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Gesture Controled Robot

Abstract*: The goal of this paper is to develop a system that will interact with the hand-controlled gesture. This system could be implemented in communication with any entity with the digital module and can be controlled via gestures. This system is consisting of a transmission side and receiver side which has a raspberry pi at the transmission end. Numerous algorithms have been proposed and implemented to achieve the goal of gesture recognition and its use in communicating. Gestures can be tracked using an accelerometer so they can also be controlled via smartphones using the inbuild Bluetooth for transmission. This paper deals with the design and implementation of a wireless gesture-controlled Robot using an Arduino processor and a Gesture-operated application to control the gestures via Bluetooth. The system can be broadly classified into two components: The Hardware part consisting of the Arduino Microcontroller, the L293D Motor Driver, HC-05 Bluetooth module, and the Gesture, and the software consists of logics of C++ based code that run the gesture.*

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I. INTRODUCTION

A Robot can be classified as an electro-mechanical moving system that can be controlled via a computer program. Robots can be autonomous or semi-autonomous. A robot that can be autonomous which is not controlled by humans can act on its own decision by sensing the environment. Majorly industrial robots are autonomous because of there operating speed is very high with greater accuracy. But few applications require semi-autonomous or human-controlled robots. Some of the most commonly used system control are touch-controlled, motion control, and voice recognition. One of the most frequent implementations is a motion-controlled robot which is a Gesture control robot. In this Project, the gesture-controlled robot is developed using a Lily pad, MPU6050, which is a 3-axis accelerometer and gyroscope and is controlled via Arduino Nano. Rather than using a remote control having a joystick and buttons instead of hand gestures makes it much easier to use using handheld gestures. Which is based on wireless communication, where the data from the handheld gesture are transmitted to the robot via Bluetooth link (both at transmitter and receiver end) the whole design is divided into transmission and receiver parts. With the help of circuit diagram components if transmission and receiver are separately explained.

II. LITERATURE REVIEW

In [1], the authors analyzed different motion technology to capture the gesture. They have used a wearable gesture device that has a sensor on the wearable device. which the movement of the hand is detected via a sensor and can be sent wirelessly through radio waves.

In [2], the author analyzed ViTel robot which is controlled with hand gesture without being at the same place it can be controlled with the smartphone using virtual reality technology to drive two-wheel robot which can go to the locations which cannot be easily accessed. Which can help the military and high security on the field.

In [3], the authors design and developed Five Figure Robotic Hand(FFRH) which consist of command such as fingers open and close, wrist up and down, base clockwise and counterclockwise. Which also secure human presence under hazardous conditions and can be precise while doing it so.

In [4], the authors made three-axis accelerometers when the person/user moves the hand in 3 directions ie. X, Y, Z. The robot captures their movement on an accelerometer which can help handicapped people to make their movement easily through hand gestures.

In [5], the authors used MEMS (Micro-Electro-Mechanical Systems) which consists of an accelerometer to record hand-controlled gestures. The MEMS identifies the gesture and sends it to a microcontroller. Which can also be sewed on the cloth material which can be much more flexible

[20] Gyroscope and accelerometer are the major technique for the human interaction devices, therefore, are used in various applications of human interaction

III. RESEARCH METHODOLOGY& IMPLEMENTATION

The Main Aim of this work is Handheld Gesture controlled robot. The user has a glove that has amounted Bluetooth and gyro to track moves rotates his hand in any direction. The Gyroscope is regulated to generate a maximum and minimum value for the movement of the hand in three-dimensional coordinates depending upon the external environmental conditions. The Lily pad does the work of sensing the accelerometer calibration and generating the maximum and minimum values from it. Depending upon the outputs obtained, it sends a specific value to the microcontroller using a Bluetooth module. The Bluetooth module is both at the receiver and transmission end, and the module transmits data to Arduino where it checks for the value and moves the robot according to the values. The whole process is in a loop, so it runs as long as power is supplied to it. The output depends upon the accelerometer which is used to control the robot. The accelerometer input depends on the gestures of the user's hand. The steps are broadly described in this section. The system consists of the following steps mentioned in fig3.1.

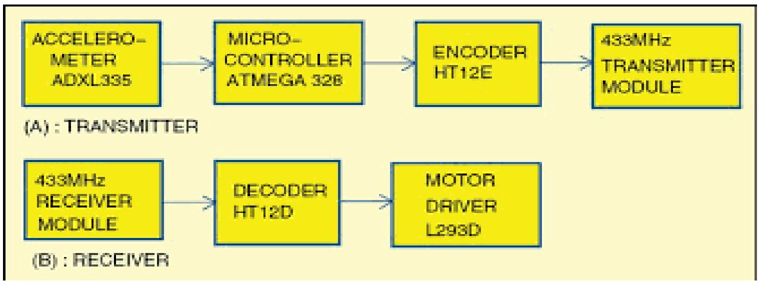

Figure 3.1-Block diagram of gesture control robot [7]

3.1 Transmission of data to Motor driver

The input to the application in the direction of movement of the hand of the user is given by the accelerometer. This is analog. It is coded in C++ in Arduino and transmits the instructions via HC-05 Bluetooth Module. The Bluetooth signals go into the pins of the Arduino board, which consists of inbuild AD/DA converted which is of 8 bits. The Arduino processes the data which is received. Based on the Data which is received, a specific signal is transmitted to the L293D Motor Driver to rotate the motor in such a way that the robot moves in the direction in which the user moves his hand which is pre-programmed.

The data is received from the Android Smartphone via the HC-05 Bluetooth module on the digital pins of the Arduino microcontroller. It is then processed in Arduino. This processed data is received by the L293D Motor Driver.

Gesture Recognition is equipped with inbuilt accelerometers. The application designed in the work receives the value of the accelerometer and sends the value to the microcontroller using Bluetooth, the Accelerometer changes its values accordingly. It is then retrieved by the application. There are two values: One is the maximum value and the other is a minimum value. The range is determined using the two values of each function of the robot. If the value received by the application lies between the specific values, and then the corresponding values are generated. The determined value is sent to the microcontroller, which receives certain value, simultaneously process it and recognize and the corresponding gesture, and send the signal to the robot which makes it move accordingly to it.

3.2 Movement of Motors and Wheels

There are 4 DC motors used in this model of robot, one motor for each wheel. The motors are controlled by the L293D Motor Driver. The shield is stacked and can run 4 DC motors. Installing the L293D Motor Driver library gives the flexibility of using the motors just by calling some pre-defined functions as motor1.setSpeed(value) that sets the speed of the motor to 250 rpm, or motor1.run (FORWARD) that makes the motor1 rotate forward. All these functions are called from the program present in the Arduino Microcontroller. The signal is sent to the motor shield that runs the motors. The wheels are connected to the motors. 4DC motors are used in this model 2 to the left and 2 to the right. When the signal is received in the motor driver to move forward direction, all the 4 wheels motor rotate forward and makes the robot move forward when the signal given to the robot to move in forward left direction, the left diagonal motors are rotated backward while the right diagonal motors are made rotated forwards. Which makes the robot turn in the left direction. Which makes the robot move in forward left. When the signal is received in the motor Driver is to turn the robot in the forward right direction, the right diagonal motors are rotated while the left diagonal motors are rotated forwards. Which makes the robot move in forward right direction. When the signal in the motor shield is to move backward, both the pairs of the motors are rotated backward resulting in the robot moving backward. When the signal in the motor shield is to stop the robot, all the motors are made stationary resulting in the robot stops. Similarly, to rotate the robot in backward directions, a similar methodology is used. To turn the robot in the backward left direction, the left diagonal motors are rotated forwards while the right diagonal motors are rotated backward. Which makes the robot move in the backward left direction. To turn the robot in the backward right direction, the right diagonal motors are rotated forwards while the left diagonal motors are rotated backward. Which makes the robot move in the backward right direction.

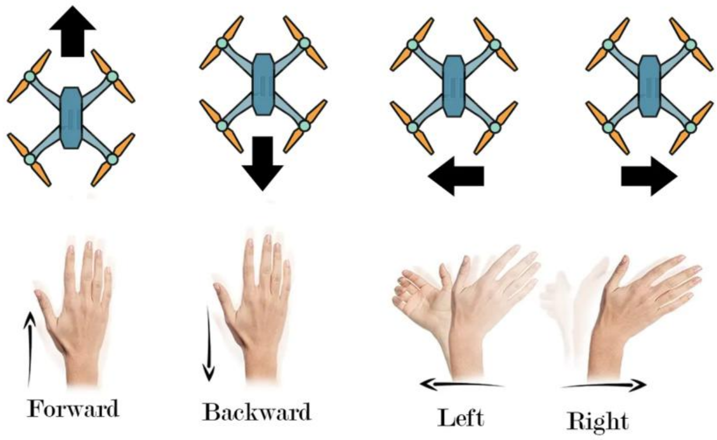

Figure 3.2 – Robotic-arm movement [13}

Movement of the Motors and Wheels. Designing the Movement Application, The Arduino application is the key to control the robot using hand gestures. The Program inside the Arduino reads the accelerometer is stated as X, Y, Z values are obtained inside the program and are dynamically changed. There are two values assigned for each movement: one is MAX and MIN Threshold. If the obtained value lies between these thresholds of a certain movement, then the character assigned to denote that movement, which is called the DET or determinant is sent to the robot via Bluetooth. The application continuously senses this until the application is ON. The application makes the calculations and accelerometer values, in the user instructions issued with the robot will show the movement of hand gesture so that the user is aware of bots movement and the wrong movement are to be avoided.
The following images show the block diagram of Hand Gesture Controlled Robot for both Transmitter and Receiver Parts.

Transmitter Block Diagram

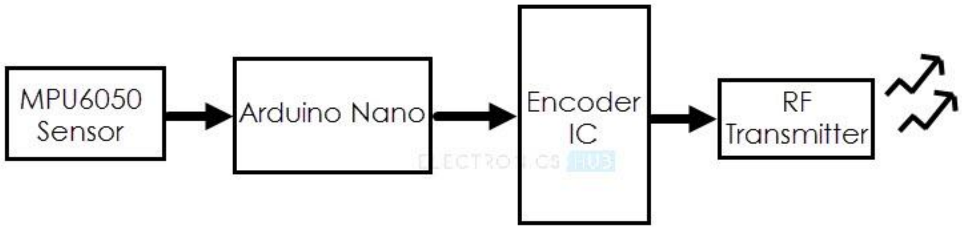

Figure 3.3 – Transmitter block Diagram [8]

Receiver Block Diagram

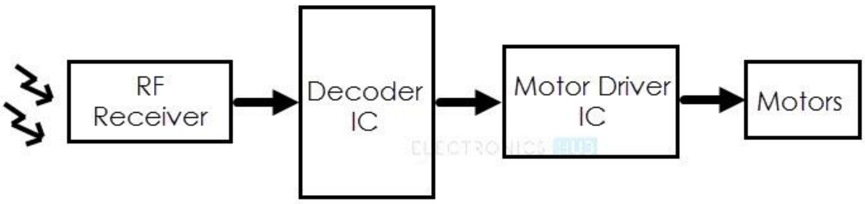

Figure 3.4 – Receiver block Diagram [9]

Circuit Diagram of the Transmitter Section

The following image shows the circuit diagram of the Transmitter part of the Hand Gesture Controlled Robot project.

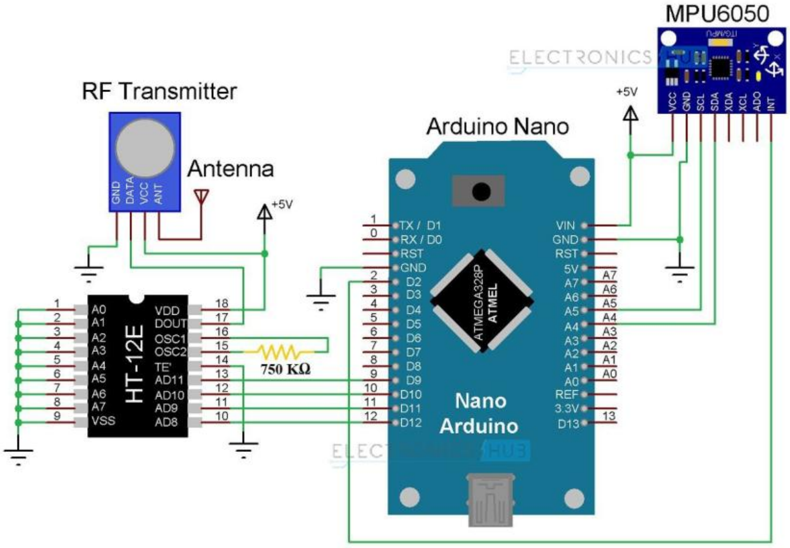

Figure 3.5 – Circuit diagram Transmitter section [10]

- Arduino Nano
- 434MHz RF Transmitter
- HT-12E Encoder IC
- MPU6050 Accelerometer/Gyroscope Sensor
- 750KΩ Resistor

Circuit Diagram of the Receiver Section

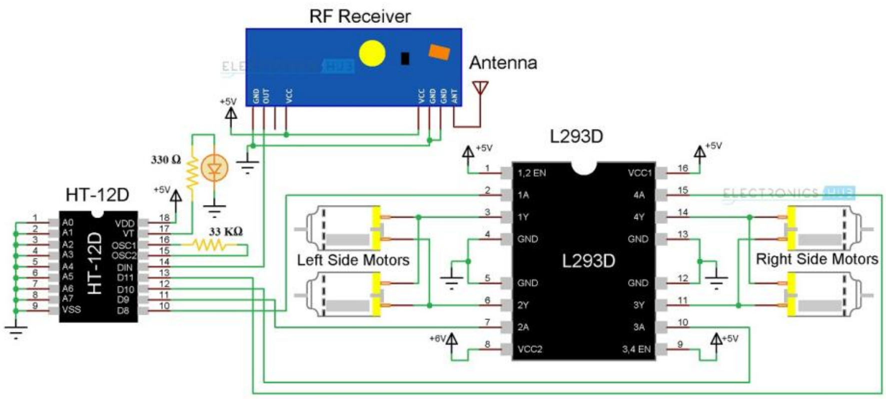

Figure 3.6- Circuit diagram of Receiver section [11]

- L293D Motor Driver IC
- HC-05 Decoder IC
- 434 MHz RF Receiver
- 33KΩ Resistor
- 330Ω Resistor
- LED
- 4 Geared Motors with Wheels
- Robot Chassis

MPU6050

The MPU6050 is one of the most commonly used Sensor Modules by hobbyists and enthusiasts. It consists of Accelerometer and Gyroscope on the same IC and provides 6 Degrees of Freedom (3-axis of an Accelerometer and 3-axis of a Gyroscope).

Figure 3.7- MPU6050 [14]

Arduino UNO
Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header, and a reset button

Figure 3.8- UNO [15]

L298N motor driver
L298N Motor Driver Module is a high-power motor driver module for driving DC and Stepper Motors.

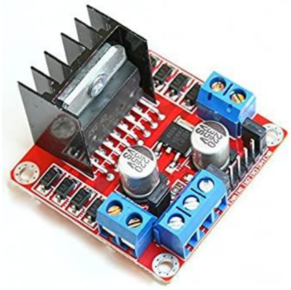
Figure 3.9- L298N motor Driver [16]

Wheel And BO Motor
The *wheels* that come with the *BO* shaft *motor* works well together


Figure 3.10- Wheel And BO Motor [17]

LilyPadArdunio
The *LilyPad Arduino* is designed for e-textiles and wearables projects. It can be sewn to fabric and similarly mounted power supplies, sensors, and actuators

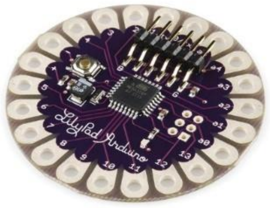

Figure 3.11- LilyPad [18]

HC-05 - Bluetooth Module
The *HC-05* is a very cool *module* that can add two-way (full-duplex) wireless functionality to your projects

Figure 3.12- HC-05 [19]

Transmitter Section

The transmission section of the robot consists of Arduino Nano, Lilypad, MPU6050 Sensor, HC-05 Bluetooth IC, and a BT Transmitter. The transmission between Arduino Nano and MPU6050 Sensor communicates through I2C Interface. Hence, the SCL and SDA pins of the MPU6050 Sensor are connected to the A5 and A4 pins of the Arduino Nano. Similarly, we are using the interrupt pin of MPU6050 and is connected to D2 of Arduino Nano. HC-05 is an encoder IC that is often associated with the BT Transmitter module. Which converts 12 Bit parallel to Serial data. The 12-bit data is segregated into data and address bits. A0 to A7 (Pin 1 to Pin8) are the address bits and they are used for the secure transmission of the data. These pins can be either left open or connected to the ground (Vss). In this circuit, Pin 1 to Pin 9 (A0 – A7 and Vss) of HC-05 are connected to the ground pins from numbers 10 to 14 (AD8,9,10,11) are data pins of HC-05. Which receives the 4bit parallel data from an external source like a microcontroller (Arduino Nano in this case). They are connected with the pin (D12,11,10&9) of Arduino nano. (Te) is the pin of transmission which enables the pin and when the pin is low. The data can only be transmitted till the Te is low. Hence, Pin 14 (Te) is also connected to the ground. The encoder IC has an internal oscillator circuit between pins 16 and 15 (OSC1 and OSC2). A 650KΩ resistor is connected between these pins to enable the oscillator. Doubt (Pin 17) is the serial data out pin. It is connected to the data in the pin of the RF Transmitter. Both Arduino Nano and MPU6050 have a 3.3V Regulator. Therefore, all the VCC pins are connected to a 5V power supply.

Receiver Section

The receiver section of the robot consists of a BT Receiver, HC-05 Bluetooth IC, L293D Motor Driver IC, and a robot chassis with four motors connected to wheels. Lilypad is the decoder IC that is connected via the BT receiver. It converts Serial data by the BT link into parallel Data. A0 to A7 (Pin 1 to Pin 8) is the address pins and must be matched with the address pins of the encoder. Hence, the Address pins of the Encoder (Lilypad) are grounded, whereas the address pins of the decoder must be grounded. Hence, pin 1 to 9 (A0-7 and Vss) are connected to the ground. The serial data from the BT receiver Is given to (Pin 14) of the Decoder IC Lilypad has an oscillator and is connected to OSC! And OSC2 (Pin 16&15). Pin 17 indicates a transmission data of pin 17 will be high when valid data is present at the data pins. An Led in series indicates a valid data Transmission. Pins 10 to 13 (D8, D9, D10, and D11) of Lilypad are the parallel data out pins. Which is connected to the input pins of L293D motor Driver Ic (pin 2,7,10 & 15) L293D motor driver IC is used to provide the current (for both Forward and Reverse Directions) to the motors. Pin 1 and 9 enable pin and connected to Vcc with pin 16 (Logic Supply). Pin 3-6 & pi 11-14 are the Outputs that are connected to the 4 motors. Pin 8 is the Motor supply pin that is connected to a Separate Power Supply. Therefore, batteries or a dedicated power source will be needed at the receiver section which is for the circuit and the motors.

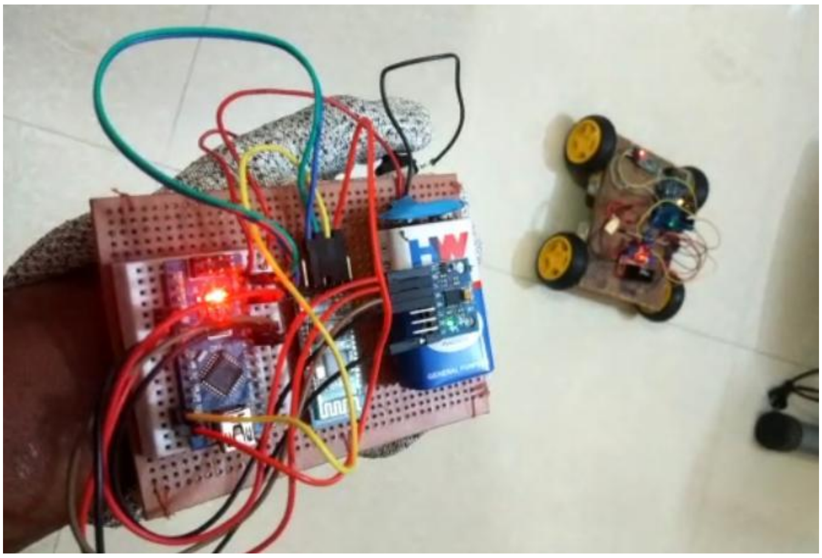

Figure 3.13 – Assembled Project

IV. SYSTEM WORKING

Step 1: Switching on the receiver and transmitter

Step 2: Wait for the Bluetooth to sync with each other the code has been made so that they connect to the same Bluetooth device.

Step 3: User Seeks the gesture as command the movement of the hand.

Step 4: The application understands the gesture and sends a signal through Bluetooth.

Step5: The microcontroller receives this data from the Bluetooth module serially and generates a binary code as per the commands in the written code.

Step6: This Binary sequence is given as input to the acting gestures of the hand and sends to the receiver module

Step7: The gesture control robot can give the output 50 -100 m as it is a prototype.

Step 8: As per the program code, the received binary code is decoded and as per the assigned trigger, the function is executed by motors. Hence the robot function as per the gesture command transmitted through Bluetooth to established communication.

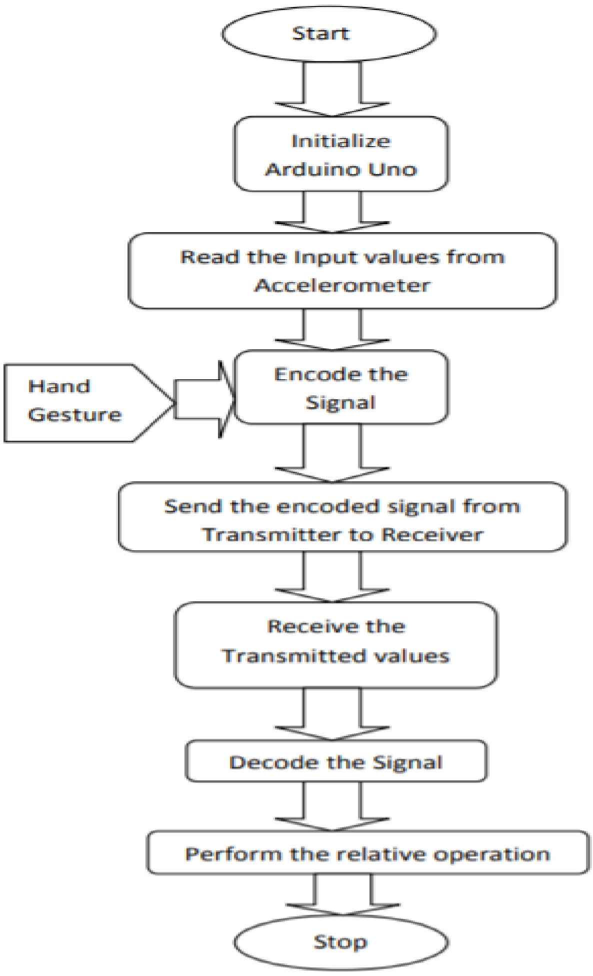

Figure 4.1-Flow chart [6]

V. CONCLUSION

The robot is designed to have Greater scopes in the future. The robot can be used for surveillance purposes. The robot can be applied in a wheelchair where the wheelchair can be driven by the movements of the rider's hand. Wi-Fi can also be used as a way of communication instead of Bluetooth which cannot be accessed from a greater distance. Edge sensors can be incorporated into it to prevent the robot from falling from any surface. Some cameras can be installed which can record and send data to the nearby computer or cell phone. It can be implemented on a watch, or in any home appliance like a Room heater. Nowadays an Arduino Chips support internet connections which will help utilize communications to a greater extend. This robotic car can be enhanced to work in military surveillance where it can be sent to some enemy camps and track its activities via the Internet. With a mind full of creativity, the possibilities are endless. In this paper, the design and implementation of Gesture Controlled Robot are presented and developed using Arduino microcontroller and Gesture. An algorithm has been provided and its work is detailed thoroughly. Hence, there are infinite possibilities so the system has a lot of future scopes. The device which has been built is on the cheaper side and is easy to carry from one place to another. The addition of some additional sensors or cameras will make it more productive. Limiting the hardware to be associated with the system has been reduced. As an end though, the system will allow the user to control it in a way that reduces the gap between the physical world and the digital world with an output more intuitive.

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