlled by the driver. The icons can be arranged according to our needs also the driver can add their name to it.

Here we are using blynk application for our project. We selected blynk because it is more comfortable, safe and user friendly, all the icons can be adjusted to our needs. Also we can add more features to it. The app interface consists of the vehicle details, time took for charging, rate and also the balance amount. It is same as recharge of a fast tag. During the charging time the driver can leave the car and after the completion of charging process he will receive a text message so that he can come and take this car. While charging the driver can move away from the car. There is a live tracking process which will be very useful for the drivers. The charging power and battery capacity decides the time required for charging the battery. In short, the rate of time to charge depends upon the level of charging of the battery, this inturn depends on the charger of the car and the ability to handle voltage of the battery.

There are different levels. Level 1 is the slowest speed charger, Level 2 is the medium speed charger ie, household 240V AC and Level 3 as the fastest level charger. The charging time of Level 3 is very fast and requires only thirty minutes to charge 80% of battery. Industrial competition is very severe about the standard that should be widely adopted. The first generation usable battery capacity of electric vehicle is 20 kWh, for a range of 160 km. The first company, Tesla introduced longer range mass production electric vehicles. They released the Model S with different battery capacities of forty kWh, sixty kWh and eighty five kWh. Plug-in hybrid vehicles have capacity of three kWh to twenty kWh, for a range of twenty to eighty kilometers. The gasoline engine produced the full range of a conventional vehicle. The basic charging process depends on the type of vehicle.

From the domestic socket, rechargeable electric equipment and vehicle can be charged. If the EV is not charging the sensing mechanism or current mechanism disconnect EV from power in a charging station. Also in charging station number of electrical vehicles can charge at a time. Charging stations for electric vehicles does not require new infrastructure in developed countries. The charging station can offer the existing electrical grid. The home recharging is an optional, as most of the driving is short distances which does not require mid trip charging. Charging stations plays an important role where vehicle have the facility of on-street parking. The present filling stations may also incorporate charging stations. Our charging method is very simple and can be used by anyone. It can also be easily accessible by anyone. The mobile app is the very useful process in the whole project. We can also provide other additional features to it.

There is an indicator light in the charging station to show whether the charging station is free. We are using a IR sensor for this purpose. When the charging station is empty the indicator lights show green, when the vehicle enters the IR sensor transmitted light reflects back by hitting on the car body and it will be captured by the receiver and turns the indicator light red and the charging station becomes active for charging.

The driver will pair their mobile with the charging station by login to the web application provided by the charging station and select the charging slot. Once they are paired the charging station gets the details of that car such as the car model, height of the charging port, the length and breadth wise distance from stopper pad to the charging port. We also use ultrasonic distance sensor to the get real time distances.

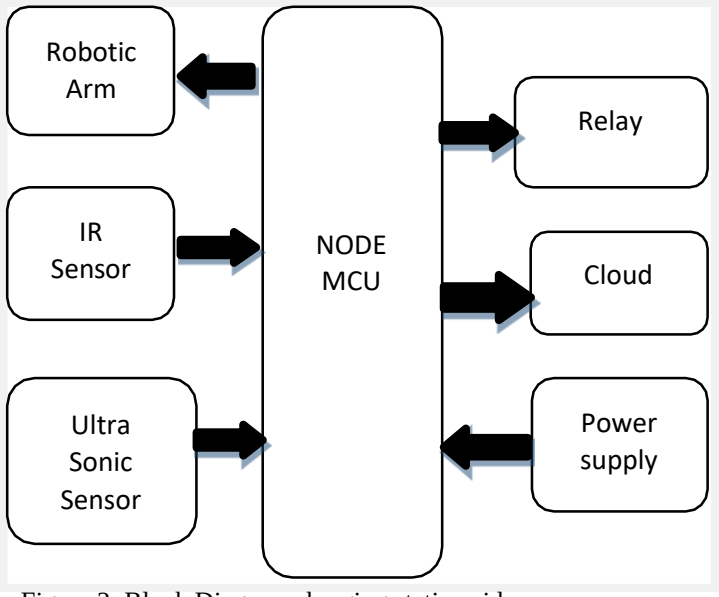

Figure 2: Block Diagram charging station side

Based on the above information robotic arm place the charging wire at the tip exactly to the charging port. We use a magnetic head charging port, so that the Plug IN of the arm will made more accurate.

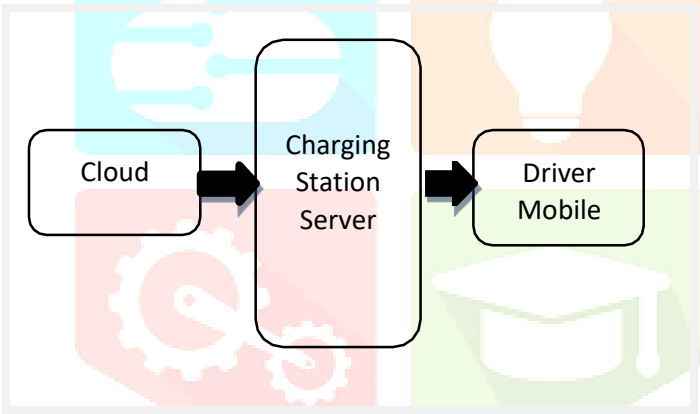

Figure 3: Block diagram Driver Interface

The driver will pair their mobile with the charging station by login to the web application provided by the charging station and select the charging slot .Once they are paired the charging station gets the details of that car such as the car model, height of the charging port, length and breadth wise distance from stopper pad to the charging port. We also use ultrasonic distance sensor to get real time distances.

Based on the above information robotic arm will place the charging wire at the tip exactly to the charging port. We have used a magnetic head charging port, so that the Plug IN of the arm will be more accurate.

After Plug IN the relay coil gets energized and current is passed for charging. Here we use TP4056 battery charge protection for Li-ion in the car for indicating the charging is taking place. Once the relay coil is energized the timer starts and stops until charging is finished or the driver stops the charging process by clicking stop button through the online web application.

Once the timer stops, the relay will be de-energized and the robotic arm will be withdrawn to the initial position. Based on the charging time, Node MCU ESP8266 calculates the bill and send to the charging station server through the Wi-Fi hotspot. This amount will be debited from the account of the driver provided by the charging station company. The above transaction details will be accessible to the driver by login to their web portal. The above proposed -system is shown in Figure 4.

Figure 4: Proposed automated charging station in public areas

III DISCUSSION AND OUTLOOK

Automated system for charging electric vehicles nestle free, convenient charging without any human intervention.. When a car approaches and is parked in the charging bay, charging plug suitable for the particular vehicle is selected by the system detecting the type automatically and is plugged to the socket after opening any cap if its there. Once the vehicle is fully charged system removes the cable and the system is restored to the normal state as it was when the vehicle reached the charging bay.

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Even though the electric vehicles are using state of the art technologies, there are lot of difficulties involved. Since the charging plug socket needs standardization. The standardization also has limitations because each manufactures is improving upon the abilities of the vehicles in respect to the storage batteries capacity. So the charging speed / current is not standardized yet. There are different types of sockets depending on the model, brand country of origin. There is no standard for position of the socket for charging. Some hybrid vehicles come with charging sockets on sides and some electric vehicles come with sockets located in front or back side of the vehicle.

The heights at which the sockets are installed are also way different in different brands of vehicles.

There will be cap provided for protecting the sockets. Some are rubber screwed caps and some others have plastic flip open caps. So the automated system for conductive charging requires lot of customization to soot all types and makes of vehicles. The system demands complex devices to handle the plugs and cable

management. In special cases of DC quick charging requirements heavy cables are involved as is the case with CCS tpye2 cable for charging weight about 1.7Kg/meter with abilities to charge upto 106.25kw. Diameter of the cables used is 28.2mm

Figure 5: charging port for proposed system in Vehicles

An overview of the proposed vehicles charging socket is presented in Figure 5 shows a typical parking station of vehicles appropriate socket for charging positioned correctly taking care of complex requirements of automated charging system including the resulting charging socket position. As mentioned, these varieties of systems and vehicle - specific requirements complicate an automation of the charging process enormously.

V CONCLUSION

Automated system for charging electric vehicles are challenging and emerging in the market. Since each new model comes with out of the box technologies with higher power retaining capacities, charging systems need to attend to the complex requirements of all electric vehicles. Presently most of the automated charging systems are of prototype status. Concept of automated charging system presented with robot in charging bay takes care of all possible challenges and provides solution. Since future electric vehicles are expected to be designed for automated charging station and the number of electric vehicles increase the potential for automatic conductive charging stations are immense. Ease of charging is also going to be determinable in improving comfort of use of electric vehicles

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