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# Electrical Power Recovery using Mobile Micro grids

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**Abstract:** This paper presents a novel way for electric power recovery using mobile micro grids. It's an integration **of** power electronics with robotics. Conventional power grid has become more complex with more and more Distributed Energy Resources (DER), calling for the need of a more flexible and reliable micro grid architecture. This paper aims to design a micro grid composed of autonomous vehicles that can navigate through a disaster stricken area for the recovery of electric power**.** The designed mobile micro grid is expected to detect for current failure and navigates to the desired load while simultaneously establishing the electrical connection**.**

**Keywords:** Microgrid, Mobile micro grid, Distributed Energy Resources (DER), Power grid

## I.INTRODUCTION

Today, we are living in a century where we rely on electric power for anything and everything. So power outages following natural or man-made disasters are proving to be catastrophic. This is because power outages may cause failure of basic infrastructures like communication, transportation, water supply, health care, etc. This may affect the normal routines of the large proportion of people in that particular disaster stricken areas. Thus, power outages itself may proves to be disastrous in many cases. Usually, the power recovery efforts may take some time depending on the terrain, no: of personnel available, etc. Microgrid is the latest power recovery effort. A micro grid is nothing but a local group of energy sources and loads with a control mechanism [1]. Microgrid may connect to the main grid at times of power outages and can be disconnected when not needed. Through this project we aim to integrate the power electronics and robotics aspects for the creation of a mobile micro grid for temporary electric power recovery. The proposed mobile micro grid [2] first detects for power outage. If there is no current, the micro grid starts deployment from the source destination to the load according to the instructions from the control side. In this mean time itself, the mobile microgrids start making electrical connections enabling faster power recovery and energy autonomy for the robots. The remaining section of this paper is organised into following sections: Literature survey, Proposed System and Conclusion

## II.LITERATURE SURVEY

Conventionally, electric power is delivered from source to load via centralised power grids. The electric sub-station is the supplier of energy in such cases. So if there is any fault in the sub-station, it may interrupt the whole power delivery system, causing power outages. Also, the architecture of a centralised power distribution system isn't scalable. ie, we can't expand, contract or repair this system without significant human intervention. The conventional method of power recovery is by a 3-phase diesel power generator. The disadvantage of this method is that it may delay the recovery efforts owing to the availability of the fossil fuel diesel. A more recent development is the deployment of micro grids for power recovery efforts. A micro grid is also a combination of localised energy sources and loads that can connect and disconnect from the main power grid through control mechanisms. As an example, take the case of solar energy harvested by local users. Such users may or may not work in conjunction with the main power grid. They may use their own solar energy and may give the additional energy to the main grid. But the disadvantage of a micro grid is that we can't rely on this method for electric power recovery of disaster stricken areas as it needs the implementation before-hand. Such systems too have a fixed architecture that isn't readily scalable without significant human intervention.

## III.THE PROPOSED SYSTEM

In this paper, we are aiming to implement a mobile micro grid that can establish electrical connections while navigating through an area. For this, robotic capabilities are added to a micro grid system. It can compensate for the shortage of personnel and can thus reduce the risk of power recovery efforts. It can be made to navigate to an affected area and restore power to loads of our interest.

The basic block diagram of our proposed system consists of the following:

- Source side robot.
- Cabling robot.
- Load section.

The cabling robot is the mobile unit for making electrical connections with the desired load section while the source robot provides the necessary power backup. Note that the design of the microgrid should be in such a way that the system can incorporate as many robots as the situation demands. ie, the system should be scalable for developing small as well as large microgrids.

B. The following figure represents the basic block diagram of our proposed system.

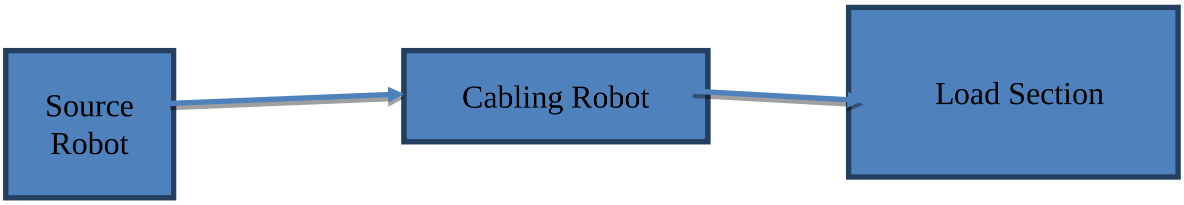


Fig.1 Basic Block Diagram

We can add as many cabling robots as the situation demands. This makes the system scalable making it suitable for small as well as large applications. The following figure shows the expanded block diagram of the proposed system.

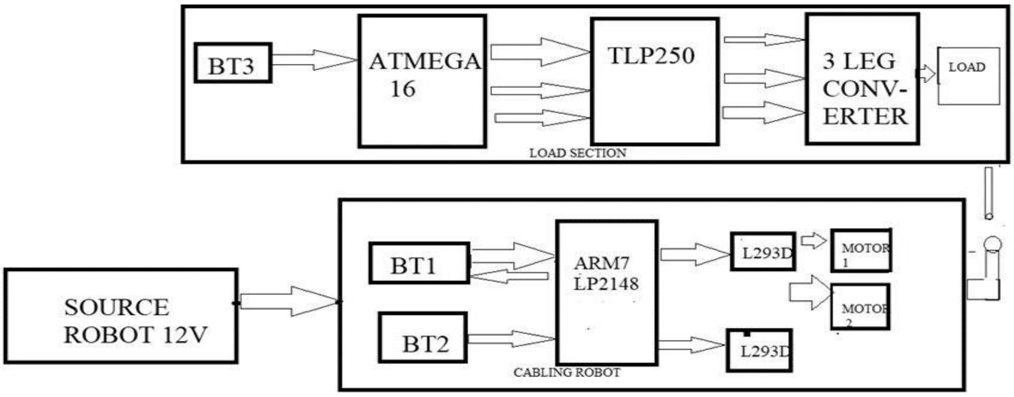


Fig.2 Block diagram of the proposed system.

**a. SOURCE ROBOT:** This is the main supply for our power recovery model. The mobile unit called the cabling robot carries this power backup with it for establishing electrical connections. In our prototype, we are using a battery source of 12V to serve this purpose.

**b. Cabling Robot:** This section is the mobile unit that is responsible for making electrical connections with the desired load. Upon the sensing of a power failure in the main power grid, this mobile robot starts deployment from the source section and reaches the desired load. The cabling robot is simply a 2 wheel robot with one wheel containing electrical cables for making electrical connections.

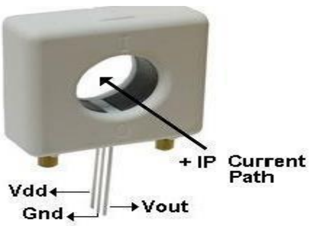


Fig.3.Winson's Current Sensor

This mobile robot is said to be composed of the following:

1. Current sensor that senses for the power failure in the main power grid. In this system, Winson's current sensor of WCS-1500 that can sense upto 200A is used.

2. 2 Bluetooth modules: In the proposed system, hc-05 is used as the Bluetooth modules. One of these Bluetooth modules BT1 controls the navigation of the cabling robot to the desired load. Also, the destination of the load is selected via this module. The second Bluetooth module BT2 selects the desired mode of power to the load. ie, ac power or dc power.

3. ARM7 LP2148: All the control commands are send to the cabling robot via the arm7 processor. Bluetooth modules and motor drivers are interfaced with this.

4. 2 MOTORS: These are responsible for the movement of the cabling robot. These 2 MOTORs are driven via the L293D motor driver ICs.

**c. Load Section**

1. The load section gives the extra power backup to the system via a 3- phase power electronic converter. The electrical connection is made with the cabling robot via electromagnetic coupling. For this, there is a solder iron with two wires in the load section. The load section comprises of the following:

2. Bluetooth module hc-05 for communication with the cabling robot.

3. ATMEGA16 microcontroller for controlling the various sections. 3-phase power electronic converter is interfaced with the controller via the driver TPL250.

4. 3 PHASE POWER ELECTRONIC CONVERTER: It gives the necessary power backup for the desired load. Our proposed prototype allows for flexibility between ac power and dc power. ie, we can drive both ac and dc loads via this power electronic converter. This flexibility between ac and dc power is achieved via the mode selection by the Bluetooth module BT3 which acts by the instructions from the Bluetooth module BT2 located at the cabling robot. The 3 phase power electronic converter is a combination of 6 power MOSFETS. It can work as an inverter and as a chopper producing ac as well as dc power. During each mode, either 3 MOSFETs from the 6 MOSFET combination will be conducting to work as an inverter or as a chopper.

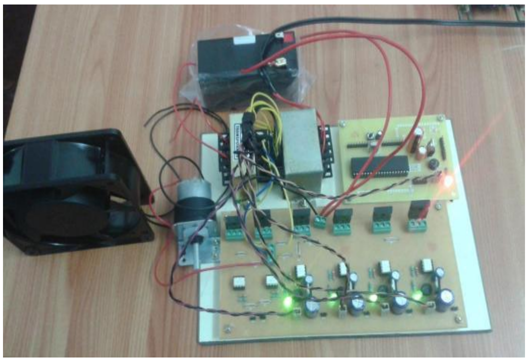

Fig.4. Image of load section

**HOW THE SYSTEM WORKS?**

Whenever there is a power failure in the main power grid, then the Winson's current sensor in the **cabling robot** senses the power outage and sends a message via Bluetooth module 1 indicating the power outage. This is the transmission mode of working of the Bluetooth module 1. Then the destination and navigation of the **mobile robot** is controlled via the Bluetooth module 1. Thus, Bluetooth module 1 works in the reception mode. Next step is the selection of the desired mode of working of load section (ie, to work as ac or dc power load). For this, a message is send via Bluetooth module 2 to the Bluetooth module 3 of the load section. After these processes, the cabling robot starts deployment to the desired load location. Simultaneously, the cabling drum of the robot unwinds the electrical cables for establishing

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the electrical connection. The power electronic converter supplies the backup current for electro magnetising the solder iron of the load section. Then, through electromagnetic coupling, the electrical cable of the mobile robot gets connected with soldering iron of the load section ensuring a proper electric connection.

## IV. RESULTS AND DISCUSSIONS

Through the prototype proposed in this paper, we are able to generate both ac and dc power with the 3 phase power electronic converter. The simulation diagram (Fig.5a) and results (Fig.5b) are presented below.

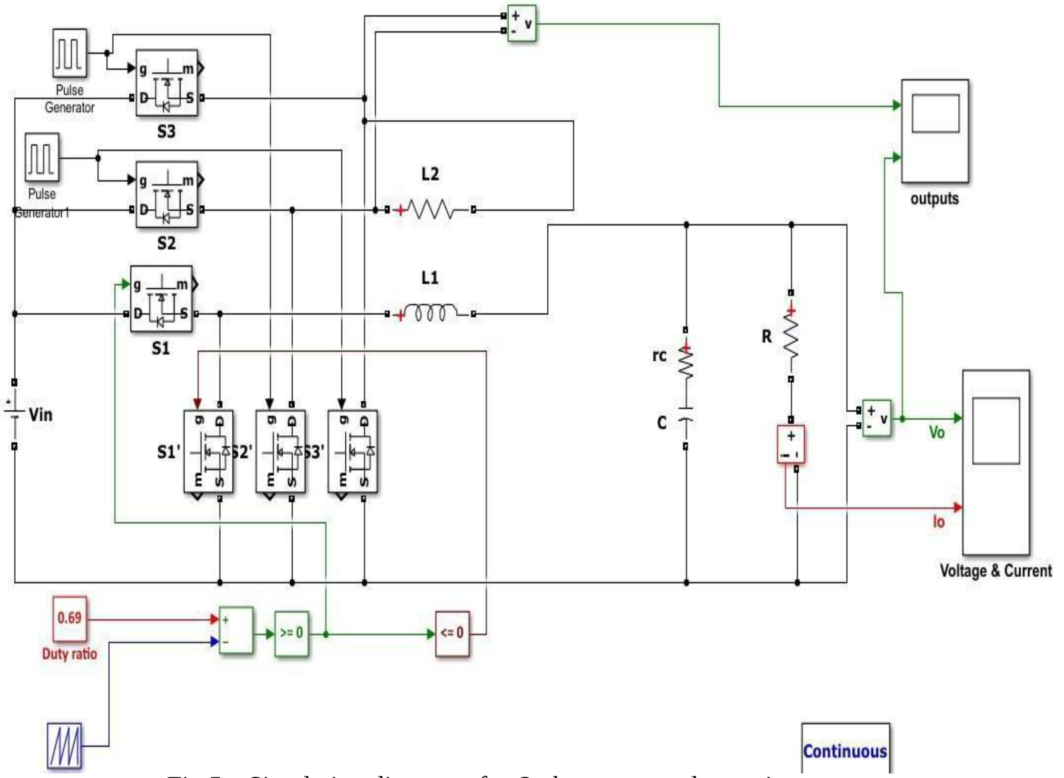


Fig.5a. Simulation diagram of a 3 phase power electronic converter.

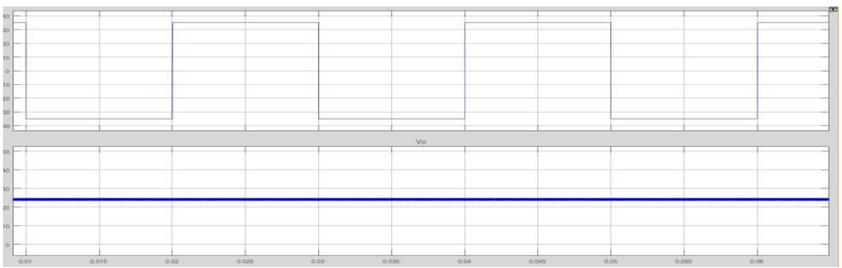

Fig.5b. Simulation diagram showing the ac and dc output

Power of a 3 phase power electronic converter for an input of 12V

## V. CONCLUSION

Today, we live in a world where we rely heavily on electric power for our routines. So the power outage is a serious problem that needs to be addressed. Also, in areas with frequent or heavy precipitations, the life of personnel is at risk during power recovery efforts. So, through this paper we designed a mobile microgrid that can establish a temporary power backup at the desired load location without significant human intervention at the load location. The mobile microgrid is capable of navigating to the desired load location while establishing electrical connections through electromagnetic coupling. This microgrid is also capable of driving both ac and dc loads. The navigation and communication between the micro grids is through Bluetooth modules. As our future enhancement, we can use 'MANET' (doesn't require significant internet connection, so suitable for disaster stricken areas) for communication between micro grids. Also, the mobile robot can be designed for any type of terrains as the situation demands.

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