

# Further Results on Odd Harmonious Labeling of Graphs

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**Abstract:** Liang and Bai proposed the notion of odd harmonious labeling of a graph in 2009. Since then, numerous papers have explored this topic. This study adds some new results to the existing literature. First, we provide a sufficient condition for an Eulerian graph to be an odd harmonious graph, which enhances the result from 2014. Furthermore, we identify several new classes of graphs that exhibit odd harmonious properties.

**Keywords:** disjoint union of graphs; odd harmonious labeling; path union of graphs; splitting graph; subdivided shell flower graph; vertex union of graphs.

**2010 Mathematics Subject Classification.** 26A25; 26A35.

## 1 Introduction

The concept of odd harmonious labeling of a graph was defined in 2009 by Liang and Bai [18] as follows: A graph  $G$  is said to be odd harmonious if there exists an injection  $f : V(G) \rightarrow \{0, 1, 2, \dots, 2q - 1\}$  such that the induced function  $f^* : E(G) \rightarrow \{1, 3, \dots, 2q - 1\}$  defined by  $f^*(uv) = f(u) + f(v)$  is a bijection. If  $f(V(G)) = \{0, 1, 2, \dots, q\}$  then  $f$  is called as strongly odd harmonious labeling and  $G$  is called as strongly odd harmonious graph. Motivated by this concept, several researchers have studied this topic and relevant results have been published in many journals and proceedings, among others. Our published results on odd harmonious labeling of graphs [5]-[17], [19] might definitely be useful to the interested researchers.

In this paper, we add further results on this labeling. Throughout the paper, we refer to the vertices and edges of the graph  $G$  by points and links respectively. We also introduce a new graph namely  $D_2 \& Spl(G)$ . To construct the graph, first find shadow graph  $D_2(G)$  and then for the original graph  $G$ , find splitting graph  $Spl(G)$ . The combination of  $D_2(G)$  and  $Spl(G)$  gives a new graph  $D_2 \& Spl(G)$ . An example for the graph  $D_2 \& Spl(P_5)$  is shown in Figure 1.

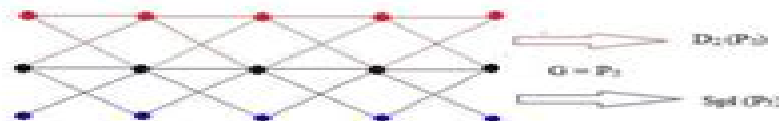


Fig. 1:  $D_2 \& Spl(P_5)$

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web according to the oxford english dictionary the first known use of computer was in a 1613 book called the yong mans gleanings by the english writer richard brathwait i haue sic read the truest computer of times and the best arithmetician that euer sic breathed and he reduceth thy dayes into a short number

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web jan 24 2022 in fact english mathematician ada lovelace wrote an algorithm what was essentially the world s first ever computer program for it in 1843 after becoming fascinated by the device while translating a french paper on it she went on to create sets of instructions that would enable the machine to compute bernoulli numbers

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the british government the project called the early 20th century turing machines are capable of computing anything that is computable the central concept of the late 20th century

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web dec 18 2000 during the late 1940s and early 1950s with the advent of electronic computing machines the phrase computing machine gradually gave way simply to computer initially usually with the prefix electronic or digital this entry surveys the history of these machines babbage analog computers the universal turing machine

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web history of computers modern technology first started evolving when electricity started to be used more often in everyday life one of the biggest inventions in the 20th century was the computer and it has gone through many changes and improvements since its creation

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web aug 30 2022 around 4000 years ago the chinese invented the abacus and it is believed to be the first computer the history of computers begins with the birth of the abacus structure abacus is basically a wooden rack that has

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web jul 26 2002 description author s praise this history of computing focuses not on chronology what came first and who deserves credit for it but on the actual architectures of the first machines th

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web the z3 computer built by german inventor konrad zuse in 1941 was the first programmable fully automatic computing machine but it was not electronic during world war ii ballistics computing was done by women who were hired as computers