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**BBC6406 A**

**Joint Programme Examinations 2020/21**

**BBC6406 Wireless Sensor Networks**

**Paper A**

**Complete the Report Before the Given Deadline.**

**Complete the information below about yourself very carefully.**

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| **QM student number** | |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | **1** | **9** | **0** | **0** | **1** | **9** | **5** | **4** | **3** | |
| **BUPT student number** | |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **2** | **0** | **1** | **8** | **2** | **1** | **3** | **1** | **7** | **6** | |
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| **Instructions**   1. Write **in English** and **print form**. 2. **Read the instructions on the inside cover.** |
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Examiners

Dr Liang Liu, Dr Dong Zhao

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Filename: 2021\_BBC6406\_A No answerbook required

**You are required to write a well-organized report to describe your design of a WSN system in detail.**

1) The length of the report should be no less than 5000 English words;

2) The targeted application scenario should be proper to cover all the requirements described below. For example, since a single-hop network doesn’t need routing protocol, direct communication model that any node can directly communicate with the sink is NOT proper because it will not satisfy the routing design requirements. Missing the design of any part can lead to significant rating downgrade.

3) Plagiarism is strictly forbidden. You can refer to existing WSN system designs but MUST write your own report based on your own designs. You MUST provide explicit reference when you refer to other published papers. Any plagiarism will directly lead to fail of the exam.

**Description:**

Please design a WSN application system for a specific domain such as industry, agriculture, environment monitoring, and etc. The design should contain:

1) the hardware and software design of WSN nodes. You should select the appropriate node hardware and the appropriate operating system, taking the functional requirements and efficiency requirements (e.g. energy efficiency) into consideration.

2) the network architecture and deployment design of your application system. Consider the application coverage and the hardware ability of your selected nodes, calculate the number of needed nodes and provide a deployment plan to cover the whole target area. The expected network topology should be presented.

3) the MAC layer design of your application system. Considering the requirements and the features of your application system, design the appropriate MAC protocol.

4) the network layer design of your application system. You should first describe the prior requirements such as reliability or low latency and then select the appropriate routing metric. Then the routing protocol should be designed with the consideration of the features of your application system.

5) application supporting service design. You should first define the functions of your application system. And then targeted these functions, you should discuss and present the supporting services that your system should provide to fulfill these functions. For example, for a fire alarm WSN system, you have to provide the real-time synchronized data with location information. Hence, your system should provide time synchronization and localization service.

Paper Title\* (use style: paper title)

*Abstract*—Birds

Keywords—component, formatting, style, styling, insert (key words)

# Introduction

T近年来，随着人类活动对野生鸟类自然栖息地的破坏，造成森林、沼泽环境破坏，或者破坏食物链，造成鸟类食物短缺鸟类野外生存受到极大挑战。

According to ,The analysis of 78 breeding season bird sample plots from 2011 to 2017 showed that 50% of the 556 bird species showed a downward trend, and the bird population density in inland water and swamp showed a significant downward trend. 可以看出，尽快落实对鸟类野外种群密度的监控，从而协助指导保护野生鸟类的工作势在必行。

传统监控方法为了监控鸟类而在野外部署具有夜视功能的红外摄像头以日夜监控，需要大量人力参与去选定最优位置，也是对传感器带宽的极大挑战，而如果通过鸟鸣去捕捉鸟类动向的方法则具有极大的适应性。因此，本文针对利用摄像头监控野外鸟类种群密度的工作的劣势，提出了一种利用鸟类鸣叫监控鸟类的创新方法。

# Related work

## Monitoring of birds at home and abroad

国内外学者对鸟类野外种群的监控已有很多工作，在野外的鸟类种群调查中，鸣声回放法一直被认为是一种重要的方法。

如下图所示，黑眉柳莺和灰岩柳莺亲缘关系较近，其在长相上难以分辨，但是在鸣声上差别很大，这一点可以在声图中看出来。

由此可见，利用鸣声区分不同鸟类从而监控它们是存在极大潜力的。已有的神经网络模型可以通过鸟类鸣叫对鸟类进行高精度的区分，但是如何将这些神经网络或分析方法与野外传感器节点相结合，以形成一个完善的监控系统，仍然缺少相关工作，同时也面临着如能量、背景噪声等诸多挑战。

## 在森林环境中部署传感器

在森林环境中部署传感器，以监控如森林火灾，盗伐树木等问题是科研工作者长期关注的问题。提出了一种WSN。本文将基于这些工作提出一种专用于声音监控的传感器网络。

# Hardware design

目前

Spatiotemporal 特点

森林鸟鸣声具有不连续的Spatiotemporal的特点。在时间上，鸟鸣声是无规律的，短暂的，在空间上，鸟鸣声广泛分布在整个森林范围内。如果传感器连续性的进行监听与发信，是对传感网能耗与带宽的极大挑战。

所以，硬件与软件设计基于如下原则

1 传感器节点要基于某种触发条件才产生一次“监听事件”

2 传感器节点本身计算性能受限，因为其必须采用低功耗处理器，所以监听算法不能过于复杂。

为了遵守这两个设计原则，传感器必须有能力进行本地的处理，对监听声道进行初步的过滤以减少发信频率。在声纹识别中，MFCC(Mel-frequency cepstral coefficients) 常被用于语音数据特征提取和降维。在鸟鸣声特征提取中，MFCC也可以得到很好的应用，但是MFCC在分帧、加窗等处理后，还涉及复杂的小波运算（较DFT运算效果更好），这在传感器节点上是难以实现的。

因此本文参考it，主要通过能量密度过滤噪声帧

首先，专用滤波器电路可以用于对输入音频信号进行初步检验。如图是利用Matlab对黑眉柳莺进行频域分析，可以看到黑眉柳莺的叫声的频域特征是十分明显的。

经调查，大部分鸟类鸣声频率在1,500 Hz and 8,000 Hz之间，所以通过一高通滤波器即可滤去大量低频噪声信号（如风声，树叶声，大部分野生哺乳动物的叫声）。随后，即可利用能量检测方法对有效帧进行提取。

*假设麦克风收到的离散声音信号为 s(i)，环境噪声为n(i)*

*,*

*故得到检验门限*

*th=\sigma ^{2}\left ( N+\sqrt{2N}Q^{-1}\left ( P\_{f} \right ) \right )*

在未来，低能耗高性能芯片或ASIC也可以被用于传感器设计，以便更好地区分鸟鸣与背景噪声。

## 硬件设计

硬件设计是基于以上分析的

1 传感器子系统

传感器子系统设计如图，在经由滤波器与能量判决之后，信息帧将被送入MCU

2 Zigbee 模块

Zigbee模块可以使用cc2530

2 处理器系统

1. Sink node

本文

，本文传感器节点将使用

在Zigbee网关上，我们也可以尝试选择基于华为Harmony OS的一系列新产品，这是由于这些产品具有直连华为云的功能，可以方便为后续复杂分析提供云服务器环境。

在zigbee组网方面可以选择

cc2530

在音频处理方面，

### Sink node design

。

### Sensor Node Design

此外，本文为传感器的外壳设计了一种如图钩锁型结构，钩子由弹性材料构成。

这样一来，传感器节点可以和降落伞一起被低空无人机空投在森林中。在传感器飘落到树冠高处时，该钩子可以钩住树干。即使传感器掉落，其弹性结构也可以有效防碰撞。这样一来，既可以让传感器部署在高处以便更好地监听鸟鸣，也可以减少人力部署的成本。

## 软件设计

针对

styled.

对于sink node, 华为Harmony OS 可以作为其板载操作系统

## Equations

* Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as “3.5-inch disk drive”.
* Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.
* Do not mix complete spellings and abbreviations of units: “Wb/m2” or “webers per square meter”, not “webers/m2”. Spell out units when they appear in text: “. . . a few henries”, not “. . . a few H”.
* Use a zero before decimal points: “0.25”, not “.25”. Use “cm3”, not “cc”. (*bullet list*)

as in:

*a**b* 

## Some Common Mistakes

* The word “data” is plural, not singular.

An excellent style manual for science writers is [7].

# 网络架构

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

## 网络架构与部署

1.网络的架构如下，传感器可由低空无人机投放在树梢。在理想情况下，传感器会被挂在树杈上。

在被投放后，传感器经由自组网步骤自动组成Mesh拓扑结构，

以北京松山森林公园为例，如果

在被投放时，每个节点都将被写入其投放位置，这是因为鸟鸣监控本来就是位置不敏感的，所以在此假定传感器不需要高精度的定位。

## Mac 层设计

**本文中，MAC层协议**

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| **Frame control** | **Sequence number** | **Destination PAN identifier** | **Destination address** | **Source PAN identifier** | **Source address** | **Frame payload** | **Frame check squence** |
| **Addressing fields** | | | |
| **MAC header** | | | | | | **MAC payload** | **MAC footer** |

### For papers with more than six authors: Add author names horizontally, moving to a third row if needed for more than 8 authors.

### For papers with less than six authors: To change the default, adjust the template as follows.

#### Selection: Highlight all author and affiliation lines.

#### Change number of columns: Select the Columns icon from the MS Word Standard toolbar and then select the correct number of columns from the selection palette.

#### Deletion: Delete the author and affiliation lines for the extra authors.

## Network Layer

传感器节点被随机部署为一网状结构

基于Zigbee的拓扑协议

基于硬件设计，本传感器应该可以被无人机进行低空空投以部署在

以下以松山国家级自然保护区为例，估算传感器部署计划与预计成本。

因为各传感器主要是与Zigbee 网关进行通信，故路由协议设计如下：

## Figures and Tables

#### Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation “Fig. 1”, even at the beginning of a sentence.

1. Table Type Styles

| Table Head | Table Column Head | | |
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| Table column subhead | Subhead | Subhead |
| copy | More table copya |  |  |

1. Sample of a Table footnote. (*Table footnote*)
2. Example of a figure caption. (*figure caption*)

F

##### Acknowledgment *(Heading 5)*

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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