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Autonomous Floor Cleaning Robot

Reyhan Ahmed[1], Hrithik Bhat[2], Atharva Kamble[3], Hiral Chudasama[4], S. K. Gabhane[5].
[1, 2, 3, 4]*Student,* [5]*Asst. Professor, Dept. Of Electronics and Telecommunication Engineering, MCT's Rajiv Gandhi Institute of Technology, Mumbai , India.*

Abstract: ***The need for technology to minimise human effort has been increasing. This paper describes our aim to create a small robot that has a primary feature to clean floors without any human intervention. This robot will be both manually and automatically controlled as per the user needs.***
For the manual part we will be using Internet Of Things (IOT) to make controlling the robot easier. We have used an android application that helps direct the robot in the desired location. For the automatic part of the robot's navigation we will be depending on the robot's sensor and L pattern algorithm.
The platform and the main brain of the robot will be a Raspberry-pi. Raspberry-Pi will help to convey the commands from the application to the robot and even take feedback from the sensor and help to steer the robot and create a new path for it without any human interaction or interference.
The Raspberry-Pi, on receiving the commands from the application through a wireless receiver, decodes the given commands and controls the motors to achieve the desired path and direction.

I. INTRODUCTION

As times have been developing the need for technology has also been increasing. The main aim for technology is to reduce human efforts and make life easier. One major chunk of technological advancement is in the field of robots. In every field and aspect of life the need for the use of robots have increased, from small chores to multi-million dollar production plants all have incorporated the use of robots.
As the research on robots have increased they are made faster, compact and easier to use and its functions have increased in their particular domains. We aspire to apply the function of the robot in the cleaning domain on a small scale, domestic level.
A floor cleaning robot is the best solution to making life a tad bit easier. A smart floor cleaning robot has been ideally designed for home and office environments.
There are many types of cleaning robots used in the market with different variations like some have vacuum and motorized cleaning mop.
The robot which we will be creating will use water storage with an anti-infection solution which will be used while the mop is spinning.
This robot on receiving the commands from the android device cleans an area using a cleaning pad by spraying water on the floor. After that two cleaning mops attached to the motors will begin to clean the surface where the robot sprayed the solution.
To prepare our algorithm for our Raspberry-Pi we will be creating a virtual simulation using the Robot Operating System (ROS) software.
This simulation once configured can navigate around a room by itself without any human interaction or interference. Once Ros is incorporated in the Raspberry Pi module it will directly execute the program without any further configuration.

A. History And Background

The first ever floor cleaning robot was created in the year 1996. It was created by Electrolux, Swedish household and professional appliances manufacturer and was called "Trilobite".
It worked fairly well but it had problems with colliding with objects and because it stopped a short distance from walls and other objects it left small areas that are not cleaned hence it was discontinued and never reached mass production. A few years later iRobot, an American advanced technology company, launched the Roomba.
This robovac can change direction when it encounters an obstacle, detect dirty spots on the floor, and can detect steep drops, which keeps it from falling down stairs. The table 1.1 (a) shows the history and advancements in the creation and preparation of the floor cleaning robot.

Table 1.1 (a): Comparison of types of floor cleaning robots

Name	Manufacturer	Launch Date	Usage	Technology	Price
Roomba	iRobot	2002	Dry Vacuum	IR, RF and auto-charging mechanism	500$
Scooba	iRobot	2005	Wet Washing of Floor	IR with virtual wall accessories	500$
Braava	iRobot	2006	Floor mopping for hard surfaces/Dry clean	IR with virtual wall accessories for industrial cleaning	700$
EYE-360	Dyson	2016	Vacuum cleaning	It uses a 360 degree panoramic vision camera to monitor its environment in real time and a turbo brush for efficient cleaning along with an auto-charging mechanism	1000$

II. SURVEY RESULTS

We conducted a custom survey to understand the needs and demands of our primary consumer market. We modified our objectives and method of approach once we got our results and understood our consumer market. The results of our survey are posted in the following images. (fig.2 (a), 2 (b), 2 (c), 2 (d))

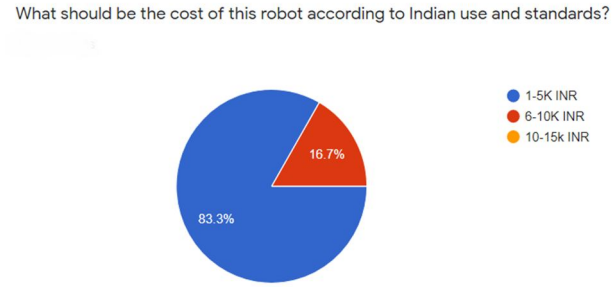
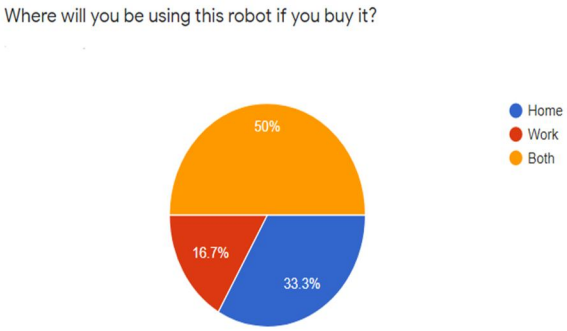


fig.2 (a)



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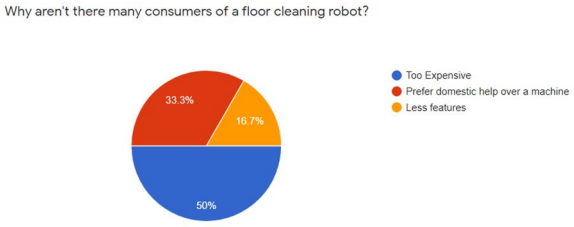

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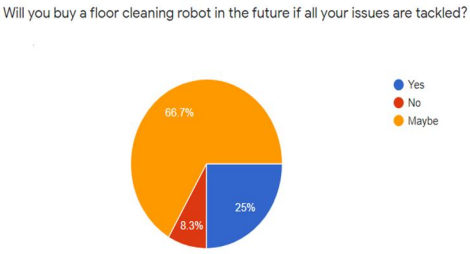

fig.2 (d)

III. PROBLEM STATEMENT

We want to live in a clean and hygienic environment but the efforts that are required to maintain the cleanliness are tremendous and it consumes a lot of time and energy. Finding a way to reduce the amount of time and energy is important. A robot is used in almost every aspect of life and it makes the task in hand a lot easier. A cleaning robot will help maintain cleanliness without much human effort. If an area needs to be cleaned then the user just has to give a simple command through the application and the robot will clean that specific area without the need of any monitoring. As engineers it is our duty to provide cost effective technology. We plan to make this technology affordable and accessible to the majority of the indian households.

IV. PROPOSED MODEL

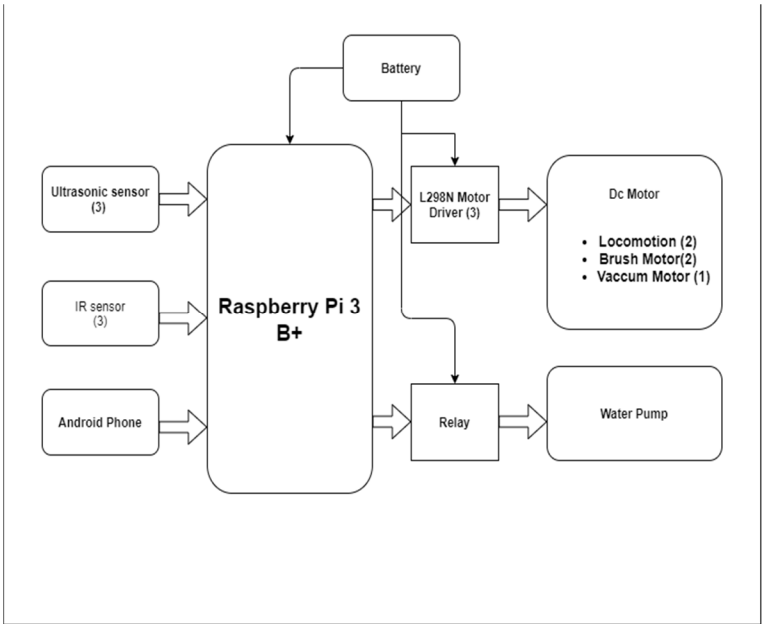

Fig.4 (a) : Block Diagram of Proposed Model.

The block diagram of Robot is shown in the Fig.5 for better clarity of proposed work. The block diagram consist of components used for autonomous control and manual control of the robot.

A. Hardware Used

1) Raspberry Pi 3 model B+: The Raspberry Pi 3 Model B+ was launched with a faster 1.4 GHz processor, a three-times faster gigabit Ethernet (throughput limited to ca. 300 Mbit/s by the internal USB 2.0 connection), and 2.4 / 5 GHz dual-band 802.11ac Wi-Fi (100 Mbit/s). In our Project it will work as a Brain of Robot (Microcontroller).

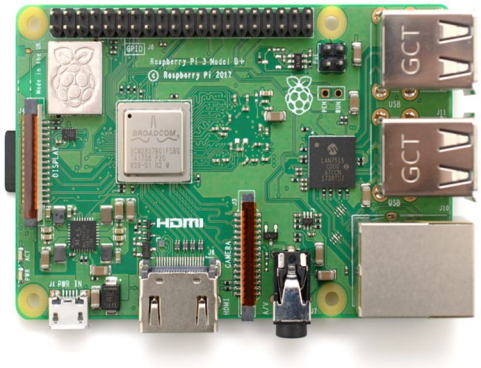

Fig.4.1.1 (a) Raspberry Pi Module

2) Ultrasonic Sensor: An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal which can be used for obstacle avoidance in automatic mode. This economical sensor provides 2cm to 400cm of non contact measuring functionality with a ranging accuracy that can reach up to 3mm.

Fig.4.1.2 (a) Ultrasonic Sensor

3) L298N Dual Channel Motor Driver: L298N is a Motor Driver IC which allows DC motor to drive on either direction. L298N motor driver IC has 16 pins which are used to control a set of two DC motors simultaneously in any direction. It is based on the concept of H-bridge. The direction of voltage or current flow will be decided by PWM signal given to the H-bridge.

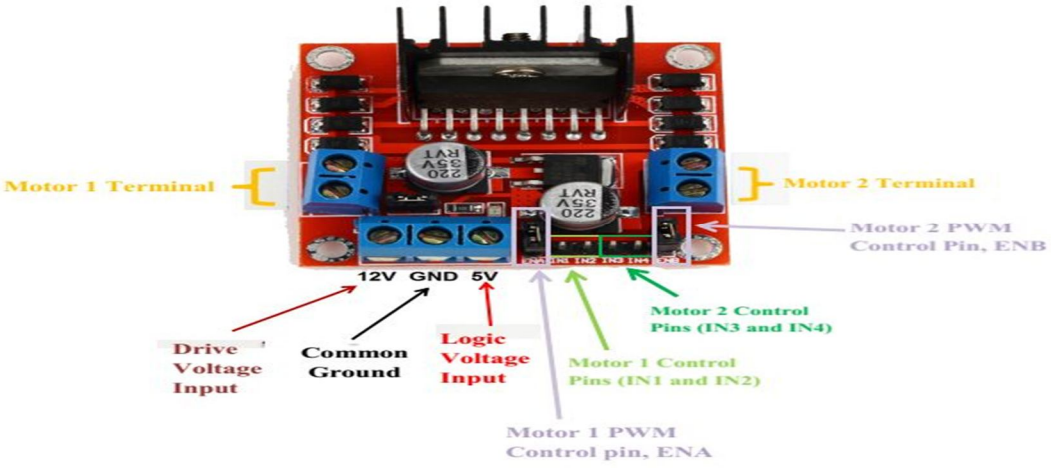

Fig.4.1.3 (a) L298N Motor driver

4) *DC Geared Motor:* A Direct Current (DC) motor is a rotating electrical device that converts direct current, of electric energy, into mechanical energy. An Inductor (coil) inside the DC motor produces a magnetic field that creates rotary motion as DC voltage is applied to its terminal. It will drive the base motors as well as the Brush motors used for seeping the Floor.

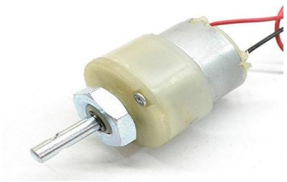

Fig.4.1.4 (a) DC Geared Motor

5) *Vacuum Cleaner:* A vacuum cleaner motor is a DC motor series that causes suction in order to remove debris from floors, upholstery, draperies, and other surfaces. It is generally electrically driven. It is used to collect the dust present on the Floor.

Fig.4.1.5 (a) Vacuum Cleaner

6) *Submersible Water Pump:* A submersible pump (or sub pump, electric submersible pump (ESP)) is a device which has a hermetically sealed motor close-coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The main advantage of this type of pump is that it prevents pump cavitation, a problem associated with a high elevation difference between pump and the fluid surface. It is used for dripping water for wet mopping of the floor.

Fig.4.1.6 (a) Submersible Water pump

B. Working

1) Autonomous Mode: The power supply is given to the Raspberry Pi module, L298N motor drivers and relay. When the autonomous mode is selected the robot is guided by the algorithm for path planning which plays an important role in efficiency of the robot. Here ultrasonic and IR sensors are connected to Raspberry Pi module which gives signal to it when it detects an object on its way. We have used 'L' pattern algorithm as it is the fastest program for full path coverage of a room. Here the robot moves in a straight line and at the end of the path, it takes a turn to get in parallel with the previous traversed straight line.It will continue until work is completed.

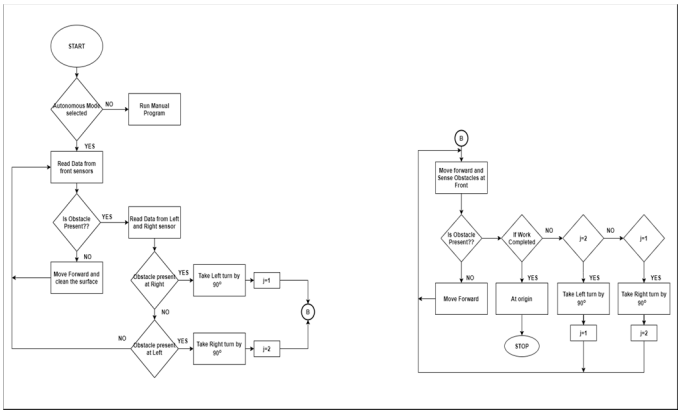

Fig.4.2.1 (a) Flowchart of the L pattern Algorithm

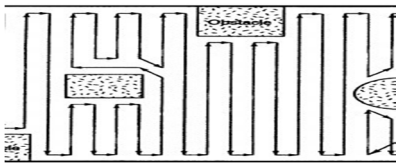

Fig.4.2.1 (b) Robot motion path

2) Manual Mode: The power supply is given to the Raspberry Pi module, L298N motor drivers and relay. Manual mode allows the user to control the robot. The user can give command to the robot to move in any pattern. User has to be careful while driving the robot as there is no automatic sensor which will detect the obstacle on its own. Robot might get damaged badly. This operation is carried out by Android smartphone and programming accordingly. It will first build the connection through Wi-fi. Then the received signal is encoded which in turn drives the motors.

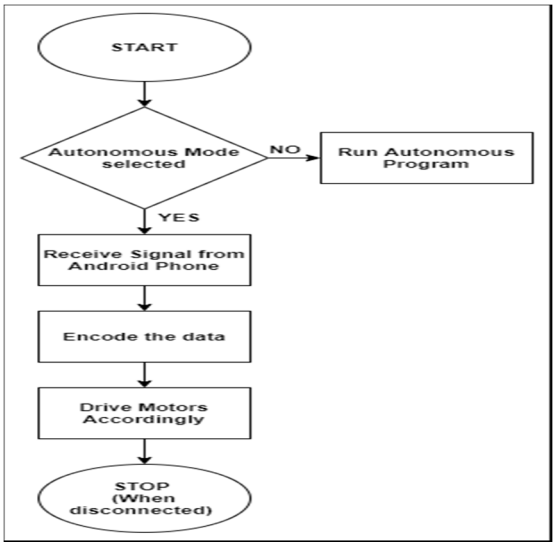

Fig.4.2.2 (a) Flowchart of Manual mode program

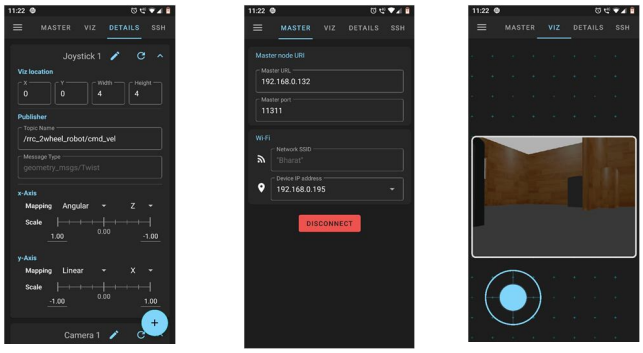

Fig.4.2.2(b)Android Application for Manual mode

V. CONCLUSION and FUTURE SCOPE

The main objective of the cleaning robot was to clean the assigned area or scout the area for any dirt or garbage. We used Raspberry-Pi as the main brain of the robot. The Raspberry-Pi made it easier to connect with the robot via its application and acted as a bridge between its motors and the sensor. We used Robot Operating System (ROS) software to configure Raspberry-Pi to make work ready and help it navigate automatically around a room. Our robot can use water and mop to clean a floor automatically.

In upcoming times we can develop a robot that can automatically detect a waste paper or any such garbage and pick it up by identifying it. In the future we can add additional cameras for the purpose of perfectly cleaning the area so that the robot can use the feedback from the camera to know the position of garbage or any impurities. To prolong its battery life in the future we can add an automatic charging dock so that the robot can navigate and charge itself without the need for any human interference this will make it truly an automatic floor cleaning robot.

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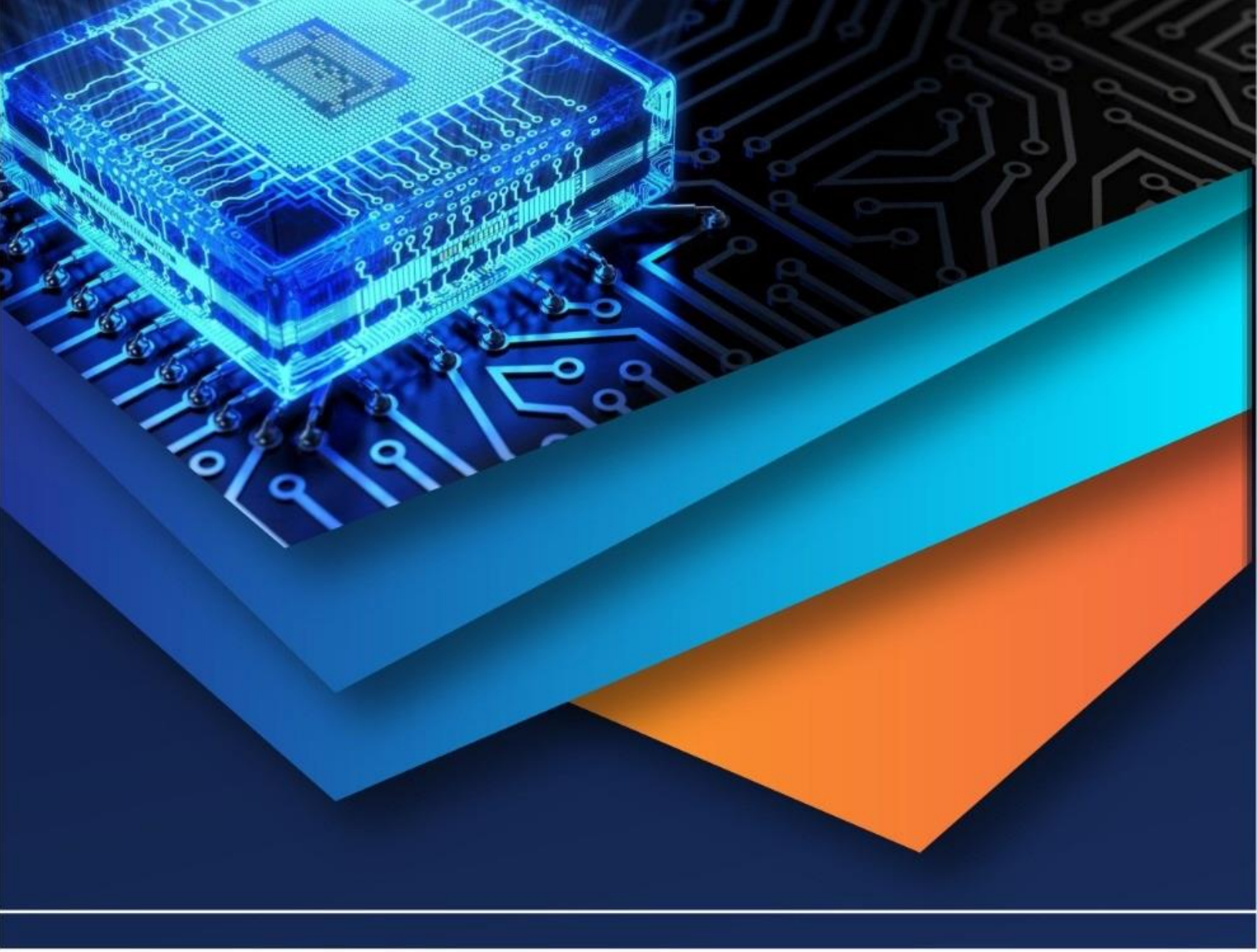

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